

NOVEL SULFONATE BENZAMIDE COMPOUNDS FOR CONTROLLING
INVERTEBRATE PESTS

5 CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 63/330,809 filed April 14, 2022.

10 FIELD

This disclosure relates to certain sulfonate benzamide compounds, their *N*-oxides, salts and compositions suitable for agronomic and nonagronomic uses, and methods of their use for controlling invertebrate pests such as arthropods in both agronomic and nonagronomic environments.

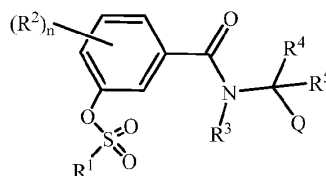
15 BACKGROUND

The control of invertebrate pests is extremely important in achieving high crop efficiency. Damage by invertebrate pests to growing and stored agronomic crops can cause significant reduction in productivity and thereby result in increased costs to the consumer. The control of invertebrate pests in forestry, greenhouse crops, ornamentals, nursery crops, stored
20 food and fiber products, livestock, household, turf, wood products, and public and animal health is also important. Many products are commercially available for these purposes, but the need continues for new compounds that are more effective, less costly, less toxic, environmentally safer or have different sites of action.

SUMMARY

25 This disclosure is directed to compounds of Formula 1 (including all geometric and stereoisomers), *N*-oxides, and salts thereof, and compositions containing them and their use for controlling invertebrate pests:

2



1

wherein

- R¹ is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₆ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is substituted with one or more R⁶; or
- 10 R¹ is phenyl optionally substituted with 1 to 3 R⁶, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and from 1 to 3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and up to 3 nitrogen atoms, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each 5- to 6-membered heteroaromatic ring is optionally substituted with one or more R⁶;
- 15 with the proviso that when R¹ is C₁-C₆ alkyl then R⁶ is other than C₁-C₆ alkyl ;
- R² is hydrogen, halogen, cyano, nitro; or
- R² is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₇ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶; or
- 20 R² is phenyl, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and from 1 to 3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and up to 3 nitrogen atoms, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each phenyl or heteroaromatic ring is optionally substituted with one or more R⁶; or
- 25 R² is C(O)R⁷, C(O)OR⁷, C(O)NR⁷R⁸, NR⁷R⁸, OR⁷, NHC(O)NR⁷R⁸, OC(O)R⁷, OC(O)OR⁷, S(O)_pR⁷, SO₂NR⁷R⁸, or OS(O)₂R⁹;
- R³ is hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₆ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶; or
- R³ is C(O)R⁷, C(O)OR⁷, NR⁷R⁸, OR⁷, S(O)_pR⁷ or SO₂NR⁷R⁸;
- 30 R⁴ is H, C₁-C₆ alkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₆ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶;
- R⁵ is hydrogen or C₁-C₄ alkyl; or R⁴ and R⁵ can be taken together to form a 3-6 membered carbocyclic ring;

R⁶ is halogen, cyano, nitro; or

R⁶ is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₇ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more X¹; or

R⁶ is phenyl, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and up to 3 nitrogen atoms, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, or a 3-to 6-membered non-aromatic heterocyclic ring containing ring members selected from carbon atoms and 1 to 5 heteroatoms independently selected from up to 2 oxygen, up to 2 sulfur, and up to 2 nitrogen atoms, wherein each phenyl, 5-to 6-membered heteroaromatic ring or 3-to 6-membered non-aromatic heterocyclic ring is optionally substituted with one or more X¹; or

R⁶ is C(O)R⁷, C(O)OR⁷, C(O)NR⁷R⁸, NR⁷R⁸, OR⁷, NHC(O)NR⁷R⁸, OC(O)R⁷, OC(O)OR⁷, S(O)pR⁷, SO₂NR⁷R⁸, or OS(O)₂R⁹;

R⁷ is hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₇ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶; or R⁷ is phenyl, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and up to 3 nitrogen atoms, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each phenyl or 5-to 6-membered heteroaromatic ring is optionally substituted with one or more R⁶;

R⁸ is hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, or C₂-C₆ alkynyl, wherein each alkyl, alkenyl, or alkynyl is optionally substituted with one or more R⁶;

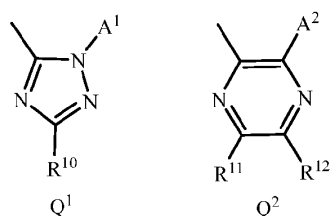
R⁹ is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₇ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶; or

R⁹ is phenyl, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and 1-3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and 1-3 nitrogen, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each phenyl or 5-to 6-membered heteroaromatic ring is optionally substituted with one or more R⁶;

n is 0-4;

p is 0-2;

Q is Q¹ or Q²;



- A¹ and A² are a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and 1-3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and 1-3 nitrogen, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each 5-to 6-membered heteroaromatic ring is optionally substituted with one or more R⁶;
- R¹⁰, R¹¹ and R¹² are hydrogen, halogen, cyano, nitro; or
- R¹⁰, R¹¹ and R¹² are C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₇ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶; or
- R¹⁰, R¹¹ and R¹² are phenyl optionally substituted with 1-3 R⁶, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and 1-3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and 1-3 nitrogen, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each 5-to 6-membered heteroaromatic ring is optionally substituted with one or more R⁶;
- or
- R¹⁰, R¹¹ and R¹² are C(O)R⁷, C(O)OR⁷, C(O)NR⁷R⁸, NR⁷R⁸, OR⁷, NHC(O)NR⁷R⁸, OC(O)R⁷, OC(O)OR⁷, S(O)_pR⁷, SO₂NR⁷R⁸, or OS(O)₂R⁹;
- X¹ is hydrogen, halogen, cyano, nitro, OH, CHO, CO₂H, CO(C₁-C₄ alkyl), CO₂(C₁-C₄ alkyl), C(O)NH(C₁-C₄ alkyl), C(O)N(C₁-C₄ alkyl)₂, NH(C₁-C₄ alkyl), N(C₁-C₄ alkyl)₂, O(C₁-C₄ alkyl), O(C₁-C₄ haloalkyl), NHC(O)NH(C₁-C₄ alkyl), NHC(O)N(C₁-C₄ alkyl)₂, OC(O)(C₁-C₄ alkyl), OCO₂(C₁-C₄ alkyl), S(O)_p(C₁-C₄ alkyl), S(O)_p(C₁-C₄ haloalkyl),

SO₂NH(C₁-C₄ alkyl), SO₂N(C₁-C₄ alkyl)₂, OS(O)₂(C₁-C₄ alkyl), OS(O)₂(C₁-C₄ haloalkyl); or

X¹ is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₃-C₇ cycloalkyl or C₄-C₈ cycloalkylalkyl; wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted

5 with one or more halogen, cyano, nitro, OH, CHO, CO₂H, CO(C₁-C₄ alkyl), CO₂(C₁-C₄ alkyl), C(O)NH(C₁-C₄ alkyl), C(O)N(C₁-C₄ alkyl)₂, NH(C₁-C₄ alkyl), N(C₁-C₄ alkyl)₂, O(C₁-C₄ alkyl), O(C₁-C₄ haloalkyl), NHC(O)NH(C₁-C₄ alkyl), NHC(O)N(C₁-C₄ alkyl)₂, OC(O)(C₁-C₄ alkyl), OCO₂(C₁-C₄ alkyl), S(O)_p(C₁-C₄ alkyl), S(O)_p(C₁-C₄ haloalkyl), SO₂NH(C₁-C₄ alkyl), SO₂N(C₁-C₄ alkyl)₂, or OS(O)₂(C₁-C₄ alkyl), OS(O)₂(C₁-C₄ haloalkyl); or

10 X¹ is phenyl, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and 1-3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and 1-3 nitrogen, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each phenyl or 5-to 6-membered

15 heteroaromatic ring is optionally substituted with one or more halogen, cyano, nitro, OH, CHO, CO₂H, CO(C₁-C₄ alkyl), CO₂(C₁-C₄ alkyl), C(O)NH(C₁-C₄ alkyl), C(O)N(C₁-C₄ alkyl)₂, NH(C₁-C₄ alkyl), N(C₁-C₄ alkyl)₂, O(C₁-C₄ alkyl), O(C₁-C₄ haloalkyl), NHC(O)NH(C₁-C₄ alkyl), NHC(O)N(C₁-C₄ alkyl)₂, OC(O)(C₁-C₄ alkyl), OCO₂(C₁-C₄ alkyl), S(O)_p(C₁-C₄ alkyl), S(O)_p(C₁-C₄ haloalkyl), SO₂NH(C₁-C₄ alkyl), SO₂N(C₁-C₄ alkyl)₂, or OS(O)₂(C₁-C₄ alkyl), OS(O)₂(C₁-C₄ haloalkyl).

20

This disclosure also provides a composition comprising a compound of Formula 1, an *N*-oxide or a salt thereof, and at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents. In one embodiment, this disclosure

25 also provides a composition for controlling an invertebrate pest comprising a compound of Formula 1, an *N*-oxide or a salt thereof, and at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents, said composition optionally further comprising at least one additional biologically active compound or agent.

This disclosure also provides a method for controlling an invertebrate pest comprising

30 contacting the invertebrate pest or its environment with a biologically effective amount of a compound of Formula 1, an *N*-oxide or a salt thereof, (e.g., as a composition described herein). This disclosure also relates to such method wherein the invertebrate pest or its environment is contacted with a composition comprising a biologically effective amount of a compound of Formula 1, an *N*-oxide or a salt thereof, and at least one additional component selected from

35 the group consisting of surfactants, solid diluents and liquid diluents, said composition

optionally further comprising a biologically effective amount of at least one additional biologically active compound or agent.

This disclosure also provides a method for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of any
5 of the aforesaid compositions wherein the environment is a plant.

This disclosure also provides a method for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of any of the aforesaid compositions wherein the environment is an animal.

This disclosure also provides a method for controlling an invertebrate pest comprising
10 contacting the invertebrate pest or its environment with a biologically effective amount of any of the aforesaid compositions wherein the environment is a seed.

This disclosure also provides a method for protecting a seed from an invertebrate pest comprising contacting the seed with a biologically effective amount of a compound of Formula **1**, an *N*-oxide or a salt thereof, (e.g., as a composition described herein). This disclosure also
15 relates to the treated seed (i.e. seed contacted with a compound of Formula **1**).

This disclosure also provides a method for increasing vigor of a crop plant comprising contacting the crop plant, the seed from which the crop plant is grown or the locus (e.g., growth medium) of the crop plant with a biologically effective amount of a compound of Formula **1** (e.g., as a composition described herein).

This disclosure further provides a method for protecting an animal from an invertebrate parasitic pest comprising administering to the animal a parasitically effective amount of a compound of Formula **1**, an *N*-oxide or a salt thereof, (e.g., as a composition described herein). This disclosure also provides for the use of a compound of Formula **1**, an *N*-oxide or a salt thereof, (e.g., as a composition described herein) in protecting an animal from an invertebrate
25 pest.

DETAILED DESCRIPTION

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

The transitional phrase “consisting of” excludes any element, step, or ingredient not specified. If in the claim, such would close the claim to the inclusion of materials other than those recited except for impurities ordinarily associated therewith. When the phrase “consisting of” appears in a clause of the body of a claim, rather than immediately following the preamble, it limits only the element set forth in that clause; other elements are not excluded from the claim as a whole.

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

Where applicants have defined an embodiment 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 embodiment 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 disclosure are intended to be nonrestrictive regarding the number of instances (i.e. occurrences) of the element or component. Therefore “a” or “an” should be read to include one or at least one, and the singular word form of the element or component also includes the plural unless the number is obviously meant to be singular.

As referred to in this disclosure, the term “invertebrate pest” includes arthropods, gastropods, nematodes and helminths of economic importance as pests. The term “arthropod” includes insects, mites, spiders, scorpions, centipedes, millipedes, pill bugs and symphylans. The term “gastropod” includes snails, slugs and other Stylommatophora. The term “nematode” includes members of the phylum Nematoda, such as phytophagous nematodes and helminth nematodes parasitizing animals. The term “helminth” includes all of the parasitic worms, such as roundworms (phylum Nematoda), heartworms (phylum Nematoda, class Secernentea), flukes (phylum Platyhelminthes, class Tematoda), acanthocephalans (phylum Acanthocephala), and tapeworms (phylum Platyhelminthes, class Cestoda).

In the context of this disclosure “invertebrate pest control” means inhibition of invertebrate pest development (including mortality, feeding reduction, and/or mating disruption), and related expressions are defined analogously.

5 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).

10 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.

15 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.

20 The term “biologically effective amount” refers to the amount of a biologically active compound (e.g., a compound of Formula 1) sufficient to produce the desired biological effect when applied to (i.e. contacted with) an invertebrate pest 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 invertebrate pest or for other desired effect (e.g., increasing plant vigor).

25 The term “biologically effective amount” refers to the amount of a biologically active compound (e.g., a compound of Formula 1) sufficient to produce the desired biological effect when applied to (i.e. contacted with) an invertebrate pest 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 invertebrate pest or for other desired effect (e.g., increasing plant vigor).

30 Nonagronomic applications include protecting an animal from an invertebrate parasitic pest by administering a parasitically effective (i.e. biologically effective) amount of a compound of the disclosure, typically in the form of a composition formulated for veterinary use, to the animal to be protected. As referred to in the present disclosure and claims, the terms “parasitidal” and “parasitically” refers to observable effects on an invertebrate parasite pest to provide protection of an animal from the pest. Parasitidal effects typically relate to diminishing the occurrence or activity of the target invertebrate parasitic pest. Such effects on the pest include necrosis, death, retarded growth, diminished mobility or lessened ability to remain on or in the host animal, reduced feeding and inhibition of reproduction.

35

These effects on invertebrate parasite pests provide control (including prevention, reduction or elimination) of parasitic infestation or infection of the animal.

A wavy line in a structure fragment denotes the attachment point of the fragment to the remainder of the molecule. For example, when the variable Q in Formula 1 is defined as Q-1, the wavy line bisecting the bond in Q-1 means that Q-1 is attached to the remainder of the structure of Formula 1 at said position.

In the above recitations, the term “alkyl”, used either alone or in compound words such as “alkylthio” or “haloalkyl” includes straight-chain or branched alkyl, such as, methyl, ethyl, *n*-propyl, *i*-propyl, or the different butyl, pentyl or hexyl isomers. “Alkenyl” includes straight-chain or branched alkenes such as ethenyl, 1-propenyl, 2-propenyl, and the different butenyl, pentenyl and hexenyl isomers. “Alkenyl” also includes polyenes such as 1,2-propadienyl and 2,4-hexadienyl. “Alkynyl” includes straight-chain or branched alkynes such as ethynyl, 1-propynyl, 2-propynyl and the different butynyl, pentynyl and hexynyl isomers. “Alkynyl” can also include moieties comprised of multiple triple bonds such as 2,5-hexadiynyl. “Alkylene” denotes a straight-chain or branched alkanediyl. Examples of “alkylene” include CH₂, CH₂CH₂, CH(CH₃), CH₂CH₂CH₂, CH₂CH(CH₃) and the different butylene isomers. “Alkenylene” denotes a straight-chain or branched alkenediyl containing one olefinic bond. Examples of “alkenylene” include CH=CH, CH₂CH=CH, CH=C(CH₃) and the different butenylene isomers. “Alkynylene” denotes a straight-chain or branched alkynediyl containing one triple bond. Examples of “alkynylene” include C≡C, CH₂C≡C, C≡CCH₂ and the different butynylene isomers.

“Alkylamino” includes an NH radical substituted with straight-chain or branched alkyl. Examples of “alkylamino” include CH₃CH₂NH, CH₃CH₂CH₂NH and (CH₃)₂CHNH. Examples of “dialkylamino” include (CH₃)₂N, (CH₃CH₂)₂N and CH₃CH₂(CH₃)N. “Alkenylamine” includes an NH radical substituted with straight-chain or branched alkenes. Examples of “Alkenylamine” include CH₂=CHNH, CH₃CH=C(CH₃)CH₂NH, (CH₃)₂CHCH=CHNH and the different butenylamine, pentenylamine and hexenylamine isomers. “Alkynylamine” includes an NH radical substituted with straight-chain or branched alkynes. Examples of “Alkynylamine” include HC≡CNH, CH₃C≡CCH₂NH, (CH₃)₂CHC≡CNH and the different butynylamine, pentynylamine and hexynylamine isomers.

“Alkoxy” includes, for example, methoxy, ethoxy, *n*-propyloxy, isopropyloxy and the different butoxy, pentoxy and hexyloxy isomers. “Alkoxyalkyl” denotes alkoxy substitution on alkyl. Examples of “alkoxyalkyl” include CH₃OCH₂, CH₃OCH₂CH₂, CH₃CH₂OCH₂, CH₃CH₂CH₂OCH₂ and CH₃CH₂OCH₂CH₂.

“Alkylthio” includes branched or straight-chain alkylthio moieties such as methylthio, ethylthio, and the different propylthio, butylthio, pentylthio and hexylthio isomers. “Alkylsulfinyl” includes both enantiomers of an alkylsulfinyl group. Examples of “alkylsulfinyl” include $\text{CH}_3\text{S(O)-}$, $\text{CH}_3\text{CH}_2\text{S(O)-}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{S(O)-}$, $(\text{CH}_3)_2\text{CHS(O)-}$ and the different butylsulfinyl, pentylsulfinyl and hexylsulfinyl isomers. Examples of “alkylsulfonyl” include $\text{CH}_3\text{S(O)}_2\text{-}$, $\text{CH}_3\text{CH}_2\text{S(O)}_2\text{-}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{S(O)}_2\text{-}$, $(\text{CH}_3)_2\text{CHS(O)}_2\text{-}$, and the different butylsulfonyl, pentylsulfonyl and hexylsulfonyl isomers. “Alkylthioalkyl” denotes alkylthio substitution on alkyl. Examples of “alkylthioalkyl” include CH_3SCH_2 , $\text{CH}_3\text{SCH}_2\text{CH}_2$, $\text{CH}_3\text{CH}_2\text{SCH}_2$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{SCH}_2$ and $\text{CH}_3\text{CH}_2\text{SCH}_2\text{CH}_2$.

“Alkylcarbonyl” denotes a straight-chain or branched alkyl moieties bonded to a C(=O) moiety. Examples of “alkylcarbonyl” include $\text{CH}_3\text{C(=O)-}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{C(=O)-}$ and $(\text{CH}_3)_2\text{CHC(=O)-}$. Examples of “alkoxycarbonyl” include $\text{CH}_3\text{OC(=O)-}$, $\text{CH}_3\text{CH}_2\text{OC(=O)-}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{OC(=O)-}$, $(\text{CH}_3)_2\text{CHOC(=O)-}$ and the different butoxycarbonyl, pentoxycarbonyl and hexoxycarbonyl isomers.

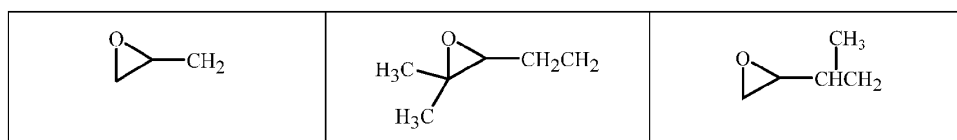
The term “alkylaminocarbonyl” denotes a straight-chain or branched alkylamino attached to and linked through a C(=O) group. Examples of “alkylaminocarbonyl” include $\text{CH}_3\text{NHC(=O)}$, $\text{CH}_3\text{CH}_2\text{NHC(=O)}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{NHC(=O)}$ and $(\text{CH}_3)_2\text{CHNHC(=O)}$. Examples of “dialkylaminocarbonyl” include $(\text{CH}_3)_2\text{NC(=O)}$, $(\text{CH}_3\text{CH}_2)_2\text{NC(=O)}$, $\text{CH}_3\text{CH}_2(\text{CH}_3)\text{NC(=O)}$ and $(\text{CH}_3)_2\text{CH}(\text{CH}_3)\text{NC(=O)}$. The term “alkenylaminocarbonyl” denotes a straight-chain or branched alkenylamino attached to and linked through a C(=O) group. Examples of “alkenylaminocarbonyl” include $\text{CH}_2=\text{CHNHC(=O)}$, $\text{CH}_3\text{CH}=\text{C}(\text{CH}_3)\text{CH}_2\text{NHC(=O)}$ and $(\text{CH}_3)_2\text{CHCH}=\text{CHNHC(=O)}$. The term “alkynylaminocarbonyl” denotes a straight-chain or branched alkynylamino attached to and linked through a C(=O) group. Examples of “alkynylaminocarbonyl” include $\text{HC}\equiv\text{CNHC(=O)}$, $\text{CH}_3\text{CH}\equiv\text{CCH}_2\text{NHC(=O)}$ and $(\text{CH}_3)_2\text{CHC}\equiv\text{CNHC(=O)}$.

“Cycloalkyl” includes, for example, cyclopropyl, cyclobutyl, cyclopentyl and cyclohexyl. The term “alkylcycloalkyl” denotes alkyl substitution on a cycloalkyl moiety and includes, for example, ethylcyclopropyl, *i*-propylcyclobutyl, 3-methylcyclopentyl and 4-methylcyclohexyl. The term “cycloalkylalkyl” denotes cycloalkyl substitution on an alkyl moiety. Examples of “cycloalkylalkyl” include cyclopropylmethyl, cyclopentylethyl, cyclohexylmethyl and other cycloalkyl moieties bonded to straight-chain or branched alkyl groups. The term “cycloalkoxy” denotes cycloalkyl linked through an oxygen atom such as cyclopentyloxy and cyclohexyloxy. “Cycloalkylamino” denotes an NH radical substituted with cycloalkyl. Examples of “cycloalkylamino” include cyclopropylamino and cyclohexylamino. “Cycloalkylaminocarbonyl” denotes cycloalkylamino bonded to a C(=O) group, for example, cyclopentylaminocarbonyl and cyclohexylaminocarbonyl.

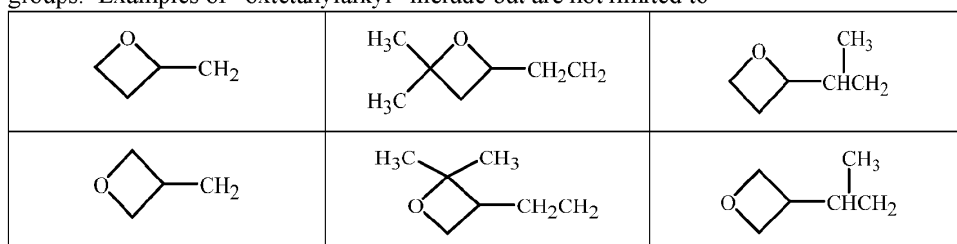
The term “halogen”, either alone or in compound words such as “haloalkyl”, or when used in descriptions such as “alkyl substituted with halogen” includes fluorine, chlorine, bromine or iodine. Further, when used in compound words such as “haloalkyl”, or when used in descriptions such as “alkyl substituted with halogen” said alkyl may be partially or fully substituted with halogen atoms which may be the same or different. Examples of “haloalkyl” or “alkyl substituted with halogen” include F_3C- , $ClCH_2-$, CF_3CH_2- and CF_3CCl_2- . The terms “halocycloalkyl”, “haloalkoxy”, “haloalkylthio”, “haloalkylcarbonyl”, “haloalkoxycarbonyl”, “haloalkylaminocarbonyl”, “halodialkylaminocarbonyl” and the like, are defined analogously to the term “haloalkyl”. Examples of “haloalkoxy” include CF_3O- , CCl_3CH_2O- , $HCF_2CH_2CH_2O-$ and CF_3CH_2O- . Examples of “haloalkylthio” include CCl_3S- , CF_3S- , CCl_3CH_2S- and $ClCH_2CH_2CH_2S-$. Examples of “haloalkylsulfinyl” include $CF_3S(O)-$, $CCl_3S(O)-$, $CF_3CH_2S(O)-$ and $CF_3CF_2S(O)-$. Examples of “haloalkylsulfonyl” include $CF_3S(O)_2-$, $CCl_3S(O)_2-$, $CF_3CH_2S(O)_2-$ and $CF_3CF_2S(O)_2-$.

The chemical abbreviations $S(O)$ and $S(=O)$ as used herein represent a sulfinyl moiety. The chemical abbreviations SO_2 , $S(O)_2$ and $S(=O)_2$ as used herein represent a sulfonyl moiety. The chemical abbreviations $C(O)$ and $C(=O)$ as used herein represent a carbonyl moiety. The chemical abbreviations $C(S)$ and $C(=S)$ as used herein represent a thiocarbonyl moiety. The chemical abbreviations CO_2 , $C(O)O$ and $C(=O)O$ as used herein represent an oxycarbonyl moiety. “CHO” means formyl.

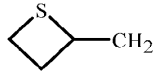
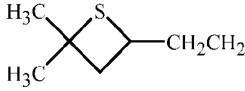
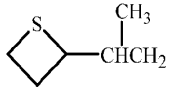
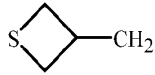
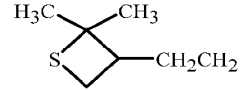
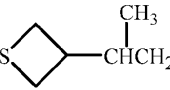
“Oxiranylalkyl” denotes oxirane substitution on straight-chain or branched alkyl groups. Examples of “oxiranylalkyl” include but are not limited to



“Oxetanylalkyl” denotes oxetane substitution on straight-chain or branched alkyl groups. Examples of “oxetanylalkyl” include but are not limited to



“Thietanylalkyl” denotes thietane substitution on straight-chain or branched alkyl groups. Examples of “thietanylalkyl” include but are not limited to

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 9. For example, C₁-C₄ alkylsulfonyl designates methylsulfonyl through butylsulfonyl; C₂ alkoxyalkyl designates CH₃OCH₂-; C₃ alkoxyalkyl designates, for example, CH₃CH(OCH₃)-, CH₃OCH₂CH₂- or CH₃CH₂OCH₂-; 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 CH₃CH₂CH₂OCH₂- and CH₃CH₂OCH₂CH₂-.

When a compound is substituted with a substituent bearing a subscript that indicates the number of said substituents can exceed 1, said substituents (when they exceed 1) are independently selected from the group of defined substituents, for example (R³)_m wherein m is 0, 1 or 2. When a group contains a substituent which can be hydrogen, for example R² or R¹², then when this substituent is taken as hydrogen, it is recognized that this is equivalent to said group being unsubstituted. When a variable group is shown to be optionally attached to a position, for example (R³)_m wherein m may be 0, then hydrogen may be at the position even if not recited in the variable group definition. When one or more positions on a group are said to be “not substituted” or “unsubstituted”, then hydrogen atoms are attached to take up any free valency.

Unless otherwise indicated, a “ring” or “ring system” as a component of Formula 1 (e.g., substituent Q¹) is carbocyclic or heterocyclic. The term “ring system” denotes two or more fused rings. The terms “bicyclic ring system” and “fused bicyclic ring system” denote a ring system consisting of two fused rings, which can be “ortho-fused”, “bridged bicyclic” or “spirobicyclic”. An “ortho-fused bicyclic ring system” denotes a ring system wherein the two constituent rings have two adjacent atoms in common. A “bridged bicyclic ring system” is formed by bonding a segment of one or more atoms to nonadjacent ring members of a ring. A “spirobicyclic ring system” is formed by bonding a segment of two or more atoms to the same ring member of a ring. The term “fused heterobicyclic ring system” denotes a fused bicyclic ring system in which at least one ring atom is not carbon. The term “ring member” refers to

an atom or other moiety (e.g., C(=O), C(=S), S(O) or S(O)₂) forming the backbone of a ring or ring system.

The terms “carbocyclic ring”, “carbocycle” or “carbocyclic ring system” denote a ring or ring system wherein the atoms forming the ring backbone are selected only from carbon.

- 5 The terms “heterocyclic ring”, “heterocycle” or “heterocyclic ring system” denote a ring or ring system in which at least one atom forming the ring backbone is not carbon, e.g., nitrogen, oxygen or sulfur. Typically a heterocyclic ring contains no more than 4 nitrogens, no more than 2 oxygens and no more than 2 sulfurs. Unless otherwise indicated, a carbocyclic ring or heterocyclic ring can be a saturated or unsaturated ring. “Saturated” refers to a ring having a backbone consisting of atoms linked to one another by single bonds; unless otherwise specified, the remaining atom valences are occupied by hydrogen atoms. Unless otherwise stated, an “unsaturated ring” may be partially unsaturated or fully unsaturated. The expression “fully unsaturated ring” means a ring of atoms in which the bonds between atoms in the ring are single or double bonds according to valence bond theory and furthermore the bonds between atoms in the ring include as many double bonds as possible without double bonds being cumulative (i.e. no C=C=C or C=C=N). The term “partially unsaturated ring” denotes a ring comprising at least one ring member bonded to an adjacent ring member through a double bond and which conceptually potentially accommodates a number of non-cumulated double bonds between adjacent ring members (i.e. in its fully unsaturated counterpart form) greater than the number of double bonds present (i.e. in its partially unsaturated form).

Unless otherwise indicated, heterocyclic rings and ring systems can be attached through any available carbon or nitrogen by replacement of a hydrogen on said carbon or nitrogen.

- 25 “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 in which $(4n + 2) \pi$ electrons, where *n* is a positive integer, are associated with the ring to comply with Hückel’s rule. The term “aromatic ring system” denotes a carbocyclic or heterocyclic ring system in which at least one ring of the ring system is aromatic. When a fully unsaturated carbocyclic ring satisfies Hückel’s rule, then said ring is also called an “aromatic ring” or “aromatic carbocyclic ring”. The term “aromatic carbocyclic ring system” denotes a carbocyclic ring system in which at least one ring of the ring system is aromatic. When a fully unsaturated heterocyclic ring satisfies Hückel’s rule, then said ring is also called a “heteroaromatic ring” or “aromatic heterocyclic ring”. The term “aromatic heterocyclic ring system” denotes a heterocyclic ring system in which at least one ring of the ring system is aromatic. The term “nonaromatic ring system” denotes a carbocyclic or heterocyclic ring system that may be fully saturated, as well as partially or fully unsaturated, provided that none of the rings in the ring system are aromatic.

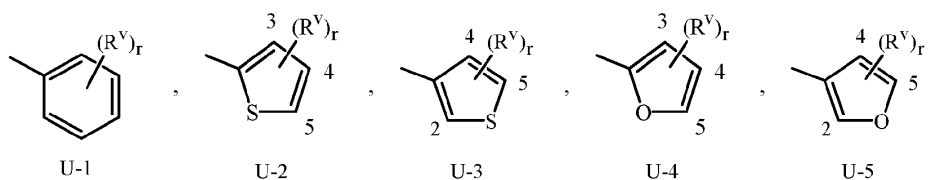
The term “nonaromatic carbocyclic ring system” denotes a carbocyclic ring in which no ring in the ring system is aromatic. The term “nonaromatic heterocyclic ring system” denotes a heterocyclic ring system in which no ring in the ring system is aromatic.

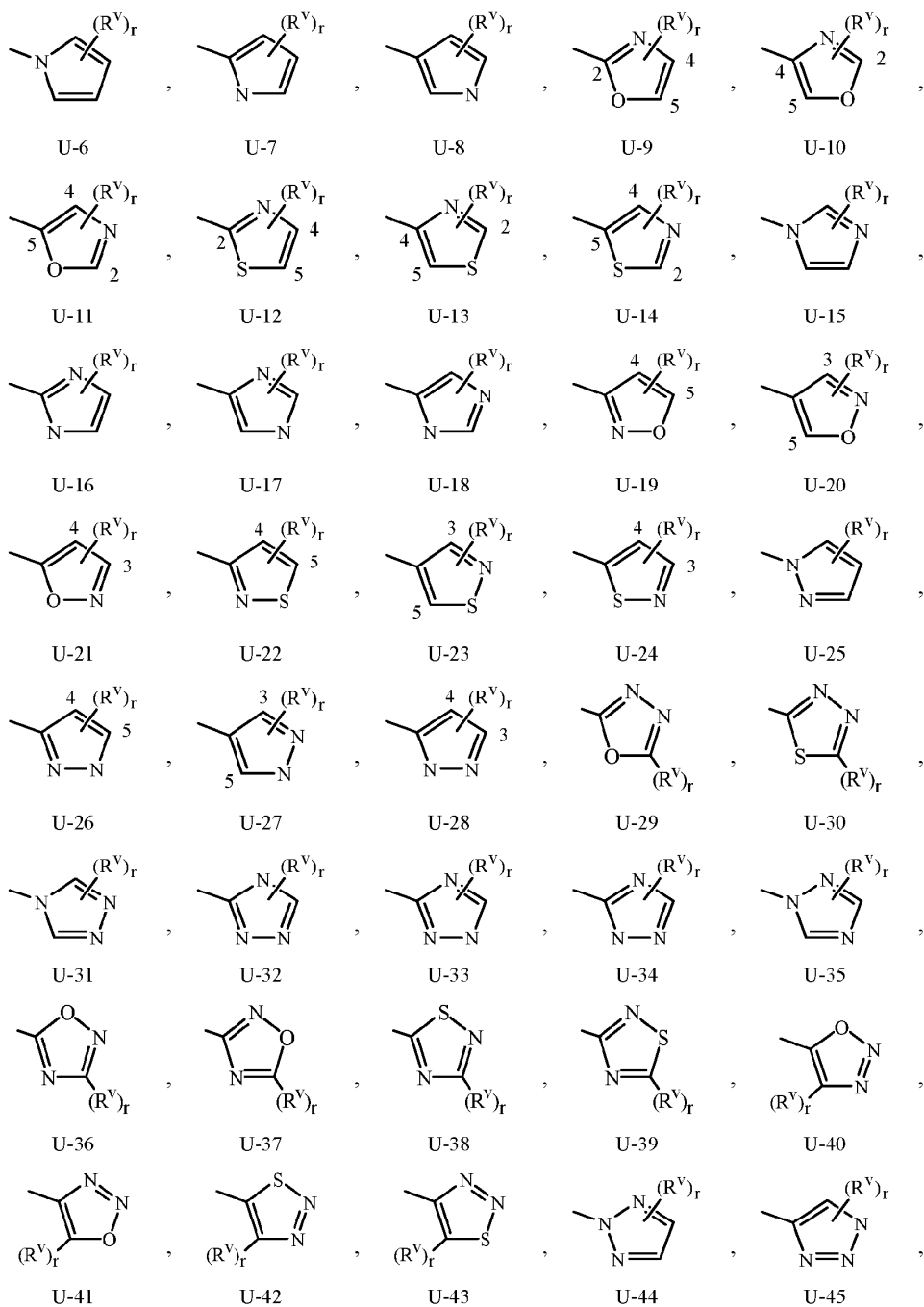
The term “optionally substituted” in connection with the heterocyclic rings refers to groups which are unsubstituted or have at least one non-hydrogen substituent that does not extinguish the biological activity possessed by the unsubstituted analog. As used herein, the following definitions shall apply unless otherwise indicated. The term “optionally substituted” is used interchangeably with the phrase “substituted or unsubstituted” or with the term “(un)substituted.” Unless otherwise indicated, an optionally substituted group may have a substituent at each substitutable position of the group, and each substitution is independent of the other.

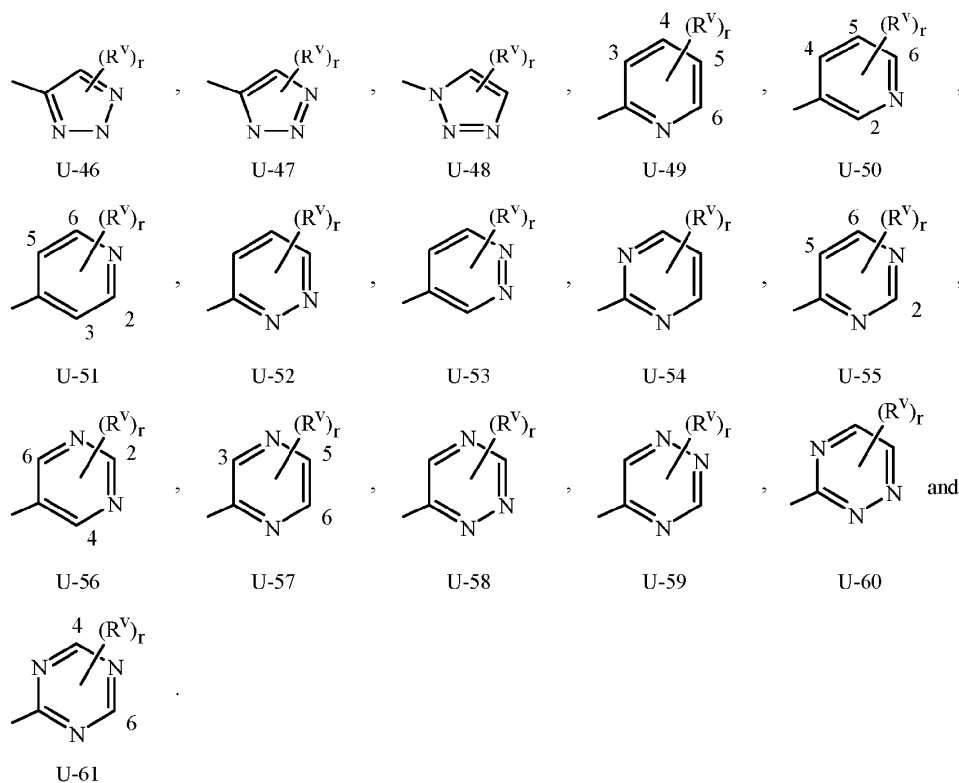
When a substituent such as for example R^1 is a 5- or 6-membered nitrogen-containing heterocyclic ring, it may be attached to the remainder of Formula 1 through any available carbon or nitrogen ring atom, unless otherwise described. As noted above, R^1 can be (among others) phenyl optionally substituted with 1 to 3 substituents selected from a group of substituents as defined in the Summary. An example of phenyl optionally substituted with one to 3 substituents is the ring illustrated as U-1 in Exhibit 1, wherein R^v is X^1 as defined in the Summary for R^1 and r is an integer from 0 to 5.

As noted above, R^1 can be (among others) 5- or 6-membered heterocyclic ring, which may be saturated or unsaturated, optionally substituted with one or more substituents selected from a group of substituents as defined in the Summary. Examples of a 5- or 6-membered unsaturated aromatic heterocyclic ring optionally substituted with from one or more substituents include the rings U-2 through U-61 illustrated in Exhibit 1 wherein R^v is any substituent as defined in the Summary for R^1 (i.e. R^6) and r is an integer from 0 to 4, limited by the number of available positions on each U group. As U-29, U-30, U-36, U-37, U-38, U-39, U-40, U-41, U-42 and U-43 have only one available position, for these U groups r is limited to the integers 0 or 1, and r being 0 means that the U group is unsubstituted and a hydrogen is present at the position indicated by $(R^v)_r$.

Exhibit 1







Note that when a substituent such as for example R^1 is a 3- or 6-membered saturated or unsaturated non-aromatic heterocyclic ring optionally substituted with one or more substituents selected from the group of substituents as defined in the Summary for R^1 , one or two carbon ring members of the heterocycle can optionally be in the oxidized form of a carbonyl moiety.

Examples of a 5- or 6-membered saturated or non-aromatic unsaturated heterocyclic ring include the rings T-1 through T-35 as illustrated in Exhibit 2. Note that when the attachment point on the T group is illustrated as floating, the T group can be attached to the remainder of Formula 1 through any available carbon or nitrogen of the T group by replacement of a hydrogen atom. The optional substituents corresponding to R^V can be attached to any available carbon or nitrogen by replacing a hydrogen atom. For these T rings, r is typically an integer from 0 to 4, limited by the number of available positions on each T group.

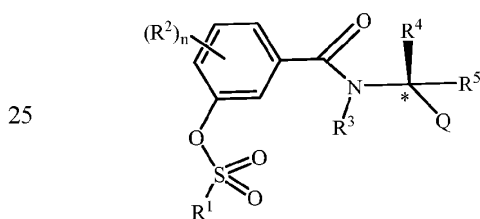
A wide variety of synthetic methods are known in the art to enable preparation of aromatic and nonaromatic heterocyclic rings and ring systems; for extensive reviews see the eight volume set of *Comprehensive Heterocyclic Chemistry*, A. R. Katritzky and C. W. Rees

editors-in-chief, Pergamon Press, Oxford, 1984 and the twelve volume set of *Comprehensive Heterocyclic Chemistry II*, A. R. Katritzky, C. W. Rees and E. F. V. Scriven editors-in-chief, Pergamon Press, Oxford, 1996.

Compounds of this disclosure 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-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.

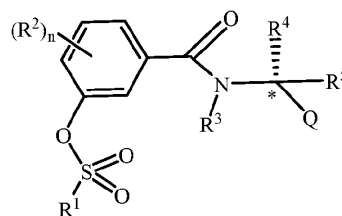
The compounds of the disclosure may be present as a mixture of stereoisomers or individual stereoisomers. For example, two possible enantiomers of Formula 1 are depicted as Formula 1' and Formula 1'' involving the chiral center identified the center bearing R⁴ with an asterisk (*). Compounds of Formula 1' refer to the (-) enantiomer at the center bearing R⁴ and Compounds of Formula 1'' refer to the (+) enantiomer at the center bearing R⁴.

20



25

Formula 1'



Formula 1''

Molecular depictions drawn herein follow standard conventions for depicting stereochemistry. To indicate stereoconfiguration, bonds rising from the plane of the drawing and towards the viewer are denoted by solid wedges wherein the broad end of the wedge is attached to the atom rising from the plane of the drawing towards the viewer. Bonds going below the plane of the drawing and away from the viewer are denoted by dashed wedges wherein the narrow end of the wedge is attached to the atom further away from the viewer.

35

This disclosure comprises racemic mixtures, for example, equal amounts of the enantiomers of Formulae **1'** and **1''**. In addition, this disclosure includes compounds that are enriched compared to the racemic mixture in an enantiomer of Formula **1**. Also included are the essentially pure enantiomers of compounds of Formula **1**, for example, Formula **1'** and Formula **1''**.

When enantiomerically enriched, one enantiomer is present in greater amounts than the other, and the extent of enrichment can be defined by an expression of enantiomeric excess ("ee"), which is defined as $(2x-1) \cdot 100\%$, where x is the mole fraction of the dominant enantiomer in the mixture (e.g., an ee of 20% corresponds to a 60:40 ratio of enantiomers). Preferably the compositions of this disclosure have at least a 50% enantiomeric excess; more preferably at least a 75% enantiomeric excess; still more preferably at least a 90% enantiomeric excess; and the most preferably at least a 94% enantiomeric excess of the more active isomer. Of particular note are enantiomerically pure embodiments of the more active isomer. This disclosure comprises racemic mixtures of equal amounts of the enantiomers of Formulae **1'** and **1''**. In addition, this disclosure includes mixtures that are enriched in the Formula **1'** enantiomer compared to the racemic mixture of Formulae **1'** and **1''**. This disclosure also comprises the essentially pure enantiomer of Formula **1'**.

An embodiment of this disclosure comprises mixtures of stereoisomers of the compounds of Formula **1'** and Formula **1''**, wherein the ratio of **1'** to **1''** is at least 75:25 (a 50% enantiomeric excess of **1'**).

An embodiment of this disclosure comprises mixtures of stereoisomers of the compounds of Formula **1'** and Formula **1''**, wherein the ratio of **1'** to **1''** is at least 90:10 (an 80% enantiomeric excess of **1'**).

An embodiment of this disclosure comprises mixtures of stereoisomers of the compounds of Formula **1'** and Formula **1''**, wherein the ratio of **1'** to **1''** is at least 95:5 (a 90% enantiomeric excess of **1'**).

An embodiment of this disclosure comprises mixtures of stereoisomers of the compounds of Formula **1'** and Formula **1''**, wherein the ratio of **1'** to **1''** is at least 98:2 (a 96% enantiomeric excess of **1'**).

An embodiment of this disclosure comprises mixtures of stereoisomers of the compounds of Formula **1'** and Formula **1''**, wherein the ratio of **1'** to **1''** is at least 99:1 (a 98% enantiomeric excess of **1'**).

An embodiment of this disclosure comprises mixtures of stereoisomers of the compounds of Formula **1'** and Formula **1''**, wherein the ratio of **1'** to **1''** is essentially 100:0.

An embodiment of this disclosure comprises the compounds of Formula **1'**.

In addition, this disclosure includes mixtures that are enriched in the Formula **1ⁱⁱ** enantiomer compared to the racemic mixture of Formulae **1ⁱⁱ** and **1ⁱ**. This disclosure also comprises the essentially pure enantiomer of Formula **1ⁱⁱ**.

5 An embodiment of this disclosure comprises mixtures of stereoisomers of the compounds of Formula **1ⁱⁱ** and Formula **1ⁱ**, wherein the ratio of **1ⁱⁱ** to **1ⁱ** is at least 75:25 (a 50% enantiomeric excess of **1ⁱⁱ**).

An embodiment of this disclosure comprises mixtures of stereoisomers of the compounds of Formula **1ⁱⁱ** and Formula **1ⁱ**, wherein the ratio of **1ⁱⁱ** to **1ⁱ** is at least 90:10 (an 80% enantiomeric excess of **1ⁱⁱ**).

10 An embodiment of this disclosure comprises mixtures of stereoisomers of the compounds of Formula **1ⁱⁱ** and Formula **1ⁱ**, wherein the ratio of **1ⁱⁱ** to **1ⁱ** is at least 95:5 (a 90% enantiomeric excess of **1ⁱⁱ**).

An embodiment of this disclosure comprises mixtures of stereoisomers of the compounds of Formula **1ⁱⁱ** and Formula **1ⁱ**, wherein the ratio of **1ⁱⁱ** to **1ⁱ** is at least 98:2 (a 96% enantiomeric excess of **1ⁱⁱ**).

15 An embodiment of this disclosure comprises mixtures of stereoisomers of the compounds of Formula **1ⁱⁱ** and Formula **1ⁱ**, wherein the ratio of **1ⁱⁱ** to **1ⁱ** is at least 99:1 (a 98% enantiomeric excess of **1ⁱⁱ**).

An embodiment of this disclosure comprises mixtures of stereoisomers of the compounds of Formula **1ⁱⁱ** and Formula **1ⁱ**, wherein the ratio of **1ⁱⁱ** to **1ⁱ** is essentially 100:0.

An embodiment of this disclosure comprises the compounds of Formula **1ⁱⁱ**.

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
25 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 3-chloroperbenzoic acid (MCPBA), hydrogen
30 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,
35 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.

5 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 invertebrate pests. The salts of the compounds of Formula 1 include acid-addition salts with inorganic or organic acids such as
10 hydrobromic, hydrochloric, nitric, phosphoric, sulfuric, acetic, butyric, fumaric, lactic, maleic, malonic, oxalic, propionic, salicylic, tartaric, 4-toluenesulfonic or valeric acids. When a compound of Formula 1 contains an acidic moiety such as a carboxylic acid or phenol, salts also include those formed with organic or inorganic bases such as pyridine, triethylamine or ammonia, or amides, hydrides, hydroxides or carbonates of sodium, potassium, lithium,
15 calcium, magnesium or barium. Accordingly, the present disclosure comprises compounds selected from Formula 1, *N*-oxides and suitable salts 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
20 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,
25 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,
30 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
35 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.

Compounds of this disclosure may exist as one or more crystalline polymorphs. This disclosure comprises both individual polymorphs and mixtures of polymorphs, including mixtures enriched in one polymorph relative to others. For a comprehensive discussion of polymorphism see R. Hilfiker, Ed., *Polymorphism in the Pharmaceutical Industry*, Wiley-VCH, Weinheim, 2006.

Embodiments of the present disclosure as described in the Summary 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 unless further defined in the Embodiments.

10 Embodiment 1. The compound of Formula 1 wherein

R¹ is C₁-C₆ alkyl, C₂-C₆ alkenyl, or C₂-C₆ alkynyl, wherein each alkyl, alkenyl, or alkynyl is substituted with one or more R⁶; or R¹ is phenyl optionally substituted with 1 to 3 R⁶; or R¹ is pyrimidine optionally substituted with one or more R⁶.

Embodiment 1a. The compound of Formula 1 or Embodiment 1, wherein R¹ is C₁-C₆ alkyl, or C₂-C₆ alkenyl, wherein each alkyl, or alkenyl, is substituted with one or more R⁶.

15 Embodiment 1b. The compound of Formula 1 or any of the preceding Embodiments, wherein R¹ is C₁-C₆ alkyl, wherein each C₁-C₆ alkyl is substituted with one or more R⁶.

Embodiment 1c. The compound of Formula 1 or any of the preceding Embodiments, wherein R¹ is C₁-C₄ alkyl wherein each C₁-C₄ alkyl is substituted with one or more halogen, cyano, nitro, C₃-C₆ cycloalkylalkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonate or C₁-C₄ haloalkylsulfonate;

25 Embodiment 1d. The compound of Formula 1 or any of the preceding Embodiments, wherein

R¹ is phenyl optionally substituted with 1-3 halogen, cyano, nitro, C₃-C₆ cycloalkylalkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl or C₁-C₄ haloalkylsulfonyl.

Embodiment 1d. The compound of Formula 1 or any of the preceding Embodiments, wherein R¹ is C₁-C₄ alkyl wherein each C₁-C₄ alkyl is substituted with one or more halogen.

- Embodiment 1e. The compound of Formula **1** or any one of the preceding Embodiments, wherein R^1 is CH_2 substituted with F, Cl, OCH_3 , CN, CO_2CH_3 .
- Embodiment 1f. A compound of Formula **1** or any of Embodiments 1-1d, wherein R^1 is CF_3 , CHF_2 , or CH_2F .
- 5 Embodiment 1f. The compound of Formula **1** or any one of Embodiments 1-1d or 1f, wherein R^1 is CF_3 .
- Embodiment 1g. The compound of Formula **1** or any of the preceding Embodiments, wherein R^1 is phenyl optionally substituted with phenyl optionally substituted with 1-3 halogen, cyano, CF_3 , OCH_3 or OCF_3 .
- 10 Embodiment 1h. The compound of Formula **1** or any of the preceding Embodiments, wherein phenyl optionally substituted with CH_3 , F, Cl, Br, OCH_3 , CN, NO_2 , CF_3 , or OCF_3 .
- Embodiment 1i. The compound of Formula **1** or any of the preceding Embodiments, wherein R^1 is pyrimidine optionally substituted with 1-3 halogen, cyano, CF_3 , OCH_3 or OCF_3 .
- 15 Embodiment 1j. The compound of Formula **1** or any of the preceding Embodiments, wherein R^1 is pyrimidine optionally substituted with CH_3 , F, Cl, Br, OCH_3 , CN, NO_2 , CF_3 , or OCF_3 .
- Embodiment 2. The compound of Formula **1** or any of the preceding Embodiments, wherein
- 20 R^2 is hydrogen, halogen, cyano, nitro; or
 R^2 is C_1 - C_6 alkyl wherein each C_1 - C_6 alkyl is optionally substituted with one or more R^6 ; or
 R^2 is $C(O)R^7$, $C(O)OR^7$, $C(O)NR^7R^8$, NR^7R^8 , OR^7 , $S(O)_pR^7$, $SO_2NR^7R^8$, or $OS(O)_2R^9$.
- 25 Embodiment 2a. The compound of Formula **1** or any one of any of the preceding Embodiments, wherein R^2 is halogen, cyano, nitro, C_1 - C_4 alkyl, C_1 - C_4 haloalkyl, C_1 - C_4 alkoxy, C_1 - C_4 haloalkoxy, C_1 - C_4 alkylamino, C_1 - C_4 dialkylamino, C_1 - C_4 alkylthio, C_1 - C_4 haloalkylthio, C_1 - C_4 alkylsulfinyl, C_1 - C_4 haloalkylsulfinyl, C_1 - C_4 alkylsulfinyl, C_1 - C_4 haloalkylsulfinyl, C_1 - C_4 alkylsulfonyl or C_1 - C_4 haloalkylsulfonyl.
- 30 Embodiment 2b. The compound of Formula **1** or any one of any of the preceding Embodiments, wherein R^2 is halogen, cyano, nitro, C_1 - C_4 alkyl, C_1 - C_4 haloalkyl, C_1 - C_4 alkoxy or C_1 - C_4 haloalkoxy.
- Embodiment 2c. The compound of Formula **1** or any one of any of the preceding
- 35 Embodiments, wherein R^2 is H, F, Cl, Br, cyano, CF_3 , or OCF_3 .

Embodiment 2d. The compound of Formula 1 or any of the preceding Embodiments, wherein R^2 is in the meta position.

Embodiment 3. The compound of Formula 1 or any of the preceding Embodiments, wherein R^3 is hydrogen, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, or C_3 - C_6 cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R^6 .

Embodiment 3a. The compound of Formula 1 or any of the preceding Embodiments, wherein R^3 is hydrogen, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, C_3 - C_6 cycloalkyl, or C_4 - C_7 alkylcycloalkyl wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R^6 .

Embodiment 3b. The compound of Formula 1 or any of the preceding Embodiments, wherein R^3 is hydrogen, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, C_3 - C_6 cycloalkyl, or C_4 - C_7 alkylcycloalkyl.

Embodiment 3c. The compound of Formula 1 or any of the preceding Embodiments, wherein R^3 is H, C_1 - C_4 alkyl, C_2 - C_6 alkylcycloalkyl.

Embodiment 3d. The compound of Formula 1 or any of the preceding Embodiments, wherein R^3 is H.

Embodiment 4. The compound of Formula 1 or any of the preceding Embodiments, wherein R^4 is H or C_1 - C_6 alkyl optionally substituted with one or more R^6 ;

Embodiment 4a. The compound of Formula 1 or any one of Embodiments 1-3d, wherein R^4 is C_1 - C_6 alkyl or C_3 - C_6 cycloalkyl.

Embodiment 4b. The compound of Formula 1 or any one of the preceding Embodiments, wherein R^4 is C_1 - C_3 alkyl.

Embodiment 4c. The compound of Formula 1 or any one of the preceding Embodiments, wherein R^4 is Me.

Embodiment 4d. The compound of Formula 1 or any one of the preceding Embodiments, wherein R^4 is H.

Embodiment 5. The compound of Formula 1 or any of the preceding Embodiments, wherein R^5 is H.

Embodiment 6. The compound of Formula 1 or any of the preceding Embodiments, wherein R^6 is C_1 - C_6 alkyl or C_3 - C_7 cycloalkyl, wherein each alkyl or cycloalkyl is optionally substituted with one or substituents selected from halogen, cyano, nitro, C_1 - C_4 alkyl, C_1 - C_4 haloalkyl, C_1 - C_4 alkoxy, C_1 - C_4 haloalkoxy, C_1 - C_4 alkylamino, C_1 - C_4 dialkylamino, C_1 - C_4 alkylthio, C_1 - C_4 haloalkylthio, C_1 - C_4 alkylsulfinyl, C_1 - C_4 haloalkylsulfinyl, C_1 - C_4 alkylsulfonyl, C_1 - C_4 haloalkylsulfonyl or C_1 - C_4 haloalkylsulfonyl.

Embodiment 6a. The compound of Formula 1 or any of the preceding Embodiments,

wherein R^6 is C_1-C_6 alkyl or C_3-C_7 cycloalkyl, wherein each alkyl or cycloalkyl is optionally substituted with one or more substituents selected from halogen, cyano, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_1-C_4 alkylamino, C_1-C_4 dialkylamino, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 haloalkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, or C_1-C_4 alkylsulfonyl.

Embodiment 6b. The compound of Formula 1 or any of the preceding Embodiments,

wherein R^6 is C_1-C_6 alkyl wherein each alkyl is optionally substituted with one or more substituents selected from halogen, cyano, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_1-C_4 alkylamino, C_1-C_4 dialkylamino, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 haloalkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, or C_1-C_4 alkylsulfonyl.

Embodiment 6b. The compound of Formula 1 or any of Embodiments 1-6a, wherein R^6 is

cycloalkyl optionally substituted with one or more substituents selected from halogen, cyano, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_1-C_4 alkylamino, C_1-C_4 dialkylamino, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 haloalkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, or C_1-C_4 alkylsulfonyl.

Embodiment 7. The compound of Formula 1 or any one of the preceding Embodiments,

wherein A^1 and A^2 are pyridine, pyrimidine, pyrazine or pyridazine optionally substituted with halogen, cyano, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_1-C_4 alkylamino, C_1-C_4 dialkylamino, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 haloalkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, $C(O)R^7$, $C(O)OR^7$, $C(O)NR^7R^8$, NR^7R^8 , OR^7 , $NHC(O)NR^7R^8$, $OC(O)R^7$, $OC(O)OR^7$, $S(O)pR^7$, $SO_2NR^7R^8$, or $OS(O)_2R^9$; R^{10} , R^{11} and R^{12} are hydrogen, halogen, cyano, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_1-C_4 alkylamino, C_1-C_4 dialkylamino, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 haloalkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylsulfonyl or C_1-C_4 haloalkylsulfonyl.

Embodiment 7a. The compound of Formula 1 or any one of the preceding Embodiments,

wherein A^1 and A^2 are pyridine, pyrimidine, pyrazine, pyridazine, or thiazole, optionally substituted with halogen, cyano, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_1-C_4 alkylamino, C_1-C_4 dialkylamino, C_1-C_4 alkylthio,

C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl; and

- 5 R¹⁰, R¹¹ and R¹² are hydrogen, halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl.

- 10 Embodiment 7b. The compound of Formula **1** or any one of the preceding Embodiments, wherein A¹ and A² are pyridine or pyrimidine, optionally substituted with halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy or C₁-C₄ haloalkoxy; and R¹⁰, R¹¹ and R¹² are hydrogen.

Embodiment 7c. The compound of Formula **1** or any one of the preceding Embodiments, wherein Q is Q¹.

- 15 Embodiment 7d. The compound of Formula **1** or any one of the preceding Embodiments, wherein Q is Q².

Embodiment 7e. The compound of Formula **1** or any of Embodiments 1-5c, wherein A¹ is pyridine, pyrimidine, pyrazine, pyridazine, or thiazole.

- 20 Embodiment 7f. The compound of Formula **1** or any of Embodiments 1-5c and 5e, wherein A¹ is pyridine, or pyrimidine.

Embodiment 7g. The compound of Formula **1** or any of Embodiments 1-5c and 5e-5f, wherein A¹ is pyridine.

Embodiment 7h. The compound of Formula **1** or any of Embodiments 1-5c and 5e-5f, wherein A¹ is pyrimidine.

- 25 Embodiment 7i. The compound of Formula **1** or any of Embodiments 1-5c, wherein A² is pyridine, pyrimidine, pyrazine, pyridazine, or thiazole.

Embodiment 7j. The compound of Formula **1** or any of Embodiments 1-5c and 5i, wherein A² is pyridine or pyrimidine.

- 30 Embodiment 7k. The compound of Formula **1** or any of Embodiments 1-5c and 5i-5j, wherein A² is pyridine.

Embodiment 7l. The compound of Formula **1** or any of Embodiments 1-5c and 5i-5k, wherein A² is pyrimidine.

Embodiment 8. The compound of Formula **1** or any of the preceding Embodiments, wherein the compound of Formula **1** is a compound of Formula **1'**.

- 35 Embodiment 8a. The compound of Formula **1** or any of Embodiments 1-7l, wherein the compound of Formula **1** is a compound of Formula **1''**.

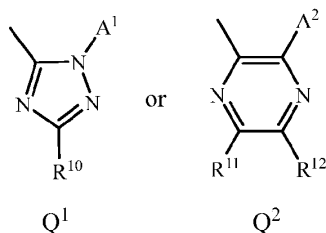
- Embodiment S1. The compound of any one of Embodiments 1-8a wherein the compound of Formula 1 is a compound of Formula 1'.
- Embodiment S2. The compound of any one of Embodiments 1-8a wherein the compound of Formula 1 is a compound of Formula 1''.
- Embodiment S3. The composition consisting of a compound of Formula 1' and a compound of Formula 1'' wherein the ratio of the compound of Formula 1' to the compound of Formula 1'' is greater than 60:40.
- Embodiment S3a. The composition of Embodiment S3 wherein the ratio of the compound of Formula 1' to the compound of Formula 1'' is greater than 80:20.
- Embodiment S3b. The composition of Embodiment S3 wherein the ratio of the compound of Formula 1' to the compound of Formula 1'' is greater than 90:10.
- Embodiment S3c. The composition of Embodiment S3 wherein the ratio of the compound of Formula 1' to the compound of Formula 1'' is greater than 99:1.
- Embodiment S4. The composition consisting of a compound of Formula 1'' and a compound of Formula 1' wherein the ratio of the compound of Formula 1'' to the compound of Formula 1' is greater than 60:40.
- Embodiment X. A method for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of a compound of Formula 1.
- Embodiment X1. The method of Claim X wherein the environment is soil or plant foliage.
- Embodiment X2. The method of Embodiment X or X1 wherein the compound of Formula 1 is a compound of Formula 1'.
- Embodiment X2. The method of Embodiment X or X1 wherein the compound of Formula 1 is a compound of Formula 1''.

Embodiments of this disclosure, including Embodiments 1-X2 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 disclosure, including Embodiments 1-X2 above as well as any other embodiments described herein, and any combination thereof, pertain to the compositions and methods of the present disclosure.

Combinations of Embodiments A1-C are illustrated by:

Embodiment A1. The compound of Formula 1 wherein

- R^1 is C_1 - C_6 alkyl wherein each alkyl is substituted with one or more R^6 ; or
 R^1 is phenyl optionally substituted with 1-3 R^6 ; or
 R^1 is pyrimidine optionally substituted with one or more R^6 ;
 R^2 is hydrogen, halogen, cyano, nitro; or
 R^2 is C_1 - C_6 alkyl wherein each C_1 - C_6 alkyl is optionally substituted with one or more R^6 ; or
 R^2 is $C(O)R^7$, $C(O)OR^7$, $C(O)NR^7R^8$, NR^7R^8 , OR^7 , $S(O)_pR^7$, $SO_2NR^7R^8$, or $OS(O)_2R^9$;
 R^3 hydrogen, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, or C_3 - C_6 cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R^6 ;
 R^4 is H or C_1 - C_6 alkyl optionally substituted with one or more R^6 ;
 R^5 is hydrogen;
 R^6 is halogen, cyano, nitro, CN, $C(O)R^7$, $C(O)OR^7$, $C(O)NR^7R^8$, NR^7R^8 , OR^7 , $NHC(O)NR^7R^8$, $OC(O)R^7$, $OC(O)OR^7$, $S(O)_pR^7$, $SO_2NR^7R^8$, $OS(O)_2R^9$, or
 R^6 is C_1 - C_6 alkyl or C_3 - C_7 cycloalkyl, wherein each alkyl or cycloalkyl is optionally substituted with one or substituents selected from, halogen, cyano, nitro, C_1 - C_4 alkyl, C_1 - C_4 haloalkyl, C_1 - C_4 alkoxy, C_1 - C_4 haloalkoxy, C_1 - C_4 alkylamino, C_1 - C_4 dialkylamino, C_1 - C_4 alkylthio, C_1 - C_4 haloalkylthio, C_1 - C_4 alkylsulfinyl, C_1 - C_4 haloalkylsulfinyl, C_1 - C_4 alkylsulfonyl, C_1 - C_4 haloalkylsulfonyl, C_1 - C_4 alkylsulfonyl or C_1 - C_4 haloalkylsulfonyl;
 R^7 , R^8 and R^9 are hydrogen, C_1 - C_4 alkyl or C_1 - C_4 haloalkyl;
 Q is



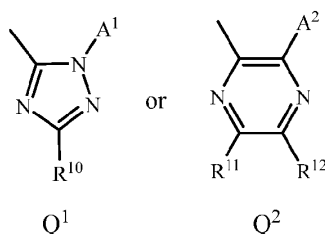
- A^1 and A^2 are pyridine, pyrimidine, pyrazine, pyridazine, or thiazole optionally substituted with halogen, cyano, nitro, C_1 - C_4 alkyl, C_1 - C_4 haloalkyl, C_1 - C_4 alkoxy, C_1 - C_4 haloalkoxy, C_1 - C_4 alkylamino, C_1 - C_4 dialkylamino, C_1 - C_4 alkylthio, C_1 - C_4 haloalkylthio, C_1 - C_4 alkylsulfinyl, C_1 - C_4 haloalkylsulfinyl, C_1 - C_4 alkylsulfonyl, C_1 - C_4 haloalkylsulfonyl,

alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl;

R¹⁰, R¹¹ and R¹² are hydrogen, halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl or C₁-C₄ haloalkylsulfonyl.

Embodiment A2. The compound of Formula 1 or Embodiment A1, wherein

R¹ is C₁-C₆ alkyl wherein each alkyl is substituted with one or more R⁶; or
 R¹ is phenyl optionally substituted with 1-3 R⁶;
 R² is hydrogen, halogen, cyano, nitro; or
 R² is C₁-C₆ alkyl wherein each C₁-C₆ alkyl is optionally substituted with one or more R⁶; or
 R² is C(O)R⁷, C(O)OR⁷, C(O)NR⁷R⁸, NR⁷R⁸, OR⁷, S(O)_pR⁷, SO₂NR⁷R⁸, or OS(O)₂R⁹;
 R³ hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₆ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶;
 R⁴ is H or C₁-C₆ alkyl optionally substituted with one or more R⁶;
 R⁵ is hydrogen;
 R⁶ is halogen, cyano, nitro, CN, C(O)R⁷, C(O)OR⁷, C(O)NR⁷R⁸, NR⁷R⁸, OR⁷, NHC(O)NR⁷R⁸, OC(O)R⁷, OC(O)OR⁷, S(O)_pR⁷, SO₂NR⁷R⁸, OS(O)₂R⁹, or R⁶ is C₁-C₆ alkyl or C₃-C₇ cycloalkyl, wherein each alkyl or cycloalkyl is optionally substituted with one or substituents selected from , halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl or C₁-C₄ haloalkylsulfonyl;
 R⁷, R⁸ and R⁹ are hydrogen, C₁-C₄ alkyl or C₁-C₄ haloalkyl;
 Q is



A¹ and A² are pyridine, pyrimidine, pyrazine, pyridazine, or thiazole optionally substituted with halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl;
 R¹⁰, R¹¹ and R¹² are hydrogen, halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl.

Embodiment A3. The compound of Formula 1 wherein

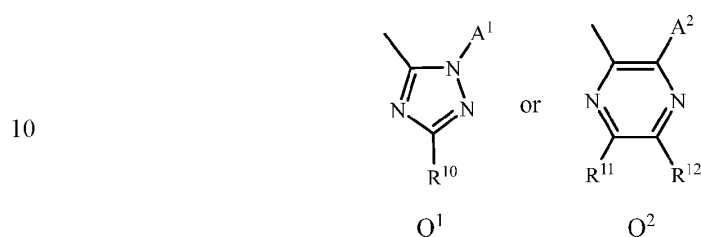
R¹ is C₁-C₄ alkyl wherein each alkyl is substituted with one or more halogen, cyano, nitro, C₃-C₆ cycloalkylalkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonate or C₁-C₄ haloalkylsulfonate; or
 R¹ is phenyl optionally substituted with 1-3 halogen, cyano, nitro, C₃-C₆ cycloalkylalkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl;
 R² is halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl;

R³ is hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₃-C₆ cycloalkyl, or C₄-C₇ alkylcycloalkyl wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶;

R⁴ is H, C₁-C₆ alkyl or C₃-C₆ cycloalkyl;

5 R⁵ is hydrogen;

Q is



15 A¹ and A² are pyridine, pyrimidine, pyrazine, pyridazine, or thiazole optionally substituted with halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl;

20 R¹⁰, R¹¹ and R¹² are hydrogen, halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl;

Embodiment A4. A compound of Formula 1 wherein

25 R¹ is CF₃, or phenyl optionally substituted with 1-3 halogen, cyano, CF₃, OCH₃ or OCF₃;

R² is halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy or C₁-C₄ haloalkoxy;

30 R³ is hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₃-C₆ cycloalkyl, or C₄-C₇ alkylcycloalkyl;

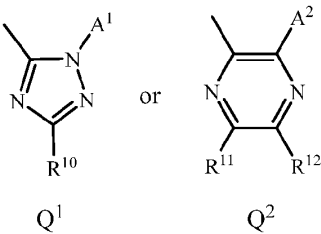
R⁴ is C₁-C₃ alkyl;

R⁵ is hydrogen;

Q is

31

5



10 A^1 and A^2 are pyridine or pyrimidine, optionally substituted with halogen, cyano, nitro, C_1 - C_4 alkyl, C_1 - C_4 haloalkyl, C_1 - C_4 alkoxy or C_1 - C_4 haloalkoxy; R^{10} , R^{11} and R^{12} are hydrogen.

Embodiment B. A compound of any one of Embodiments A-A3 wherein the compound of Formula 1 is Formula 1'.

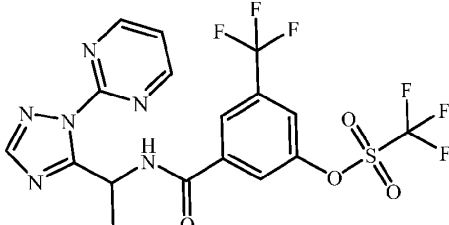
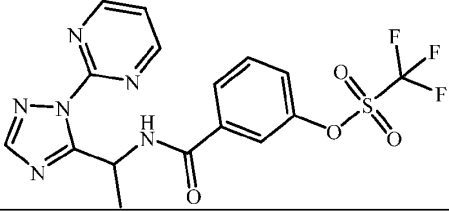
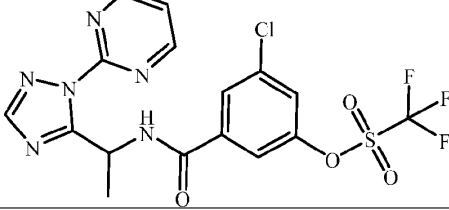
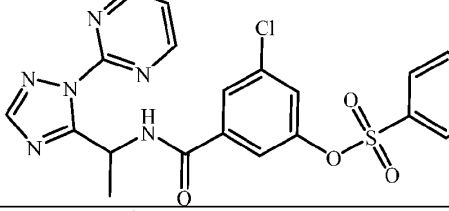
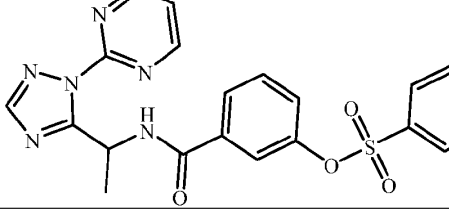
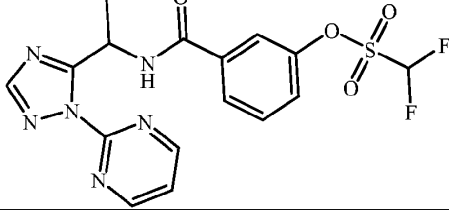
15 Embodiment C. A compound of any one of Embodiments A-A3 wherein the compound of Formula 1 is Formula 1''.

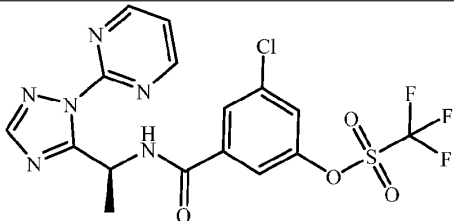
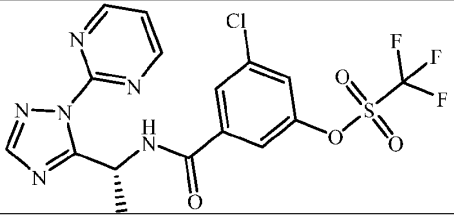
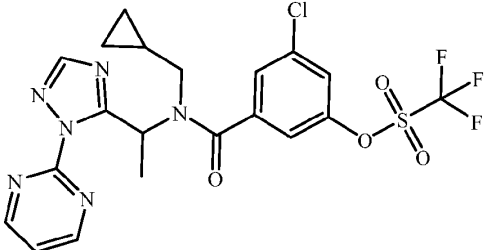
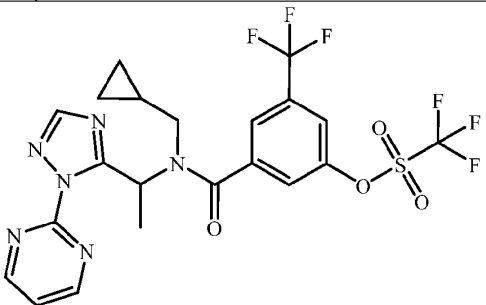
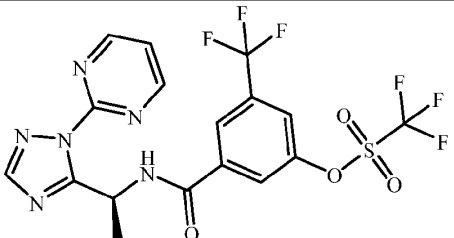
Specific embodiments of the disclosure include compounds selected from the group consisting of as depicted in Table 1:

20

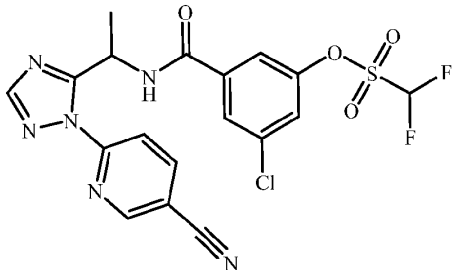
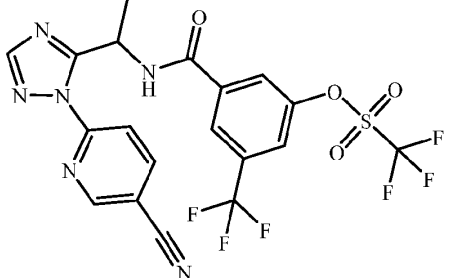
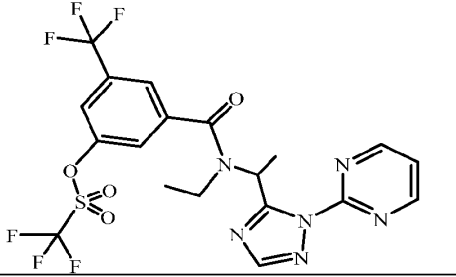
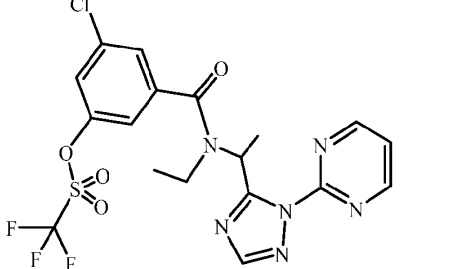
Table 1

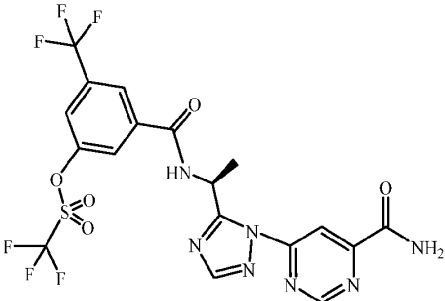
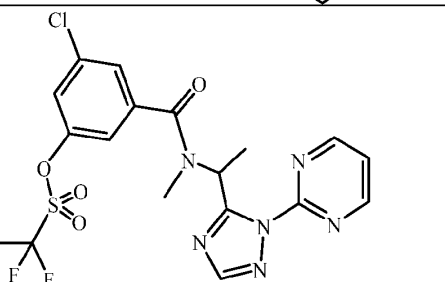
Compound	Structure	Chemical Name
1		3-[(Phenylsulfonyl)oxy]-N-[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]-5-(trifluoromethyl)benzamide

2		3-[[[1-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate
3		3-[[[1-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate
4		3-Chloro-5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate
5		3-Chloro-5-[(phenylsulfonyl)oxy]-N-[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]benzamide
6		3-[(Phenylsulfonyl)oxy]-N-[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]benzamide
7		3-[[[1-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1-difluoromethanesulfonate

8		3-Chloro-5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate; (-) enantiomer
9		3-Chloro-5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate; (+) enantiomer
10		3-Chloro-5-[(cyclopropylmethyl)[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate
11		3-[(cyclopropylmethyl)[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate
12		3-[[[(1S)-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate; (-) enantiomer

13		(R)-3-[[[1-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate; (+) enantiomer
14		3-Fluoro-5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate
15		3-Bromo-5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate
16		1,1'-[5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-1,3-phenylene] bis(1,1,1-trifluoromethanesulfonate)
17		3-[[[1-[1-(5-Cyano-2-pyridinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1-difluoromethanesulfonate

18		3-Chloro-5-[[[1-[1-(5-cyano-2-pyridinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1-difluoromethanesulfonate
19		3-[[[1-[1-(5-cyano-2-pyridinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate
27		3-[[ethyl[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate
50		3-chloro-5-[[ethyl[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate

71		3-[[[(1S)-1-[1-[6-(Aminocarbonyl)-4-pyrimidinyl]-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate
72		3-chloro-5-[[methyl[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate

Embodiment Y1. A composition comprising a compound of Formula 1 or any one of the preceding embodiments and at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents, said composition optionally further comprising at least one additional biologically active compound or agent.

Embodiment Y2. The composition of embodiment Y1 wherein the at least one additional biologically active compound or agent is selected from the group consisting of abamectin, acephate, acequinocyl, acetamiprid, acrinathrin, afidopyropen, amidoflumet, amitraz, avermectin, azadirachtin, azinphos-methyl, benfuracarb, bensultap, bifenthrin, bifenazate, bistrifluron, borate, bromantraniliprole, buprofezin, carbaryl, carbofuran, cartap, carzol, chlorantraniliprole, chlorfenapyr, chlorfluazuron, chlorpyrifos, chlorpyrifos-methyl, chromafenozide, clofentezin, clothianidin, cyantraniliprole, cyclaniliprole, cycloprothrin, cycloxaprid, cyflumetofen, cyfluthrin, beta-cyfluthrin, cyhalodiamide, cyhalothrin, gamma-cyhalothrin, lambda-cyhalothrin, cypermethrin, alpha-cypermethrin, zeta-cypermethrin, cyromazine, deltamethrin, diafenthiuron, diazinon, dichlorantraniliprole, dieldrin, diflubenzuron, dimefluthrin, dimehypo, dimethoate, dinotefuran, diofenolan, emamectin, endosulfan, esfenvalerate, ethiprole, etofenprox, etoxazole, fenbutatin oxide, fenitrothion, fenothiocarb, fenoxycarb, fenpropathrin, fenvalerate, fipronil, flometoquin, flonicamid, flubendiamide, flucythrinate, flufenerim, flufenoxuron,

flufenoxystrobin, fluensulfone, fluopyram, flupyradifurone, fluvalinate, tau-fluvalinate,
 fonophos, formetanate, fosthiazate, halofenozide, heptafluthrin, hexaflumuron,
 hexythiazox, hydramethylnon, imidacloprid, indoxacarb, insecticidal soaps,
 isofenphos, lufenuron, malathion, meperfluthrin, metaflumizone, metaldehyde,
 5 methamidophos, methidathion, methiocarb, methomyl, methoprene,
 methoxychlor, methoxyfenozide, metofluthrin, monocrotophos, monofluorothrin,
 nicotine, *N*-[1,1-dimethyl-2-(methylthio)ethyl]-7-fluoro-2-(3-pyridinyl)-2*H*-
 indazole-4-carboxamide, *N*-[1,1-dimethyl-2-(methylsulfinyl)ethyl]-7-fluoro-2-(3-
 pyridinyl)-2*H*-indazole-4-carboxamide, *N*-[1,1-dimethyl-2-(methylsulfonyl)ethyl]-7-
 10 fluoro-2-(3-pyridinyl)-2*H*-indazole-4-carboxamide, *N*-(1-methylcyclopropyl)-2-(3-
 pyridinyl)-2*H*-indazole-4-carboxamide, *N*-[1-(difluoromethyl)cyclopropyl]-2-(3-
 pyridinyl)-2*H*-indazole-4-carboxamide, nitenpyram, nithiazine, novaluron,
 noviflumuron, oxamyl, parathion, parathion-methyl, permethrin, phorate, phosalone,
 phosmet, phosphamidon, pirimicarb, profenofos, profluthrin, propargite,
 15 protriflubenbut, pyflubumide, pymetrozine, pyrafluprole, pyrethrin, pyridaben, pyridalyl,
 pyrifluquinazon, pyriminostrobin, pyriprole, pyriproxifen, rotenone, ryanodine,
 silafluofen, spinetoram, spinosad, spirotetramat, sulprofos,
 sulfoxaflor, tebufenozide, tebufenpyrad, teflubenzuron, tefluthrin,
 tetrachlorantraniliprole, tetrachlorvinphos, tetramethrin, tetramethylfluthrin,
 20 thiachlorid, thiamethoxam, thiodicarb, thiosultap-sodium, tioazafen, tolfenpyrad,
 tralometrin, triazamate, trichlorfon, triflumezopyrim, triflumuron, *Bacillus*
thuringiensis delta-endotoxins, entomopathogenic bacteria, entomopathogenic
 viruses and entomopathogenic fungi.

Embodiment Y3. The composition of embodiment Y2 wherein the at least one additional
 25 biologically active compound or agent is selected from the group consisting of
 abamectin, acetamiprid, acrinathrin, afidopyropen, amitraz, avermectin,
 azadirachtin, benfuracarb, bensultap, bifenthrin, buprofezin, carbaryl, cartap,
 chlorantraniliprole, chlorfenapyr, chlorpyrifos, clothianidin, cyantraniliprole,
 cyclaniliprole, cycloprothrin, cyfluthrin, beta- cyfluthrin, cyhalothrin, gamma-
 30 cyhalothrin, lambda-cyhalothrin, cypermethrin, alpha-cypermethrin, zeta-cypermethrin,
 cyromazine, deltamethrin, dieldrin, dinotefuran, diofenolan, emamectin,
 endosulfan, esfenvalerate, ethiprole, etofenprox, etoxazole, fenitrothion,
 fenothiocarb, fenoxycarb, fenvalerate, fipronil, flometoquin, flonicamid,
 flubendiamide, flufenoxuron, flufenoxystrobin, fluensulfone, flupiprole,
 35 flupyradifurone, fluvalinate, formetanate, fosthiazate, heptafluthrin,
 hexaflumuron, hydramethylnon, imidacloprid, indoxacarb, lufenuron,

- meperfluthrin, metaflumizone, methiocarb, methomyl, methoprene, methoxyfenozide, metofluthrin, monofluorothrin, nitenpyram, nithiazine, novaluron, oxamyl, pyflubumide, pymetrozine, pyrethrin, pyridaben, pyridalyl, pyriminostrobin, pyriproxyfen, ryanodine, spinetoram, spinosad, spirotetramat, sulfoxaflor, tebufenozide, tetramethrin, tetramethylfluthrin, thiacloprid, thiamethoxam, thiodicarb, thiosultap-sodium, tralomethrin, triazamate, triflumezopyrim, triflumuron, *Bacillus thuringiensis* delta-endotoxins, all strains of *Bacillus thuringiensis* and all strains of nuclear polyhedrosis viruses.
- 5 Embodiment Y4. The composition of any one of embodiments Y1-Y3 further comprising a liquid fertilizer.
- 10 Embodiment Y5. The composition of Embodiment Y4 wherein the liquid fertilizer is aqueous-based.
- Embodiment Y6. A soil drench formulation comprising the composition of any one of embodiments Y1-Y3.
- 15 Embodiment Y7. A spray composition comprising the composition of any one of embodiments Y1-Y3 and a propellant.
- Embodiment Y8. A bait composition, comprising the composition of any one of embodiments Y1-Y3, one or more food materials, optionally an attractant, and optionally a humectant.
- 20 Embodiment Y9. A trap device for controlling an invertebrate pest, comprising: the bait composition of Embodiment Y8 and a housing adapted to receive said bait composition, wherein the housing has at least one opening sized to permit the invertebrate pest to pass through the opening so the invertebrate pest can gain access to said bait composition from a location outside the housing, and wherein the housing is further adapted to be placed in or near a locus of potential or known activity for the invertebrate pest.
- 25 Embodiment Y10. A composition comprising the composition of any of Embodiments Y1-Y3 wherein the composition is a solid composition selected from dusts, powders, granules, pellets, prills, pastilles, tablets, and filled films.
- Embodiment Y11. The composition of Embodiment Y10 wherein the composition is water-dispersible or water-soluble.
- 30 Embodiment Y12. A liquid or dry formulation comprising the composition of any one of Embodiments Y1-Y3 for use in a drip irrigation system, furrow during planting, handheld sprayer, backpack sprayer, boom sprayer, ground sprayer, aerial application, unmanned aerial vehicle, or a seed treatment.

Embodiment Y13. The liquid or dry formulation of Embodiment Y12 wherein said formulation is sprayed at an ultra-low volume.

Of note is that compounds of this disclosure are characterized by favorable metabolic
5 and/or soil residual patterns and exhibit activity controlling a spectrum of agronomic and nonagronomic invertebrate pests.

Of particular note, for reasons of invertebrate pest control spectrum and economic importance, protection of agronomic crops from damage or injury caused by invertebrate pests by controlling invertebrate pests are embodiments of the disclosure. Compounds of this
10 disclosure because of their favorable translocation properties or systemicity in plants also protect foliar or other plant parts which are not directly contacted with a compound of Formula 1 or a composition comprising the compound.

Also noteworthy as embodiments of the present disclosure are compositions comprising a compound of any of the preceding Embodiments, as well as any other embodiments
15 described herein, and any combinations thereof, and at least one additional component selected from the group consisting of a surfactant, a solid diluent and a liquid diluent, said compositions optionally further comprising at least one additional biologically active compound or agent.

Further noteworthy as embodiments of the present disclosure are compositions for controlling an invertebrate pest comprising a compound of any of the preceding Embodiments,
20 as well as any other embodiments described herein, and any combinations thereof, and at least one additional component selected from the group consisting of a surfactant, a solid diluent and a liquid diluent, said compositions optionally further comprising at least one additional biologically active compound or agent. Embodiments of the disclosure further include methods for controlling an invertebrate pest comprising contacting the invertebrate pest or its
25 environment with a biologically effective amount of a compound of any of the preceding Embodiments (e.g., as a composition described herein).

Embodiments of the disclosure also include a composition comprising a compound of any of the preceding Embodiments, in the form of a soil drench liquid formulation. Embodiments of the disclosure further include methods for controlling an invertebrate pest
30 comprising contacting the soil with a liquid composition as a soil drench comprising a biologically effective amount of a compound of any of the preceding Embodiments.

Embodiments of the disclosure also include a spray composition for controlling an invertebrate pest comprising a biologically effective amount of a compound of any of the preceding Embodiments and a propellant. Embodiments of the disclosure further include a
35 bait composition for controlling an invertebrate pest comprising a biologically effective

amount of a compound of any of the preceding Embodiments, one or more food materials, optionally an attractant, and optionally a humectant. Embodiments of the disclosure also include a device for controlling an invertebrate pest comprising said bait composition and a housing adapted to receive said bait composition, wherein the housing has at least one opening
5 sized to permit the invertebrate pest to pass through the opening so the invertebrate pest can gain access to said bait composition from a location outside the housing, and wherein the housing is further adapted to be placed in or near a locus of potential or known activity for the invertebrate pest.

Embodiments of the disclosure also include methods for protecting a seed from an
10 invertebrate pest comprising contacting the seed with a biologically effective amount of a compound of any of the preceding Embodiments.

Embodiments of the disclosure also include methods for protecting an animal from an invertebrate parasitic pest comprising administering to the animal a parasitically effective amount of a compound of any of the preceding Embodiments.

Embodiments of the disclosure also include methods for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of a compound of Formula 1, an *N*-oxide or a salt thereof, (e.g., as a composition described herein), provided that the methods are not methods of medical treatment of a human
15 or animal body by therapy.

This disclosure also relates to such methods wherein the invertebrate pest or its environment is contacted with a composition comprising a biologically effective amount of a compound of Formula 1, an *N*-oxide or a salt thereof, and at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents, said composition optionally further comprising a biologically effective amount of at least one
25 additional biologically active compound or agent, provided that the methods are not methods of medical treatment of a human or animal body by therapy.

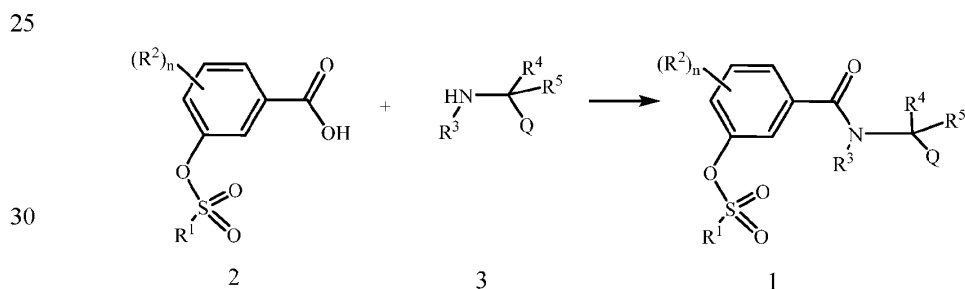
Embodiments of this disclosure also include use of an unmanned aerial vehicle (UAV) for the dispersion of the compositions disclosed herein over a planted area. In some embodiments the planted area is a crop-containing area. In some embodiments, the crop is
30 selected from a monocot or dicot. In some 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
35 (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).

The compounds of Formula **1** can be prepared by one or more of the following methods and variations as described in Schemes 1–6. The definitions of substituents in the compounds of Formulae **1–13** below are as defined above in the Summary unless otherwise noted. Compounds of Formulae **1a** and **1b** are subsets of the compounds of Formula **1**. Substituents for each subset formula are as defined for its parent formula unless otherwise noted. Ambient or room temperature is defined as about 20–25 °C.

Compounds of Formula **1** may be prepared by the method illustrated in Scheme 1. The values of R¹, R², R³, R⁴, R⁵, n and Q are as previously defined. In the method of Scheme 1 a carboxylic acid of Formula **2** is reacted with an amine of Formula **3** by a condensation facilitated by known amide coupling reagents. Coupling reagents useful in this method include, but are not limited to, T3P (1-propanephosphonic acid cyclic anhydride), DIC/HOBt (diisopropylcarboximide/hydroxybenzotriazole), HATU (1-[bis(dimethylamino)methylene]-1H-1,2,3-triazolo[4,5-b]pyridinium 3-oxid hexafluorophosphate), CDI (carbonyl diimidazole), and EDC (ethyl-3-(3-dimethylaminopropyl)carbodiimide). The coupling reagents are typically used in the presence of a base such as triethylamine, pyridine, 4-(dimethylamino)pyridine and *N,N*-diisopropylethylamine. Typical reaction conditions include an anhydrous aprotic solvent such as dichloromethane or tetrahydrofuran and the reaction is generally run at temperatures between room temperature and the reflux temperature of the solvent. These reactions are well documented in the art and demonstrated in Examples 1-3.

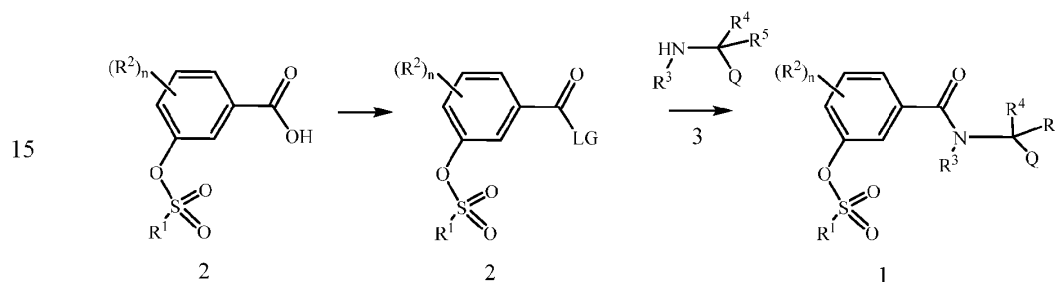
Scheme 1



Compounds of Formula **1** can also be prepared by the two-step method shown in Scheme 2. In this method, an acid of Formula **2** is converted to a compound of Formula **4**, where LG is a suitable leaving group, and then reacted with an amine of Formula **3** to yield compounds of Formula **1**. Compounds where LG is chloro (acid chlorides) are very commonly used in this

method. The coupling of acid chlorides with amines can be carried out in a wide variety of solvents including tetrahydrofuran, diethyl ether, and methylene chloride. The reaction is also conducted in the presence of a base such as triethylamine, pyridine, picolines, 4-(dimethylamino)pyridine and *N,N*-diisopropylethylamine. The acid chlorides are readily available from the corresponding acids by well-known methods such as treatment with thionyl chloride or oxalyl chloride. An alternative useful leaving group are the carboxylic acid sulfonates which can be prepared from the acids of Formula 2 by treatment with alkyl or aryl sulfonyl chlorides or sulfonic anhydrides to form the intermediate sulfonates which are then reacted directly with the amine of Formula 3 in the presence of a base as described for the acid chlorides to yield the Formula 1 compounds directly.

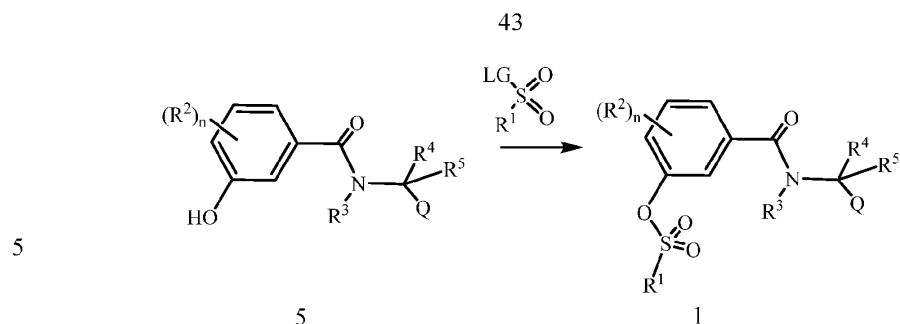
Scheme 2



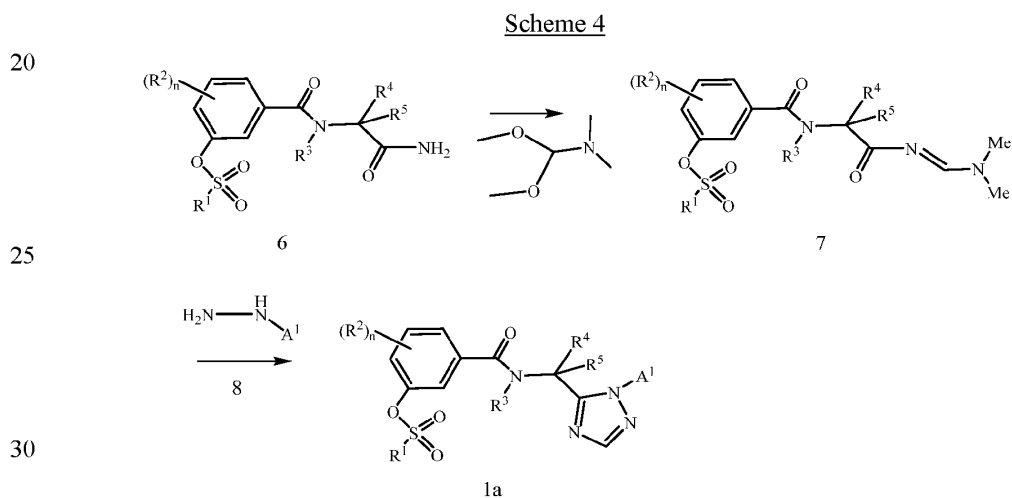
Compounds of Formula 1 may be prepared by the method illustrated in Scheme 3. In this method 3-hydroxybenzamides of Formula 5 are treated with sulfonating reagents such as sulfonyl chlorides or sulfonic anhydrides in the presence of a base such as triethylamine, pyridine, picolines, collidine, 4-(dimethylamino)pyridine and *N,N*-diisopropylethylamine. Typical reaction conditions include an anhydrous aprotic solvent such as dichloromethane or tetrahydrofuran. The reaction is generally run at temperatures between 0° C and room temperature.

30

Scheme 3



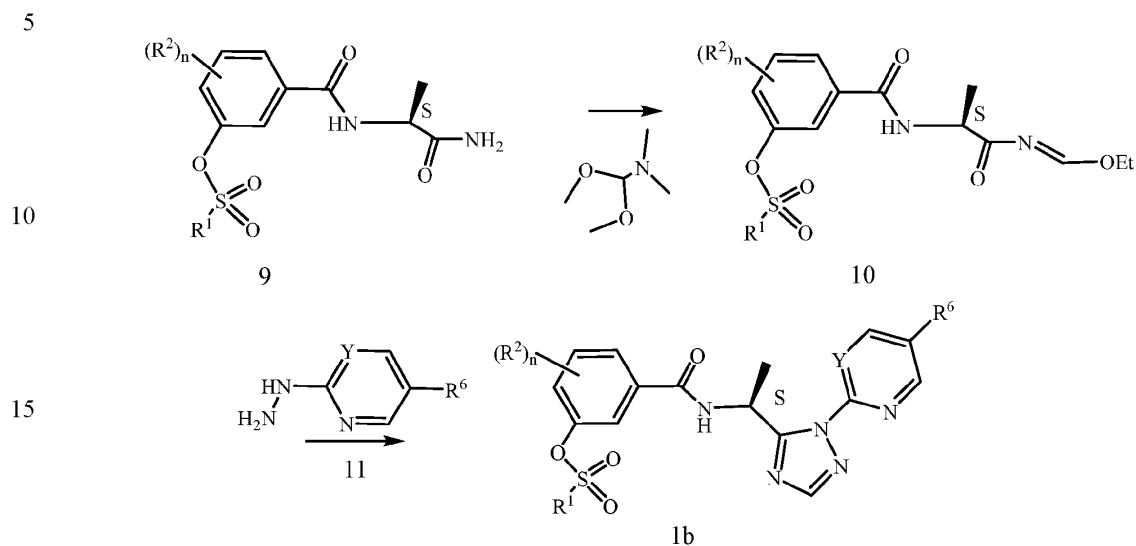
Compounds of Formula **1a**, a subset of Formula **1** where **Q** contains a central triazole ring, may be prepared by the method illustrated in Scheme 4. In this method a compound of Formula **6** is reacted with 1,1-dimethoxy-*N,N*-dimethylmethanamine to form the intermediate dimethylamino imide of Formula **7**. This reaction is typically conducted in aprotic solvents such as methylene chloride, tetrahydrofuran, benzene, and toluene at temperatures up to the reflux temperature of the solvent. Compounds of Formula **7** are then treated directly with hydrazines of Formula **8** to provide the triazoles of Formula **1a**. This reaction is generally conducted in acetic acid and may include a cosolvent at temperatures from room temperature to 100°C. This method is described in WO 2017/192385.



Compounds of Formula **1b**, a preferred subset of Formula **1** containing products derived from *S*-alanine and pyridine or pyrimidine triazoles, can be prepared by the method illustrated in Scheme 5. The procedures for this method are the same as those described in Scheme 4 where

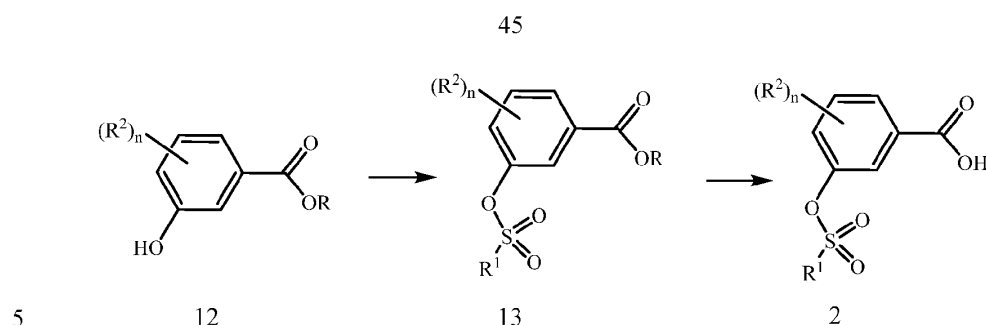
the intermediate of Formula **9** is derived from the S-alanine fragment and the hydrazine is a substituted pyridine or pyrimidine of Formula **11**.

Scheme 5



20 Intermediates of Formula **2** can be prepared by the method illustrated in Scheme 6. In this method 3-hydroxybenzoates of Formula **12** are treated with sulfonating reagents such as sulfonyl chlorides or sulfonic anhydrides in the presence of a base such as triethylamine, pyridine, picolines, collidine, 4-(dimethylamino)pyridine and *N,N*-diisopropylethylamine. A preferred sulfonating reagent is trifluoromethanesulfonic anhydride. Typical reaction

25 conditions include an anhydrous aprotic solvent such as dichloromethane or tetrahydrofuran. The reaction is generally run at temperatures between 0⁰ C and room temperature. The esters of Formula **13** can then be hydrolyzed with bases such as sodium hydroxide or lithium hydroxide under standard conditions which upon acidification afford the acids of Formula **2**.



It is recognized that some reagents and reaction conditions described above for preparing compounds of Formula **1** may not be compatible with certain functionalities present in the intermediates. In these instances, the incorporation of protection/deprotection sequences or functional group interconversions into the synthesis will aid in obtaining the desired products. The use and choice of the protecting groups will be apparent to one skilled in chemical synthesis (see, for example, Greene, T. W.; Wuts, P. G. M. *Protective Groups in Organic Synthesis*, 2nd ed.; Wiley: New York, 1991). One skilled in the art will recognize that, in some cases, after 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 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 schemes presented to prepare the compounds of Formula **1**.

Preparation of intermediates of Formula **3** are described in WO 2017/192385, WO 2019/197468, WO 2020/ 193341, WO 2020/201079, WO 2021/083936, WO 2021/013720, WO 2021/013719, 2021 2021/037614, WO 2021/165195, and WO 2021/068179.

It is recognized that some reagents and reaction conditions described above for preparing compounds of Formula **1** may not be compatible with certain functionalities present in the intermediates. In these instances, the incorporation of protection/deprotection sequences or functional group interconversions into the synthesis will aid in obtaining the desired products. The use and choice of the protecting groups will be apparent to one skilled in chemical synthesis (see, for example, Greene, T. W.; Wuts, P. G. M. *Protective Groups in Organic Synthesis*, 2nd ed.; Wiley: New York, 1991). One skilled in the art will recognize that, in some cases, after 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 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 sequence presented to prepare the compounds of Formula **1**.

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

- 5 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 Synthesis Examples are, therefore, to be construed as merely illustrative, and not limiting of the disclosure in any way whatsoever. Steps in the following Synthesis Examples illustrate a procedure for each step in an overall synthetic transformation, and the starting material for
- 10 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 chromatographic solvent mixtures or where otherwise indicated. Parts and percentages for chromatographic solvent mixtures are by volume unless otherwise indicated. ¹H NMR spectra are reported in ppm downfield from tetramethylsilane; “s” means singlet, “d” means doublet, “t” means triplet, “q” means quartet,
- 15 “m” means multiplet, “dd” means doublet of doublets, “br s” means broad singlet.

Examples of intermediates useful in the preparation of compounds of this disclosure are shown in Tables A1-A18.

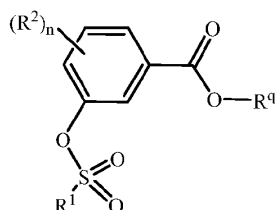


Table A1 R ⁹ is H		Table A2 R ⁹ is Me		Table A3 R ⁹ is Et	
R ¹	R ²	R ¹	R ²	R ¹	R ²
CH ₂ Cl	H	CH ₂ Cl	H	R ¹	R ²
CH ₂ CH ₂ Cl	H	CH ₂ CH ₂ Cl	H	CH ₂ Cl	H
CF ₂ H	H	CF ₂ H	H	CH ₂ CH ₂ Cl	H
CF ₃	H	CF ₃	H	CF ₂ H	H
CH ₂ CF ₃	H	CH ₂ CF ₃	H	CF ₃	H
CH ₂ CH ₂ CF ₃	H	CH ₂ CH ₂ CF ₃	H	CH ₂ CF ₃	H
CH ₂ CN	H	CH ₂ CN	H	CH ₂ CH ₂ CF ₃	H

CH ₂ CH ₂ OCH ₃	H	CH ₂ CH ₂ OCH ₃	H	CH ₂ CN	H
CH ₂ OCH ₃	H	CH ₂ OCH ₃	H	CH ₂ CH ₂ OCH ₃	H
CH ₂ SCH ₃	H	CH ₂ SCH ₃	H	CH ₂ OCH ₃	H
CH ₂ SO ₂ CH ₃	H	CH ₂ SO ₂ CH ₃	H	CH ₂ SCH ₃	H
CH ₂ CO ₂ CH ₃	H	CH ₂ CO ₂ CH ₃	H	CH ₂ SO ₂ CH ₃	H
CH ₂ CH ₂ CO ₂ CH ₃	H	CH ₂ CH ₂ CO ₂ CH ₃	H	CH ₂ CO ₂ CH ₃	H
CH ₂ (CH=CH ₂)	H	CH ₂ (CH=CH ₂)	H	CH ₂ CH ₂ CO ₂ CH ₃	H
c-Pr	H	c-Pr	H	CH ₂ (CH=CH ₂)	H
c-Bu	H	c-Bu	H	c-Pr	H
c-Pent	H	c-Pent	H	c-Bu	H
c-Hex	H	c-Hex	H	c-Pent	H
CH ₂ (c-Pr)	H	CH ₂ (c-Pr)	H	c-Hex	H
CH ₂ (c-Bu)	H	CH ₂ (c-Bu)	H	CH ₂ (c-Pr)	H
CH ₂ (c-Pent)	H	CH ₂ (c-Pent)	H	CH ₂ (c-Bu)	H
CH ₂ (c-Hex)	H	CH ₂ (c-Hex)	H	CH ₂ (c-Pent)	H
CH ₂ Ph	H	CH ₂ Ph	H	CH ₂ (c-Hex)	H
CH ₂ CH ₂ Ph	H	CH ₂ CH ₂ Ph	H	CH ₂ Ph	H
CH ₂ (2-F-Ph)	H	CH ₂ (2-F-Ph)	H	CH ₂ CH ₂ Ph	H
CH ₂ (2-F-Ph)	H	CH ₂ (2-F-Ph)	H	CH ₂ (2-F-Ph)	H
CH ₂ (2-Br-Ph)	H	CH ₂ (2-Br-Ph)	H	CH ₂ (2-F-Ph)	H
CH ₂ (2-CF ₃ -Ph)	H	CH ₂ (2-CF ₃ -Ph)	H	CH ₂ (2-Br-Ph)	H
CH ₂ (2-CN-Ph)	H	CH ₂ (2-CN-Ph)	H	CH ₂ (2-CF ₃ -Ph)	H
CH ₂ (2-NO ₂ -Ph)	H	CH ₂ (2-NO ₂ -Ph)	H	CH ₂ (2-CN-Ph)	H
CH ₂ (3-F-Ph)	H	CH ₂ (3-F-Ph)	H	CH ₂ (2-NO ₂ -Ph)	H
CH ₂ (3-F-Ph)	H	CH ₂ (3-F-Ph)	H	CH ₂ (3-F-Ph)	H
CH ₂ (3-Br-Ph)	H	CH ₂ (3-Br-Ph)	H	CH ₂ (3-F-Ph)	H
CH ₂ (3-CF ₃ -Ph)	H	CH ₂ (3-CF ₃ -Ph)	H	CH ₂ (3-Br-Ph)	H
CH ₂ (3-CN-Ph)	H	CH ₂ (3-CN-Ph)	H	CH ₂ (3-CF ₃ -Ph)	H
CH ₂ (3-NO ₂ -Ph)	H	CH ₂ (3-NO ₂ -Ph)	H	CH ₂ (3-CN-Ph)	H
CH ₂ (4-F-Ph)	H	CH ₂ (4-F-Ph)	H	CH ₂ (3-NO ₂ -Ph)	H
CH ₂ (4-Cl-Ph)	H	CH ₂ (4-Cl-Ph)	H	CH ₂ (4-F-Ph)	H
CH ₂ (4-Br-Ph)	H	CH ₂ (4-Br-Ph)	H	CH ₂ (4-Cl-Ph)	H
CH ₂ (4-CF ₃ -Ph)	H	CH ₂ (4-CF ₃ -Ph)	H	CH ₂ (4-Br-Ph)	H
CH ₂ (4-CN-Ph)	H	CH ₂ (4-CN-Ph)	H	CH ₂ (4-CF ₃ -Ph)	H
CH ₂ (4-NO ₂ -Ph)	H	CH ₂ (4-NO ₂ -Ph)	H	CH ₂ (4-CN-Ph)	H

Ph	H	Ph	H	CH ₂ (4-NO ₂ -Ph)	H
2-F-Ph	H	2-F-Ph	H	Ph	H
2-Cl-Ph	H	2-Cl-Ph	H	2-F-Ph	H
2-CN-Ph	H	2-CN-Ph	H	2-Cl-Ph	H
2-CF ₃ -Ph	H	2-CF ₃ -Ph	H	2-CN-Ph	H
2-OCH ₃ -Ph	H	2-OCH ₃ -Ph	H	2-CF ₃ -Ph	H
2-OCF ₃ -Ph	H	2-OCF ₃ -Ph	H	2-OCH ₃ -Ph	H
3-F-Ph	H	3-F-Ph	H	2-OCF ₃ -Ph	H
3-Cl-Ph	H	3-Cl-Ph	H	3-F-Ph	H
3-CN-Ph	H	3-CN-Ph	H	3-Cl-Ph	H
3-CF ₃ -Ph	H	3-CF ₃ -Ph	H	3-CN-Ph	H
3-OCH ₃ -Ph	H	3-OCH ₃ -Ph	H	3-CF ₃ -Ph	H
3-OCF ₃ -Ph	H	3-OCF ₃ -Ph	H	3-OCH ₃ -Ph	H
4-F-Ph	H	4-F-Ph	H	3-OCF ₃ -Ph	H
4-Cl-Ph	H	4-Cl-Ph	H	4-F-Ph	H
4-CN-Ph	H	4-CN-Ph	H	4-Cl-Ph	H
4-CF ₃ -Ph	H	4-CF ₃ -Ph	H	4-CN-Ph	H
4-OCH ₃ -Ph	H	4-OCH ₃ -Ph	H	4-CF ₃ -Ph	H
4-OCF ₃ -Ph	H	4-OCF ₃ -Ph	H	4-OCH ₃ -Ph	H

Table A4 through Table A6 is constructed in the same way as Table A1 through Table A3, respectively, except that R² is -5-F.

Table A7 through Table A9 is constructed in the same way as Table A1 through Table A3, respectively, except that R² is 5-Cl.

Table A10 through Table A12 is constructed in the same way as Table A1 through Table A3, respectively, except that R² is 5-Br.

Table A13 through Table A15 is constructed in the same way as Table A1 through Table A3, respectively, except that R² is 5-CF₃.

Table A16 through Table A18 is constructed in the same way as Table A1 through Table A3, respectively, except that R² is -5-OCF₃.

Without further elaboration, it is believed that one skilled in the art using the preceding description can utilize the present disclosure to its fullest extent.

SYNTHESIS EXAMPLE 1

Preparation of 3-[[[1-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate (Compound 2)

5

Step A: Preparation of methyl 3-(trifluoromethyl)-5-(trifluoromethylsulfonyloxy)benzoate

To a stirred solution of methyl 3-trifluoromethyl-5-hydroxy benzoate (0.5 g, 2.27 mmol) in dichloromethane (20 ml) was added 2,4,6-collidine (0.36 ml, 2.72 mmol), 4-dimethylaminopyridine (55 mg, 0.45 mmol) and triphos anhydride (0.45 ml, 2.72 mmol) at 0°C and the mixture was stirred at room temperature for 1 hour. Progress of the reaction was monitored by TLC (50% EtOAc /pet ether). The mixture was quenched with ice cold water (50 ml) and extracted with ethyl acetate (2 X 50 ml). The combined organic layers were washed with brine solution (25ml) and dried over anhydrous sodium sulfate. The solvent was evaporated under reduced pressure at 35 °C to give the crude compound which was charged on silica gel column. Elution of the column with 10% ethyl acetate/pet ether gave the title compound (0.5 g, 62.5% yield) as pale-yellow liquid. ¹H-NMR (400 MHz, CDCl₃): δ = 8.35 (s, 1H), 8.13 (s, 1H), 7.72 (s, 1H), 4.00 (s, 3H). MS (EI): *m/z* 352

Step B: Preparation of 3-(trifluoromethyl)-5-(trifluoromethylsulfonyloxy)benzoic acid

To a stirred solution of the compound from Step A (0.5g, 1.42 mmol) in tetrahydrofuran (12 ml) and water (4ml) was added lithium hydroxide hydrate (0.089 g, 2.13 mmol) at 0°C and the mixture was stirred at room temperature for 15 minutes. Progress of the reaction was monitored by TLC (100% ethyl acetate). The solvent was evaporated, and the mixture was acidified with 1N HCl (~pH=2) and extracted with ethyl acetate (2 X 50 ml). The combined organic layers were washed with brine (50 ml) and dried over anhydrous sodium sulfate. The solvent was evaporated under reduced pressure to give the crude compound which was purified by Prep-HPLC to give the title compound (200 mg, 41.6% yield) as an off white solid. MS (EI): *m/z* 337 (M-H, 100).

Step C: Preparation of 3-[[[1-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-

yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate

To a stirred solution of the compound from Example 1 Step B (0.150g, 1.08mmol) in dichloromethane (8 ml) was added 1-(2-pyrimidin-2-yl-1,2,4-triazol-3-yl)ethanamine (compound 4, 0.247 g, 1.30 mmol) and triethylamine (0.3 ml, 2.17mmol) at 0°C. Then, propanephosphonic acid anhydride (T3P, 1.38 ml, 2.17 mmol) was added and the mixture was stirred at room temperature for 16 hours. Progress of the reaction was monitored by TLC (100% ethyl acetate). The reaction was quenched with ice water (30 ml) and extracted with dichloromethane (2 X 50 ml). The combined organic extracts were washed with brine (30 ml)

and dried over anhydrous sodium sulfate. The solvent was evaporated under reduced pressure to give the crude product, which was purified by Prep-HPLC to give the title compound (50 mg, 22.6% yield). ¹H NMR (400 MHz, CDCl₃): δ=9.51-9.50 (d, 1H), 8.98-8.97 (d, 2H), 8.29 (s, 1H), 8.24 (s, 1H), 8.17 (s, 1H), 8.15 (s, 1H), 7.63-7.60 (t, 1H), 6.03-6.00 (t, 1H), 1.66-1.65 (d, 3H). MS (EI): *m/z* 511 (M+1,100)

Preparation of intermediate 1-(2-pyrimidin-2-yl-1,2,4-triazol-3-yl)ethanamine can be found in WO 2017 /192385.

SYNTHESIS EXAMPLE 2

- 10 Preparation of 3-[[[1-[1-(5-cyano-2-pyridinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate (Compound 19)

Step-A: Preparation of 3-[[[1-[1-(5-cyano-2-pyridinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate

- 15 To a stirred solution of 3-(trifluoromethyl)-5-(trifluoromethylsulfonyloxy)benzoic acid from Example 1 Step B (0.250 g, 1.16 mmol) in dichloromethane (10 ml) was added 6-[5-(1-aminoethyl)-1H-1,2,4-triazol-1-yl]-3-pyridinecarbonitrile (0.393 g, 1.16 mmol) and triethylamine (0.48 ml, 3.50 mmol) at 0°C. Then, propanephosphonic acid anhydride (T3P, 1.48 ml, 2.33 mmol) was added and the mixture was stirred at room temperature for 16 hours.
- 20 Progress of the reaction was monitored by TLC (70% EtOAc/Petroleum ether). The reaction was quenched with ice water (50 ml) and extracted with dichloromethane (2 X 50 ml). The combined organic extracts were washed with brine (50 ml) and dried over anhydrous sodium sulfate. The solvent was evaporated under reduced pressure to give the crude product which was purified by Prep-HPLC give the title compound (56 mg, 10% yield). ¹H NMR (400 MHz, CDCl₃): δ=8.87-8.86(s, 1H), 8.18-8.17(m, 2H), 8.10 (s, 1H), 8.01(s, 1H), 7.96 (s, 1H), 7.68(s, 1H), 7.55-7.53(d, 1H), 6.45-6.41(t, 1H), 1.73-1.72(d, 3H). MS (EI): *m/z* 535 (M+1,100)

- 30 SYNTHESIS EXAMPLE 3

3-[[[(Cyclopropylmethyl)[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate (Compound 11)

Step-A: Preparation of 3-[[[(Cyclopropylmethyl)[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate

- 35

To a stirred solution of 3-(trifluoromethyl)-5-(trifluoromethylsulfonyloxy)benzoic acid from Example 1 Step B (0.2g, 0.59 mmol) in dichloromethane (10 ml) was added *N*-(cyclopropylmethyl)- α -methyl-1-(2-pyrimidinyl)-1*H*-1,2,4-Triazole-5-methanamine (0.173 g, 0.71 mmol) and triethylamine (0.24 ml, 1.77 mmol) at 0°C. Then, propanephosphonic acid anhydride (0.75 ml, 1.18 mmol) was added and the reaction was stirred at room temperature for 16 hours. Progress of the reaction was monitored by TLC (100% EtOAc). The reaction was quenched with ice water (100 ml) and extracted with dichloromethane (2 x 50 ml). The combined organic extracts were washed with brine (50 ml) and dried over anhydrous sodium sulfate. The solvent was evaporated under reduced pressure to give the crude product, which was purified by Combi-flash to give the title compound (60 mg, 18% yield) as pale-yellow gummy liquid. ¹H NMR (400 MHz, CDCl₃): δ = 8.84 (bs, 2H), 8.12 (s, 1H), 7.53 (d, 2H), 7.36 (bs, 2H), 6.69 (bs, 1H), 3.01 (bs, 2H), 1.87-1.86 (d, 3H), 0.90-0.86 (m, 1H), 0.42-0.37 (m, 2H), 0.04-0.02 (m, 2H). MS (EI): *m/z* 565 (M+1, 100). Preparation of intermediate *N*-(cyclopropylmethyl)- α -methyl-1-(2-pyrimidinyl)-1*H*-1,2,4-Triazole-5-methanamine can be found in WO 2017/192385.

SYNTHESIS EXAMPLE 4

Enantiomer Separation 3-Chloro-5-[[[1-[1-(2-pyrimidinyl)-1*H*-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate (Compound 8; (-) enantiomer) and 3-Chloro-5-[[[1-[1-(2-pyrimidinyl)-1*H*-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate (Compound 9; (+)enantiomer)

Procedure: The enantiomers of 3-[[[1-[1-(2-Pyrimidinyl)-1*H*-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate (Compound 2) from Example 1 were separated and characterized by chiral supercritical fluid chromatography (SFC) using the following method.

SFC Method Conditions:

Column: CHIRALPAK IC (4.6*250mm)5 μ m

Co-solvent: 0.5% DEA in Methanol

Total flow: 3 g/min

% Of Co-Solvent: 10

ABPR: 1500si

Temperature: 30° C

SFC purification gave:

Peak 1 (RT Value: 1.98 in chiral HPLC): 110 mg; ¹H-NMR, MS and optical rotation comply with the (-) enantiomer of 3-[[[1-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate.

¹H NMR (400 MHz, CDCl₃): δ= 8.93-8.92 (d, 2H), 8.11 (s, 1H), 8.06 (s, 1H), 7.97 (s, 1H), 7.67-7.65 (d, 2H), 7.43-7.41 (t, 1H), 6.48-6.42 (m, 1H), 1.72-1.71 (d, 3H).

MS (EI): *m/z* 511.23 (M+1).

[α]_D= - 101.2 (C=0.2% , MeOH)

Peak 2 (RT Value: 2.55 in chiral HPLC) : 110 mg; ¹H-NMR, MS and optical rotation comply with the (+) enantiomer of 3-Chloro-5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate.

¹H NMR (400 MHz, CDCl₃): δ=8.93-8.92 (d, 2H), 8.11-8.06 (d, 1H), 7.97 (s, 1H), 7.67-7.64 (t, 2H), 7.43-7.4 (t, 1H), 6.47-6.43 (m, 1H), 1.72-1.7 (d, 3H).

MS (EI): *m/z* 511.19 (M+1).

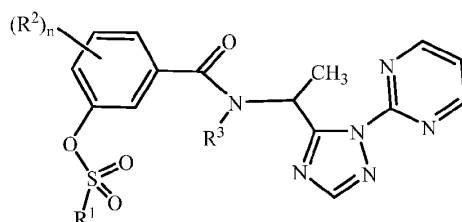
[α]_D= + 84.32 (C=0.2% , MeOH)

15

By the procedures described herein together with methods known in the art, the following compounds of Tables 1 to 120 can be prepared. The following abbreviations are used in the Tables which follow: Me means methyl, OMe means methoxy, Et means ethyl, OEt means ethoxy, *n*-Pr means *n*-propyl, *i*-Pr means isopropyl, *c*-Pr means cyclopropyl, *n*-Bu means *n*-butyl, *s*-Bu means sec-butyl, *t*-Bu means tertiary butyl, *c*-Bu means cyclobutyl, Ph means phenyl and CN means cyano.

20

Table 1

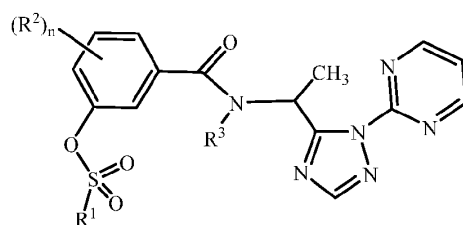


5 wherein R³ is H

R1	R2
CH ₂ Cl	H
CH ₂ CH ₂ Cl	H
CF ₂ H	H
CF ₃	H
CH ₂ CF ₃	H
CH ₂ CH ₂ CF ₃	H
CH ₂ CN	H
CH ₂ CH ₂ OCH ₃	H
CH ₂ OCH ₃	H
CH ₂ SCH ₃	H
CH ₂ SO ₂ CH ₃	H
CH ₂ CO ₂ CH ₃	H
CH ₂ CH ₂ CO ₂ CH ₃	H
CH ₂ (CH=CH ₂)	H
c-Pr	H
c-Bu	H
c-Pent	H
c-Hex	H
CH ₂ (c-Pr)	H
CH ₂ (c-Bu)	H
CH ₂ (c-Pent)	H
CH ₂ (c-Hex)	H
CH ₂ Ph	H
CH ₂ CH ₂ Ph	H

R1	R2
CH ₂ (2-F-Ph)	H
CH ₂ (2-F-Ph)	H
CH ₂ (2-Br-Ph)	H
CH ₂ (2-CF ₃ -Ph)	H
CH ₂ (2-CN-Ph)	H
CH ₂ (2-NO ₂ -Ph)	H
CH ₂ (4-F-Ph)	H
CH ₂ (4-Cl-Ph)	H
CH ₂ (4-Br-Ph)	H
CH ₂ (4-CF ₃ -Ph)	H
CH ₂ (4-CN-Ph)	H
CH ₂ (4-NO ₂ -Ph)	H
Ph	H
2-F-Ph	H
2-Cl-Ph	H
2-CN-Ph	H
2-CF ₃ -Ph	H
2-OCH ₃ -Ph	H
2-OCF ₃ -Ph	H
3-F-Ph	H
3-Cl-Ph	H
3-CN-Ph	H
3-CF ₃ -Ph	H
3-OCH ₃ -Ph	H
3-OCF ₃ -Ph	H
4-F-Ph	H
4-Cl-Ph	H
4-CN-Ph	H
4-CF ₃ -Ph	H
4-OCH ₃ -Ph	H
4-OCF ₃ -Ph	H

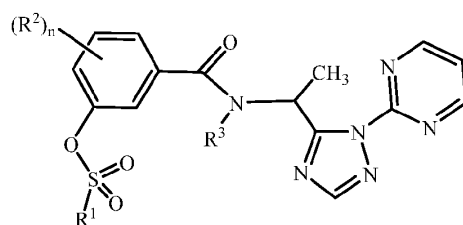
Table 2

Wherein R³ is Me

R1	R2
CH ₂ Cl	H
CH ₂ CH ₂ Cl	H
CF ₂ H	H
CF ₃	H
CH ₂ CF ₃	H
CH ₂ CH ₂ CF ₃	H
CH ₂ CN	H
CH ₂ CH ₂ OCH ₃	H
CH ₂ OCH ₃	H
CH ₂ SCH ₃	H
CH ₂ SO ₂ CH ₃	H
CH ₂ CO ₂ CH ₃	H
CH ₂ CH ₂ CO ₂ CH ₃	H
CH ₂ (CH=CH ₂)	H
c-Pr	H
c-Bu	H
c-Pent	H
c-Hex	H
CH ₂ (c-Pr)	H
CH ₂ (c-Bu)	H
CH ₂ (c-Pent)	H
CH ₂ (c-Hex)	H
CH ₂ Ph	H
CH ₂ CH ₂ Ph	H
CH ₂ (2-F-Ph)	H
CH ₂ (2-F-Ph)	H

R1	R2
CH2(2-Br-Ph)	H
CH2(2-CF3-Ph)	H
CH2(2-CN-Ph)	H
CH2(2-NO2-Ph)	H
CH2(4-F-Ph)	H
CH2(4-Cl-Ph)	H
CH2(4-Br-Ph)	H
CH2(4-CF3-Ph)	H
CH2(4-CN-Ph)	H
CH2(4-NO2-Ph)	H
Ph	H
2-F-Ph	H
2-Cl-Ph	H
2-CN-Ph	H
2-CF3-Ph	H
2-OCH3-Ph	H
2-OCF3-Ph	H
3-F-Ph	H
3-Cl-Ph	H
3-CN-Ph	H
3-CF3-Ph	H
3-OCH3-Ph	H
3-OCF3-Ph	H
4-F-Ph	H
4-Cl-Ph	H
4-CN-Ph	H
4-CF3-Ph	H
4-OCH3-Ph	H
4-OCF3-Ph	H

Table 3

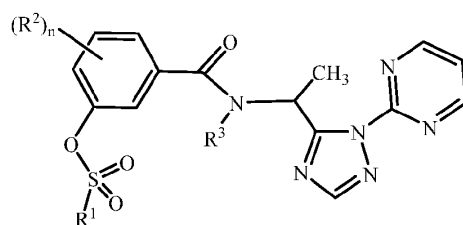


wherein R³ is i-Pr

R1	R2
CH ₂ Cl	H
CH ₂ CH ₂ Cl	H
CF ₂ H	H
CF ₃	H
CH ₂ CF ₃	H
CH ₂ CH ₂ CF ₃	H
CH ₂ CN	H
CH ₂ CH ₂ OCH ₃	H
CH ₂ OCH ₃	H
CH ₂ SCH ₃	H
CH ₂ SO ₂ CH ₃	H
CH ₂ CO ₂ CH ₃	H
CH ₂ CH ₂ CO ₂ CH ₃	H
CH ₂ (CH=CH ₂)	H
c-Pr	H
c-Bu	H
c-Pent	H
c-Hex	H
CH ₂ (c-Pr)	H
CH ₂ (c-Bu)	H
CH ₂ (c-Pent)	H
CH ₂ (c-Hex)	H
CH ₂ Ph	H
CH ₂ CH ₂ Ph	H
CH ₂ (2-F-Ph)	H
CH ₂ (2-F-Ph)	H

R1	R2
CH2(2-Br-Ph)	H
CH2(2-CF3-Ph)	H
CH2(2-CN-Ph)	H
CH2(2-NO2-Ph)	H
CH2(4-F-Ph)	H
CH2(4-Cl-Ph)	H
CH2(4-Br-Ph)	H
CH2(4-CF3-Ph)	H
CH2(4-CN-Ph)	H
CH2(4-NO2-Ph)	H
Ph	H
2-F-Ph	H
2-Cl-Ph	H
2-CN-Ph	H
2-CF3-Ph	H
2-OCH3-Ph	H
2-OCF3-Ph	H
3-F-Ph	H
3-Cl-Ph	H
3-CN-Ph	H
3-CF3-Ph	H
3-OCH3-Ph	H
3-OCF3-Ph	H
4-F-Ph	H
4-Cl-Ph	H
4-CN-Ph	H
4-CF3-Ph	H
4-OCH3-Ph	H
4-OCF3-Ph	H

Table 4

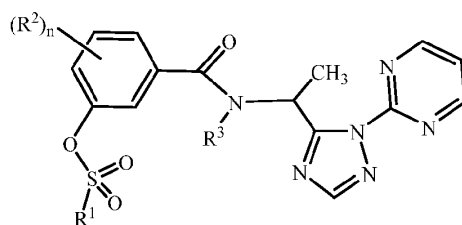


wherein R^3 is $\text{CH}_2(\text{c-Pr})$

R1	R2
CH ₂ Cl	H
CH ₂ CH ₂ Cl	H
CF ₂ H	H
CF ₃	H
CH ₂ CF ₃	H
CH ₂ CH ₂ CF ₃	H
CH ₂ CN	H
CH ₂ CH ₂ OCH ₃	H
CH ₂ OCH ₃	H
CH ₂ SCH ₃	H
CH ₂ SO ₂ CH ₃	H
CH ₂ CO ₂ CH ₃	H
CH ₂ CH ₂ CO ₂ CH ₃	H
CH ₂ (CH=CH ₂)	H
c-Pr	H
c-Bu	H
c-Pent	H
c-Hex	H
CH ₂ (c-Pr)	H
CH ₂ (c-Bu)	H
CH ₂ (c-Pent)	H
CH ₂ (c-Hex)	H
CH ₂ Ph	H
CH ₂ CH ₂ Ph	H
CH ₂ (2-F-Ph)	H
CH ₂ (2-F-Ph)	H

R1	R2
CH2(2-Br-Ph)	H
CH2(2-CF3-Ph)	H
CH2(2-CN-Ph)	H
CH2(2-NO2-Ph)	H
CH2(4-F-Ph)	H
CH2(4-Cl-Ph)	H
CH2(4-Br-Ph)	H
CH2(4-CF3-Ph)	H
CH2(4-CN-Ph)	H
CH2(4-NO2-Ph)	H
Ph	H
2-F-Ph	H
2-Cl-Ph	H
2-CN-Ph	H
2-CF3-Ph	H
2-OCH3-Ph	H
2-OCF3-Ph	H
3-F-Ph	H
3-Cl-Ph	H
3-CN-Ph	H
3-CF3-Ph	H
3-OCH3-Ph	H
3-OCF3-Ph	H
4-F-Ph	H
4-Cl-Ph	H
4-CN-Ph	H
4-CF3-Ph	H
4-OCH3-Ph	H
4-OCF3-Ph	H

Table 5



5 wherein R³ is CH₂Ph

R1	R2
CH ₂ Cl	H
CH ₂ CH ₂ Cl	H
CF ₂ H	H
CF ₃	H
CH ₂ CF ₃	H
CH ₂ CH ₂ CF ₃	H
CH ₂ CN	H
CH ₂ CH ₂ OCH ₃	H
CH ₂ OCH ₃	H
CH ₂ SCH ₃	H
CH ₂ SO ₂ CH ₃	H
CH ₂ CO ₂ CH ₃	H
CH ₂ CH ₂ CO ₂ CH ₃	H
CH ₂ (CH=CH ₂)	H
c-Pr	H
c-Bu	H
c-Pent	H
c-Hex	H
CH ₂ (c-Pr)	H
CH ₂ (c-Bu)	H
CH ₂ (c-Pent)	H
CH ₂ (c-Hex)	H
CH ₂ Ph	H
CH ₂ CH ₂ Ph	H

R1	R2
CH2(2-F-Ph)	H
CH2(2-F-Ph)	H
CH2(2-Br-Ph)	H
CH2(2-CF3-Ph)	H
CH2(2-CN-Ph)	H
CH2(2-NO2-Ph)	H
CH2(4-F-Ph)	H
CH2(4-Cl-Ph)	H
CH2(4-Br-Ph)	H
CH2(4-CF3-Ph)	H
CH2(4-CN-Ph)	H
CH2(4-NO2-Ph)	H
Ph	H
2-F-Ph	H
2-Cl-Ph	H
2-CN-Ph	H
2-CF3-Ph	H
2-OCH3-Ph	H
2-OCF3-Ph	H
3-F-Ph	H
3-Cl-Ph	H
3-CN-Ph	H
3-CF3-Ph	H
3-OCH3-Ph	H
3-OCF3-Ph	H
4-F-Ph	H
4-Cl-Ph	H
4-CN-Ph	H
4-CF3-Ph	H
4-OCH3-Ph	H
4-OCF3-Ph	H

Table 6 through Table 10

63

5

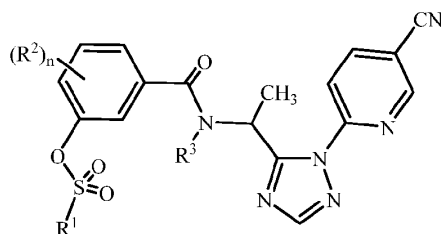


Table 6 through Table 10 is constructed in the same way as Table 1 through Table 5, respectively, except that the structure in Table 1 through Table 5 is replaced with the structure above for Table 6 through Table 10.

10

Table 11 through Table 15

15

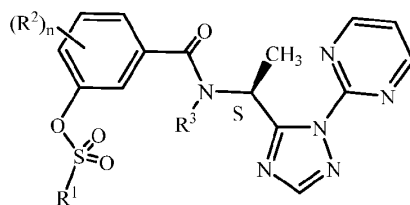


Table 11 through Table 15 is constructed in the same way as Table 1 through Table 5, respectively, except that the structure in Table 1 through Table 5 is replaced with the structure above for Table 11 through Table 15.

20

Table 16 through Table 20

25

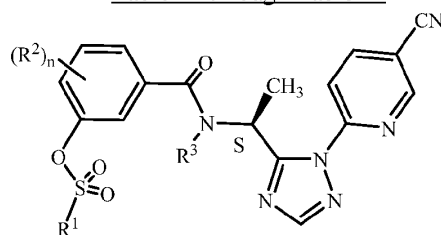


Table 16 through Table 20 is constructed in the same way as Table 1 through Table 5, respectively, except that the structure in Table 1 through Table 5 is replaced with the structure above for Table 16 through Table 20.

Table 21 through Table 40 is constructed in the same way as Table 1 through Table 20, respectively, except that R^2 is 5-F.

Table 41 through Table 60 is constructed in the same way as Table 1 through Table 20, respectively, except that R^2 is 5-Cl.

Table 61 through Table 80 is constructed in the same way as Table 1 through Table 20, respectively, except that R^2 is 5-CF₃.

Table 81 through Table 100 is constructed in the same way as Table 1 through Table 20, respectively, except that R^2 is 5-OCF₃.

Table 101 through Table 120 is constructed in the same way as Table 1 through Table 20, respectively, except that R^2 is 5-Br.

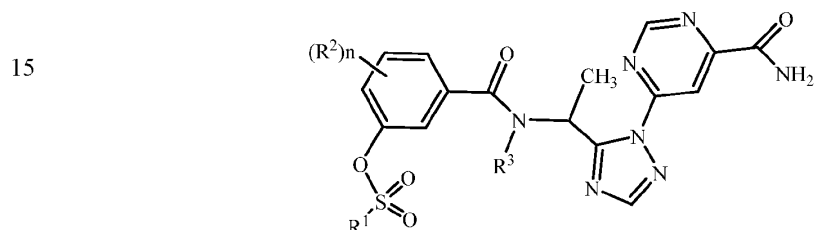


Table 121 through Table 125 is constructed in the same way as Table 1 through Table 5, respectively, except that the structure in Table 1 through Table 5 is replaced with the structure above for Table 121 through Table 125.

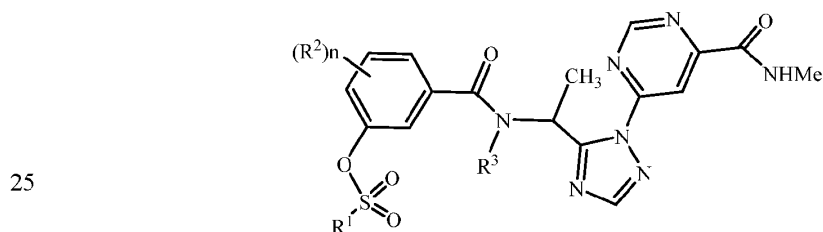
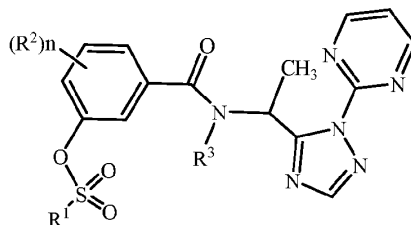


Table 126 through Table 130 is constructed in the same way as Table 1 through Table 5, respectively, except that the structure in Table 1 through Table 5 is replaced with the structure above for Table 126 through Table 130.

65



5

Table 131 through Table 135 is constructed in the same way as Table 1 through Table 5, respectively, except that the structure in Table 1 through Table 5 is replaced with the structure above for Table 131 through Table 135.

Table 136 through Table 140 are constructed in the same way as Tables 126-130, respectively, except that R^2 is 5-F.

Table 141 through Table 145 are constructed in the same way as Tables 126-130, respectively, except that R^2 is 5-Cl.

Table 146 through Table 150 are constructed in the same way as Tables 126-130, respectively, except that R^2 is 5-CF₃.

Table 151 through Table 155 are constructed in the same way as Tables 126-130, respectively, except that R^2 is 5-OCF₃.

Table 156 through Table 160 are constructed in the same way as Tables 126-130, respectively, except that R^2 is 5-Br.

Table 161 through Table 165 are constructed in the same way as Tables 126-130, respectively, except that R^2 is 5-F.

20

Table 166 through Table 170 are constructed in the same way as Tables 126-130, respectively, except that R² is 5-Cl.

Table 171 through Table 175 are constructed in the same way as Tables 126-130, respectively, except that R² is 5-CF₃.

5 Table 176 through Table 180 are constructed in the same way as Tables 126-130, respectively, except that R² is 5-OCF₃.

Table 181 through Table 185 are constructed in the same way as Tables 126-130, respectively, except that R² is 5-Br.

10 Table 186 through Table 190 are constructed in the same way as Tables 126-130, respectively, except that R² is 5-F.

Table 191 through Table 195 are constructed in the same way as Tables 126-130, respectively, except that R² is 5-Cl.

Table 196 through Table 200 are constructed in the same way as Tables 126-130, respectively, except that R² is 5-CF₃.

15 Table 201 through Table 205 are constructed in the same way as Tables 126-130, respectively, except that R² is 5-OCF₃.

Table 206 through Table 210 are constructed in the same way as Tables 126-130, respectively, except that R² is 5-Br.

Formulation/Utility

20 A compound of this disclosure will generally be used as an invertebrate pest control 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 serves 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
25 factors such as soil type, moisture and temperature.

Useful formulations include both liquid and solid compositions. Liquid compositions include solutions (including emulsifiable concentrates), suspensions, emulsions (including microemulsions, 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
30 compositions are soluble concentrate, suspension concentrate, capsule suspension, concentrated emulsion, microemulsion, oil in water emulsion, flowable concentrate and suspoemulsion. 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,
35 pastilles, tablets, filled films (including seed coatings) and the like, which can be

water-dispersible (“wetable”) 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.

One way of dispensing the compositions disclosed herein over a target area, such as, but not limited to a crop-containing field, is by using drones. Use of drones or unmanned aerial vehicles (UAVs) in agricultural applications, such as for treating fields with chemical products, is rapidly expanding. A container of chemical products is coupled to the UAV and a material dispensing system mounted to the UAV, and the UAV is piloted above the area to be treated while the chemical product is dispensed.

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>
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	0.001–99	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., triethylphosphate), 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, 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 disclosure often include one or more surfactants. When added to a liquid, surfactants (also known as “surface-active agents”) generally modify, most often reduce, the surface tension of the liquid. Depending on the nature of the hydrophilic and lipophilic groups in a surfactant molecule, surfactants can be useful as wetting agents, dispersants, emulsifiers or defoaming agents.

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

Useful anionic surfactants include, but are not limited to: alkylaryl sulfonic acids and their salts; carboxylated alcohol or alkylphenol ethoxylates; diphenyl sulfonate derivatives; lignin and lignin derivatives such as lignosulfonates; maleic or succinic acids or their anhydrides; olefin sulfonates; phosphate esters such as phosphate esters of alcohol alkoxylates, phosphate esters of alkylphenol alkoxylates and phosphate esters of styryl phenol ethoxylates; protein-based surfactants; sarcosine derivatives; styryl phenol ether sulfate; sulfates and sulfonates of oils and fatty acids; sulfates and sulfonates of ethoxylated alkylphenols; sulfates of alcohols; sulfates of ethoxylated alcohols; sulfonates of amines and amides such as *N,N*-alkyltaurates; sulfonates of benzene, cumene, toluene, xylene, and dodecyl and tridecylbenzenes; sulfonates of condensed naphthalenes; sulfonates of naphthalene and alkyl

naphthalene; sulfonates of fractionated petroleum; sulfosuccinamates; and sulfosuccinates and their derivatives such as dialkyl sulfosuccinate salts.

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

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

Compositions of this disclosure 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, pages 8–57 and following, and WO 91/13546. Pellets can be prepared as described in U.S. 4,172,714. Water-dispersible and water-soluble granules can be prepared as taught in U.S. 4,144,050, U.S. 3,920,442 and DE 3,246,493. Tablets can be prepared as taught in U.S. 5,180,587, U.S. 5,232,701 and U.S. 5,208,030. Films can be prepared as taught in GB 2,095,558 and U.S. 3,299,566.

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

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

72

Example AHigh Strength Concentrate

Compound 2	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 1	10.0%
attapulgit granules (low volatile matter, 0.71/0.30 mm; U.S.S. No. 25–50 sieves)	90.0%

5

Example DExtruded Pellet

Compound 3	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 2	10.0%
polyoxyethylene sorbitol hexoleate	20.0%
C ₆ –C ₁₀ fatty acid methyl ester	70.0%

Example FMicroemulsion

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

water	20.0%
-------	-------

Example GSeed Treatment

Compound 2	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 1	2.5%
pyrrolidone-styrene copolymer	4.8%
tristyrylphenyl 16-ethoxylate	2.3%
talc	0.8%
corn starch	5.0%
slow-release fertilizer	36.0%
kaolin	38.0%
water	10.6%

Example ISuspension Concentrate

Compound 4	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 10	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 19	25%
polyoxyethylene sorbitol hexaoleate	15%
organically modified bentonite clay	2.5%
fatty acid methyl ester	57.5%

Example LSuspoemulsion

Compound 2	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%

- Compounds of this disclosure exhibit activity against a wide spectrum of invertebrate pests. These pests include invertebrates inhabiting a variety of environments such as, for example, plant foliage, roots, soil, harvested crops or other foodstuffs, building structures or animal integuments. These pests include, for example, invertebrates feeding on foliage

(including leaves, stems, flowers and fruits), seeds, wood, textile fibers or animal blood or tissues, and thereby causing injury or damage to, for example, growing or stored agronomic crops, forests, greenhouse crops, ornamentals, nursery crops, stored foodstuffs or fiber products, or houses or other structures or their contents, or being harmful to animal health or public health. Those skilled in the art will appreciate that not all compounds are equally effective against all growth stages of all pests.

These present compounds and compositions are thus useful agronomically for protecting field crops from phytophagous invertebrate pests, and also nonagronomically for protecting other horticultural crops and plants from phytophagous invertebrate pests. This utility includes protecting crops and other plants (i.e. both agronomic and nonagronomic) that contain genetic material introduced by genetic engineering (i.e. transgenic) or modified by mutagenesis to provide advantageous traits. Examples of such traits include tolerance to herbicides, resistance to phytophagous pests (e.g., insects, mites, aphids, spiders, nematodes, snails, plant-pathogenic fungi, bacteria and viruses), improved plant growth, increased tolerance of adverse growing conditions such as high or low temperatures, low or high soil moisture, and high salinity, increased flowering or fruiting, greater harvest yields, more rapid maturation, higher quality and/or nutritional value of the harvested product, or improved storage or process properties of the harvested products. Transgenic plants can be modified to express multiple traits. Examples of plants containing traits provided by genetic engineering or mutagenesis include varieties of corn, cotton, soybean and potato expressing an insecticidal *Bacillus thuringiensis* toxin such as YIELD GARD[®], KNOCKOUT[®], STARLINK[®], BOLLGARD[®], NuCOTN[®] and NEWLEAF[®], INVICTA RR2 PRO[™], and herbicide-tolerant varieties of corn, cotton, soybean and rapeseed such as ROUNDUP READY[®], LIBERTY LINK[®], IMI[®], STS[®] and CLEARFIELD[®], as well as crops expressing *N*-acetyltransferase (GAT) to provide resistance to glyphosate herbicide, or crops containing the HRA gene providing resistance to herbicides inhibiting acetolactate synthase (ALS). The present compounds and compositions may exhibit enhanced effects with traits introduced by genetic engineering or modified by mutagenesis, thus enhancing phenotypic expression or effectiveness of the traits or increasing the invertebrate pest control effectiveness of the present compounds and compositions. In particular, the present compounds and compositions may exhibit enhanced effects with the phenotypic expression of proteins or other natural products toxic to invertebrate pests to provide greater-than-additive control of these pests.

Compositions of this disclosure can also optionally comprise plant nutrients, e.g., a fertilizer composition comprising at least one plant nutrient selected from nitrogen, phosphorus, potassium, sulfur, calcium, magnesium, iron, copper, boron, manganese, zinc, and molybdenum. Of note are compositions comprising at least one fertilizer composition

comprising at least one plant nutrient selected from nitrogen, phosphorus, potassium, sulfur, calcium and magnesium. Compositions of the present disclosure which further comprise at least one plant nutrient can be in the form of liquids or solids. Of note are solid formulations in the form of granules, small sticks or tablets. Solid formulations comprising a fertilizer composition can be prepared by mixing the compound or composition of the present disclosure with the fertilizer composition together with formulating ingredients and then preparing the formulation by methods such as granulation or extrusion. Alternatively solid formulations can be prepared by spraying a solution or suspension of a compound or composition of the present disclosure in a volatile solvent onto a previously prepared fertilizer composition in the form of dimensionally stable mixtures, e.g., granules, small sticks or tablets, and then evaporating the solvent.

Nonagronomic uses refer to invertebrate pest control in the areas other than fields of crop plants. Nonagronomic uses of the present compounds and compositions include control of invertebrate pests in stored grains, beans and other foodstuffs, and in textiles such as clothing and carpets. Nonagronomic uses of the present compounds and compositions also include invertebrate pest control in ornamental plants, forests, in yards, along roadsides and railroad rights of way, and on turf such as lawns, golf courses and pastures. Nonagronomic uses of the present compounds and compositions also include invertebrate pest control in houses and other buildings which may be occupied by humans and/or companion, farm, ranch, zoo or other animals. Nonagronomic uses of the present compounds and compositions also include the control of pests such as termites that can damage wood or other structural materials used in buildings.

Nonagronomic uses of the present compounds and compositions also include protecting human and animal health by controlling invertebrate pests that are parasitic or transmit infectious diseases. The controlling of animal parasites includes controlling external parasites that are parasitic to the surface of the body of the host animal (e.g., shoulders, armpits, abdomen, inner part of the thighs) and internal parasites that are parasitic to the inside of the body of the host animal (e.g., stomach, intestine, lung, veins, under the skin, lymphatic tissue). External parasitic or disease transmitting pests include, for example, chiggers, ticks, lice, mosquitoes, flies, mites and fleas. Internal parasites include heartworms, hookworms and helminths. Compounds and compositions of the present disclosure are suitable for systemic and/or non-systemic control of infestation or infection by parasites on animals. Compounds and compositions of the present disclosure are particularly suitable for combating external parasitic or disease transmitting pests. Compounds and compositions of the present disclosure are suitable for combating parasites that infest agricultural working animals, such as cattle, sheep, goats, horses, pigs, donkeys, camels, buffalos, rabbits, hens, turkeys, ducks, geese and

bees; pet animals and domestic animals such as dogs, cats, pet birds and aquarium fish; as well as so-called experimental animals, such as hamsters, guinea pigs, rats and mice. By combating these parasites, fatalities and performance reduction (in terms of meat, milk, wool, skins, eggs, honey, etc.) are reduced, so that applying a composition comprising a compound of the present disclosure allows more economic and simple husbandry of animals.

Examples of agronomic or nonagronomic invertebrate pests include eggs, larvae and adults of the order Lepidoptera, such as armyworms, cutworms, loopers, and heliothines in the family Noctuidae (e.g., pink stem borer (*Sesamia inferens* Walker), corn stalk borer (*Sesamia nonagrioides* Lefebvre), southern armyworm (*Spodoptera eridania* Cramer), fall armyworm (*Spodoptera frugiperda* J. E. Smith), beet armyworm (*Spodoptera exigua* Hübner), cotton leafworm (*Spodoptera littoralis* Boisduval), yellowstriped armyworm (*Spodoptera ornithogalli* Guenée), black cutworm (*Agrotis ipsilon* Hufnagel), velvetbean caterpillar (*Anticarsia gemmatilis* Hübner), green fruitworm (*Lithophane antennata* Walker), cabbage armyworm (*Barathra brassicae* Linnaeus), soybean looper (*Pseudoplusia includens* Walker), cabbage looper (*Trichoplusia ni* Hübner), tobacco budworm (*Heliothis virescens* Fabricius)); borers, casebearers, webworms, coneworms, cabbageworms and skeletonizers from the family Pyralidae (e.g., European corn borer (*Ostrinia nubilalis* Hübner), navel orangeworm (*Amyelois transitella* Walker), corn root webworm (*Crambus caliginosellus* Clemens), sod webworms (Pyralidae: *Crambinae*) such as sod worm (*Herpetogramma licarsisalis* Walker), sugarcane stem borer (*Chilo infuscatellus* Snellen), tomato small borer (*Neoleucinodes elegantalis* Guenée), green leafroller (*Cnaphalocrocis medinalis*), grape leafroller (*Desmia funeralis* Hübner), melon worm (*Diaphania nitidalis* Stoll), cabbage center grub (*Helhuala hydralis* Guenée), yellow stem borer (*Scirpophaga incertulas* Walker), early shoot borer (*Scirpophaga infuscatellus* Snellen), white stem borer (*Scirpophaga innotata* Walker), top shoot borer (*Scirpophaga nivella* Fabricius), dark-headed rice borer (*Chilo polychrysus* Meyrick), striped riceborer (*Chilo suppressalis* Walker), cabbage cluster caterpillar (*Crocidolomia binotalis* English)); leafrollers, budworms, seed worms, and fruit worms in the family Tortricidae (e.g., codling moth (*Cydia pomonella* Linnaeus), grape berry moth (*Endopiza viteana* Clemens), oriental fruit moth (*Grapholita molesta* Busck), citrus false codling moth (*Cryptophlebia leucotreta* Meyrick), citrus borer (*Ecdytolopha aurantiana* Lima), redbanded leafroller (*Argyrotaenia velutinana* Walker), obliquebanded leafroller (*Choristoneura rosaceana* Harris), light brown apple moth (*Epiphyas postvittana* Walker), European grape berry moth (*Eupoecilia ambiguella* Hübner), apple bud moth (*Pandemis pyrusana* Kearfott), omnivorous leafroller (*Platynota stultana* Walsingham), barred fruit-tree tortrix (*Pandemis cerasana* Hübner), apple brown tortrix (*Pandemis heparana* Denis & Schiffermüller)); and many other economically important lepidoptera (e.g., diamondback

moth (*Plutella xylostella* Linnaeus), pink bollworm (*Pectinophora gossypiella* Saunders), gypsy moth (*Lymantria dispar* Linnaeus), peach fruit borer (*Carposina niponensis* Walsingham), peach twig borer (*Anarsia lineatella* Zeller), potato tuberworm (*Phthorimaea operculella* Zeller), spotted teniform leafminer (*Lithocolletis blancardella* Fabricius), Asiatic apple leafminer (*Lithocolletis ringoniella* Matsumura), rice leafroller (*Lerodea eufala* Edwards), apple leafminer (*Leucoptera scitella* Zeller)); eggs, nymphs and adults of the order Blattodea including cockroaches from the families Blattellidae and Blattidae (e.g., oriental cockroach (*Blatta orientalis* Linnaeus), Asian cockroach (*Blattella asahinai* Mizukubo), German cockroach (*Blattella germanica* Linnaeus), brownbanded cockroach (*Supella longipalpa* Fabricius), American cockroach (*Periplaneta americana* Linnaeus), brown cockroach (*Periplaneta brunnea* Burmeister), Madeira cockroach (*Leucophaea maderae* Fabricius)), smoky brown cockroach (*Periplaneta fuliginosa* Service), Australian Cockroach (*Periplaneta australasiae* Fabr.), lobster cockroach (*Nauphoeta cinerea* Olivier) and smooth cockroach (*Symploce pallens* Stephens)); eggs, foliar feeding, fruit feeding, root feeding, seed feeding and vesicular tissue feeding larvae and adults of the order Coleoptera including weevils from the families Anthribidae, Bruchidae, and Curculionidae (e.g., boll weevil (*Anthonomus grandis* Boheman), rice water weevil (*Lissorhoptrus oryzophilus* Kuschel), granary weevil (*Sitophilus granarius* Linnaeus), rice weevil (*Sitophilus oryzae* Linnaeus)), annual bluegrass weevil (*Listronotus maculicollis* Dietz), bluegrass billbug (*Sphenophorus parvulus* Gyllenhal), hunting billbug (*Sphenophorus venatus vestitus*), Denver billbug (*Sphenophorus cicatristriatus* Fahraeus)); flea beetles, cucumber beetles, rootworms, leaf beetles, potato beetles, and leafminers in the family Chrysomelidae (e.g., Colorado potato beetle (*Leptinotarsa decemlineata* Say), western corn rootworm (*Diabrotica virgifera virgifera* LeConte)); chafers and other beetles from the family Scarabaeidae (e.g., Japanese beetle (*Popillia japonica* Newman), oriental beetle (*Anomala orientalis* Waterhouse, *Exomala orientalis* (Waterhouse) Baraud), northern masked chafer (*Cyclocephala borealis* Arrow), southern masked chafer (*Cyclocephala immaculata* Olivier or *C. lurida* Bland), dung beetle and white grub (*Aphodius* spp.), black turfgrass ataenius (*Ataenius spretulus* Haldeman), green June beetle (*Cotinis nitida* Linnaeus), Asiatic garden beetle (*Maladera castanea* Arrow), May/June beetles (*Phyllophaga* spp.) and European chafer (*Rhizotrogus majalis* Razoumowsky)); carpet beetles from the family Dermestidae; wireworms from the family Elateridae; bark beetles from the family Scolytidae and flour beetles from the family Tenebrionidae.

In addition, agronomic and nonagronomic pests include: eggs, adults and larvae of the order Dermaptera including earwigs from the family Forficulidae (e.g., European earwig (*Forficula auricularia* Linnaeus), black earwig (*Chelisoches morio* Fabricius)); eggs,

immatures, adults and nymphs of the order Hemiptera such as, plant bugs from the family Miridae, cicadas from the family Cicadidae, leafhoppers (e.g. *Empoasca* spp.) from the family Cicadellidae, bed bugs (e.g., *Cimex lectularius* Linnaeus) from the family Cimicidae, planthoppers from the families Fulgoridae and Delphacidae, treehoppers from the family Membracidae, psyllids from the families Liviidae, Psyllidae, and Triozidae, whiteflies from the family Aleyrodidae, aphids from the family Aphididae, phylloxera from the family Phylloxeridae, mealybugs from the family Pseudococcidae, scales from the families Coccidae, Diaspididae and Margarodidae, lace bugs from the family Tingidae, stink bugs from the family Pentatomidae, chinch bugs (e.g., hairy chinch bug (*Blissus leucopterus hirtus* Montandon) and southern chinch bug (*Blissus insularis* Barber)) and other seed bugs from the family Lygaeidae, spittlebugs from the family Cercopidae squash bugs from the family Coreidae, and red bugs and cotton stainers from the family Pyrrhocoridae.

Agronomic and nonagronomic pests also include: eggs, larvae, nymphs and adults of the order Acari (mites) such as spider mites and red mites in the family Tetranychidae (e.g., European red mite (*Panonychus ulmi* Koch), two spotted spider mite (*Tetranychus urticae* Koch), McDaniel mite (*Tetranychus mcdanieli* McGregor)); flat mites in the family Tenuipalpidae (e.g., citrus flat mite (*Brevipalpus lewisi* McGregor)); rust and bud mites in the family Eriophyidae and other foliar feeding mites and mites important in human and animal health, i.e. dust mites in the family Epidermoptidae, follicle mites in the family Demodicidae, grain mites in the family Glycyphagidae; ticks in the family Ixodidae, commonly known as hard ticks (e.g., deer tick (*Ixodes scapularis* Say), Australian paralysis tick (*Ixodes holocyclus* Neumann), American dog tick (*Dermacentor variabilis* Say), lone star tick (*Amblyomma americanum* Linnaeus)) and ticks in the family Argasidae, commonly known as soft ticks (e.g., relapsing fever tick (*Ornithodoros turicata*), common fowl tick (*Argas radiatus*)); scab and itch mites in the families Psoroptidae, Pyemotidae, and Sarcoptidae; eggs, adults and immatures of the order Orthoptera including grasshoppers, locusts and crickets (e.g., migratory grasshoppers (e.g., *Melanoplus sanguinipes* Fabricius, *M. differentialis* Thomas), American grasshoppers (e.g., *Schistocerca americana* Drury), desert locust (*Schistocerca gregaria* Forskal), migratory locust (*Locusta migratoria* Linnaeus), bush locust (*Zonocerus* spp.), house cricket (*Acheta domesticus* Linnaeus), mole crickets (e.g., tawny mole cricket (*Scapteriscus vicinus* Scudder) and southern mole cricket (*Scapteriscus borellii* Giglio-Tos)); eggs, adults and immatures of the order Diptera including leafminers (e.g., *Liriomyza* spp. such as serpentine vegetable leafminer (*Liriomyza sativae* Blanchard)), midges, fruit flies (Tephritidae), frit flies (e.g., *Oscinella frit* Linnaeus), soil maggots, house flies (e.g., *Musca domestica* Linnaeus), lesser house flies (e.g., *Fannia canicularis* Linnaeus, *F. femoralis* Stein), stable flies (e.g., *Stomoxys calcitrans* Linnaeus), face flies, horn flies, blow flies (e.g.,

Chrysomya spp., *Phormia* spp.), and other muscoid fly pests, horse flies (e.g., *Tabanus* spp.), bot flies (e.g., *Gastrophilus* spp., *Oestrus* spp.), cattle grubs (e.g., *Hypoderma* spp.), deer flies (e.g., *Chrysops* spp.), keds (e.g., *Melophagus ovinus* Linnaeus) and other Brachycera, mosquitoes (e.g., *Aedes* spp., *Anopheles* spp., *Culex* spp.), black flies (e.g., *Prosimulium* spp.,
 5 *Simulium* spp.), biting midges, sand flies, sciarids, and other Nematocera; eggs, adults and immatures of the order Thysanoptera including onion thrips (*Thrips tabaci* Lindeman), flower thrips (*Frankliniella* spp.), and other foliar feeding thrips; insect pests of the order Hymenoptera including ants of the Family Formicidae including the Florida carpenter ant (*Camponotus floridanus* Buckley), red carpenter ant (*Camponotus ferrugineus* Fabricius),
 10 black carpenter ant (*Camponotus pennsylvanicus* De Geer), white-footed ant (*Technomyrmex albipes* fr. Smith), big headed ants (*Pheidole* sp.), ghost ant (*Tapinoma melanocephalum* Fabricius); Pharaoh ant (*Monomorium pharaonis* Linnaeus), little fire ant (*Wasmannia auropunctata* Roger), fire ant (*Solenopsis geminata* Fabricius), red imported fire ant (*Solenopsis invicta* Buren), Argentine ant (*Iridomyrmex humilis* Mayr), crazy ant
 15 (*Paratrechina longicornis* Latreille), pavement ant (*Tetramorium caespitum* Linnaeus), cornfield ant (*Lasius alienus* Förster) and odorous house ant (*Tapinoma sessile* Say). Other Hymenoptera including bees (including carpenter bees), hornets, yellow jackets, wasps, and sawflies (*Neodiprion* spp.; *Cephus* spp.); insect pests of the order Isoptera including termites in the Termitidae (e.g., *Macrotermes* sp., *Odontotermes obesus* Rambur), Kalotermitidae (e.g.,
 20 *Cryptotermes* sp.), and Rhinotermitidae (e.g., *Reticulitermes* sp., *Coptotermes* sp., *Heterotermes tenuis* Hagen) families, the eastern subterranean termite (*Reticulitermes flavipes* Kollar), western subterranean termite (*Reticulitermes hesperus* Banks), Formosan subterranean termite (*Coptotermes formosanus* Shiraki), West Indian drywood termite (*Incisitermes immigrans* Snyder), powder post termite (*Cryptotermes brevis* Walker),
 25 drywood termite (*Incisitermes snyderi* Light), southeastern subterranean termite (*Reticulitermes virginicus* Banks), western drywood termite (*Incisitermes minor* Hagen), arboreal termites such as *Nasutitermes* sp. and other termites of economic importance; insect pests of the order Thysanura such as silverfish (*Lepisma saccharina* Linnaeus) and firebrat (*Thermobia domestica* Packard); insect pests of the order Mallophaga and including the head
 30 louse (*Pediculus humanus capitis* De Geer), body louse (*Pediculus humanus* Linnaeus), chicken body louse (*Menacanthus stramineus* Nitsch), dog biting louse (*Trichodectes canis* De Geer), fluff louse (*Goniocotes gallinae* De Geer), sheep body louse (*Bovicola ovis* Schrank), short-nosed cattle louse (*Haematopinus eurysternus* Nitzsch), long-nosed cattle louse (*Linognathus vituli* Linnaeus) and other sucking and chewing parasitic lice that attack
 35 man and animals; insect pests of the order Siphonoptera including the oriental rat flea (*Xenopsylla cheopis* Rothschild), cat flea (*Ctenocephalides felis* Bouche), dog flea

(*Ctenocephalides canis* Curtis), hen flea (*Ceratophyllus gallinae* Schrank), sticktight flea (*Echidnophaga gallinacea* Westwood), human flea (*Pulex irritans* Linnaeus) and other fleas afflicting mammals and birds. Additional arthropod pests covered include: spiders in the order Araneae such as the brown recluse spider (*Loxosceles reclusa* Gertsch & Mulaik) and the black widow spider (*Latrodectus mactans* Fabricius), and centipedes in the order Scutigeraomorpha such as the house centipede (*Scutigera coleoptrata* Linnaeus).

Examples of invertebrate pests of stored grain include larger grain borer (*Prostephanus truncatus*), lesser grain borer (*Rhyzopertha dominica*), rice weevil (*Stiophilus oryzae*), maize weevil (*Stiophilus zeamais*), cowpea weevil (*Callosobruchus maculatus*), red flour beetle (*Tribolium castaneum*), granary weevil (*Stiophilus granarius*), Indian meal moth (*Plodia interpunctella*), Mediterranean flour beetle (*Ephestia kuhniella*) and flat or rusty grain beetle (*Cryptolestis ferrugineus*).

Compounds of the present disclosure may have activity on members of the Classes Nematoda, Cestoda, Trematoda, and Acanthocephala including economically important members of the orders Strongylida, Ascaridida, Oxyurida, Rhabditida, Spirurida, and Enoplida such as but not limited to economically important agricultural pests (i.e. root knot nematodes in the genus *Meloidogyne*, lesion nematodes in the genus *Pratylenchus*, stubby root nematodes in the genus *Trichodorus*, etc.) and animal and human health pests (i.e. all economically important flukes, tapeworms, and roundworms, such as *Strongylus vulgaris* in horses, *Toxocara canis* in dogs, *Haemonchus contortus* in sheep, *Dirofilaria immitis* Leidy in dogs, *Anoplocephala perfoliata* in horses, *Fasciola hepatica* Linnaeus in ruminants, etc.).

Compounds of the disclosure show particularly high activity against pests in the order Lepidoptera (e.g., *Alabama argillacea* Hübner (cotton leaf worm), *Archips argyrospila* Walker (fruit tree leaf roller), *A. rosana* Linnaeus (European leaf roller) and other *Archips* species, *Chilo suppressalis* Walker (rice stem borer), *Cnaphalocrosis medinalis* Guenée (rice leaf roller), *Crambus caliginosellus* Clemens (corn root webworm), *Crambus teterrellus* Zincken (bluegrass webworm), *Cydia pomonella* Linnaeus (codling moth), *Earias insulana* Boisduval (spiny bollworm), *Earias vittella* Fabricius (spotted bollworm), *Helicoverpa armigera* Hübner (American bollworm), *Helicoverpa zea* Boddie (corn earworm), *Heliothis virescens* Fabricius (tobacco budworm), *Herpetogramma licarsisalis* Walker (sod webworm), *Lobesia botrana* Denis & Schiffermüller (grape berry moth), *Pectinophora gossypiella* Saunders (pink bollworm), *Phyllocnistis citrella* Stainton (citrus leafminer), *Pieris brassicae* Linnaeus (large white butterfly), *Pieris rapae* Linnaeus (small white butterfly), *Plutella xylostella* Linnaeus (diamondback moth), *Spodoptera exigua* Hübner (beet armyworm), *Spodoptera litura* Fabricius (tobacco cutworm, cluster caterpillar), *Spodoptera frugiperda* J.

E. Smith (fall armyworm), *Trichoplusia ni* Hübner (cabbage looper) and *Tuta absoluta* Meyrick (tomato leafminer)).

Compounds of the disclosure may also have significant activity on members from the order Hemiptera including: *Acyrtosiphon pisum* Harris (pea aphid), *Aphis craccivora* Koch (cowpea aphid), *Aphis fabae* Scopoli (black bean aphid), *Aphis gossypii* Glover (cotton aphid, 5 melon aphid), *Aphis pomi* De Geer (apple aphid), *Aphis spiraeicola* Patch (spirea aphid), *Aulacorthum solani* Kaltenbach (foxglove aphid), *Chaetosiphon fragaefolii* Cockerell (strawberry aphid), *Diuraphis noxia* Kurdjumov/Mordvilko (Russian wheat aphid), *Dysaphis plantaginea* Passerini (rosy apple aphid), *Eriosoma lanigerum* Hausmann (woolly apple aphid), *Hyalopterus pruni* Geoffroy (mealy plum aphid), *Lipaphis pseudobrassicae* Davis (turnip aphid), *Metopolophium dirhodum* Walker (rose-grain aphid), *Macrosiphum euphorbiae* Thomas (potato aphid), *Myzus persicae* Sulzer (peach-potato aphid, green peach aphid), *Nasonovia ribisnigri* Mosley (lettuce aphid), *Pemphigus* spp. (root aphids and gall aphids), *Rhopalosiphum maidis* Fitch (corn leaf aphid), *Rhopalosiphum padi* Linnaeus (bird 10 cherry-oat aphid), *Schizaphis graminum* Rondani (greenbug), *Sitobion avenae* Fabricius (English grain aphid), *Therioaphis maculata* Buckton (spotted alfalfa aphid), *Toxoptera aurantii* Boyer de Fonscolombe (black citrus aphid), and *Toxoptera citricidus* Kirkaldy (brown citrus aphid); *Adelges* spp. (adelgids); *Phylloxera devastatrix* Pergande (pecan phylloxera); *Bemisia tabaci* Gennadius (tobacco whitefly, sweetpotato whitefly), *Bemisia argentifolii* Bellows & Perring (silverleaf whitefly), *Dialeurodes citri* Ashmead (citrus whitefly) and *Trialeurodes vaporariorum* Westwood (greenhouse whitefly); *Empoasca fabae* Harris (potato leafhopper), *Laodelphax striatellus* Fallen (smaller brown planthopper), *Macrostelus quadrilineatus* Forbes (aster leafhopper), *Nephotettix cincticeps* Uhler (green rice leafhopper), *Nephotettix nigropictus* Stål (rice leafhopper), *Nilaparvata lugens* Stål (brown 25 planthopper), *Peregrinus maidis* Ashmead (corn planthopper), *Sogatella furcifera* Horvath (white-backed planthopper), *Tagosodes orizicolus* Muir (rice delphacid), *Typhlocyba pomaria* McAtee (white apple leafhopper), *Erythroneura* spp. (grape leafhoppers); *Magicidada septendecim* Linnaeus (periodical cicada); *Icerya purchasi* Maskell (cottony cushion scale), *Quadraspidiotus perniciosus* Comstock (San Jose scale); *Planococcus citri* Risso (citrus mealybug); *Pseudococcus* spp. (other mealybug complex); *Cacopsylla pyricola* Foerster (pear psylla), *Trioza diospyri* Ashmead (persimmon psylla).

Compounds of this disclosure also have activity on members from the order Hemiptera including: *Acrosternum hilare* Say (green stink bug), *Anasa tristis* De Geer (squash bug), *Blissus leucopterus leucopterus* Say (chinch bug), *Cimex lectularius* Linnaeus (bed bug) 35 *Corythucha gossypii* Fabricius (cotton lace bug), *Cyrtopeltis modesta* Distant (tomato bug), *Dysdercus suturellus* Herrich-Schäffer (cotton stainer), *Euchistus servus* Say (brown stink

bug), *Euchistus variolarius* Palisot de Beauvois (one-spotted stink bug), *Graptosthetus* spp. (complex of seed bugs), *Halymorpha halys* Stål (brown marmorated stink bug), *Leptoglossus corculus* Say (leaf-footed pine seed bug), *Lygus lineolaris* Palisot de Beauvois (tarnished plant bug), *Nezara viridula* Linnaeus (southern green stink bug), *Oebalus pugnax* Fabricius (rice stink bug), *Oncopeltus fasciatus* Dallas (large milkweed bug), *Pseudatomoscelis seriatus* Reuter (cotton fleahopper). Other insect orders controlled by compounds of the disclosure include Thysanoptera (e.g., *Frankliniella occidentalis* Pergande (western flower thrips), *Scirtothrips citri* Moulton (citrus thrips), *Sericothrips variabilis* Beach (soybean thrips), and *Thrips tabaci* Lindeman (onion thrips); and the order Coleoptera (e.g., *Leptinotarsa decemlineata* Say (Colorado potato beetle), *Epilachna varivestis* Mulsant (Mexican bean beetle) and wireworms of the genera *Agriotes*, *Athous* or *Limonius*).

Of note is use of compounds of this disclosure for controlling western flower thrip (*Frankliniella occidentalis*). Of note is use of compounds of this disclosure for controlling diamondback moth (*Plutella xylostella*). Of note is use of compounds of this disclosure for controlling fall armyworm (*Spodoptera frugiperda*).

Compounds of the present disclosure are also 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.

5 The compounds of the present disclosure can increase the vigor of treated plants compared to untreated plants by killing or otherwise preventing feeding of phytophagous invertebrate pests in the environment of the plants. In the absence of such control of phytophagous invertebrate pests, the pests reduce plant vigor by consuming plant tissues or sap, or transmitting plant pathogens such as viruses. Even in the absence of phytophagous invertebrate pests, the compounds of the disclosure may increase plant vigor by modifying
10 metabolism of plants. Generally, the vigor of a crop plant will be most significantly increased by treating the plant with a compound of the disclosure 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 the present method for increasing vigor of a crop plant wherein the crop plant
15 is grown in an environment comprising phytophagous invertebrate pests. Also of note is the present method for increasing vigor of a crop plant wherein the crop plant is grown in an environment not comprising phytophagous invertebrate pests. Also of note is the present 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. Of
20 note is the present method for increasing vigor of a crop plant wherein the crop is rice. Also of note is the present method for increasing vigor of a crop plant wherein the crop is maize (corn). Also of note is the present method for increasing vigor of a crop plant wherein the crop is soybean.

Compounds of this disclosure can also be mixed with one or more other biologically
25 active compounds or agents including insecticides, fungicides, nematocides, bactericides, acaricides, herbicides, herbicide safeners, growth regulators such as insect molting inhibitors and rooting stimulants, chemosterilants, semiochemicals, repellents, attractants, pheromones, feeding stimulants, other biologically active compounds or entomopathogenic bacteria, virus or fungi to form a multi-component pesticide giving an even broader spectrum of agronomic
30 and nonagronomic utility. Thus the present disclosure also pertains to a composition comprising a biologically effective amount of a compound of Formula 1, at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents, and at least one additional biologically active compound or agent. For mixtures of the present disclosure, the other biologically active compounds or agents can be formulated together with
35 the present compounds, including the compounds of Formula 1, to form a premix, or the other biologically active compounds or agents can be formulated separately from the present

compounds, including the compounds of Formula 1, and the two formulations combined together before application (e.g., in a spray tank) or, alternatively, applied in succession.

Examples of such biologically active compounds or agents with which compounds of this disclosure can be formulated are insecticides such as abamectin, acephate, acequinocyl, acetamiprid, acrinathrin, acynonapyr, afidopyropen ([*(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), amidothymol, amitraz, avermectin, azadirachtin, azinphos-methyl, benfuracarb, bensultap, benzpyrimoxan, bifenthrin, kappa-bifenthrin, bifenazate, bistrifluron, borate, broflanilide, buprofezin, cadusafos, carbaryl, carbofuran, cartap, carzol, chlorantraniliprole, chlorfenapyr, chlorflazuron, chloroprallethrin, chlorpyrifos, chlorpyrifos-*e*, chlorpyrifos-methyl, chromafenozide, clofentezin, chloroprallethrin, 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), cycloprothrin, 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), cyenopyrafen, cyflumetofen, cyfluthrin, beta-cyfluthrin, cyhalodiamide, cyhalothrin, gamma-cyhalothrin, lambda-cyhalothrin, cypermethrin, alpha-cypermethrin, zeta-cypermethrin, cyromazine, deltamethrin, diafenthiuron, diazinon, dicloromesotiaz, dieldrin, diflubenzuron, dimefluthrin, dimehypo, dimethoate, dimpropridaz, dinotefuran, diofenolan, emamectin, emamectin benzoate, endosulfan, esfenvalerate, ethiprole, etofenprox, epsilon-metofluthrin, etoxazole, fenbutatin oxide, fenitrothion, fenothiocarb, fenoxycarb, fenpropathrin, fenvalerate, fipronil, flometoquin (2-ethyl-3,7-dimethyl-6-[4-(trifluoromethoxy)phenoxy]-4-quinolinyl methyl carbonate), flonicamid, fluazaindolizine, flubendiamide, flucythrinate, flufenerim, flufenoxuron, 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), fluhexafon, fluopyram, 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), flupyrimin, fluvalinate, tau-fluvalinate, fluxametamide, fonophos, formetanate, fosthiazate, gamma-cyhalothrin, 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, hexythiazox, hydramethylnon, imidacloprid, indoxacarb, insecticidal soaps, isofenphos, isocycloseram, kappa-tefluthrin, lambda-cyhalothrin, 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, methiocarb, methomyl, methoprene, methoxychlor, metofluthrin, methoxyfenozide, epsilon-metofluthrin, epsilon-momfluorothrin, monocrotophos, monofluorothrin ([2,3,5,6-tetrafluoro-4-(methoxymethyl)phenyl]methyl 3-(2-cyano-1-propen-1-yl)-2,2-dimethylcyclopropanecarboxylate), nicotine, nitenpyram, nithiazine, novaluron, noviflumuron, oxamyl, oxazosulfonyl, parathion, parathion-methyl, permethrin, phorate, phosalone, phosmet, phosphamidon, pirimicarb, profenofos, profluthrin, propargite, prothifonbutyl, 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), pymetrozine, pyrafluprole, pyrethrin, pyridaben, pyridalyl, pyriproxyfen, pyriminostrobin (methyl (*αE*)-2-[[[2-(2,4-dichlorophenyl)amino]-6-(trifluoromethyl)-4-pyrimidinyl]oxy]methyl]-*α*-(methoxymethylene)benzeneacetate), pyriprole, pyriproxyfen, rotenone, ryanodine, silafluofen, spinetoram, spinosad, spiromesifen, spiropidion, spirotetramat, sulprofos, sulfoxaflor (*N*-[methyloxido[1-[6-(trifluoromethyl)-3-pyridinyl]ethyl]- λ^4 -sulfanylidene]cyanamide), tebufenozide, tebufenpyrad, teflubenzuron, tefluthrin, kappa-tefluthrin, terbufos, tetrachlorantraniliprole, tetrachlorvinphos, tetramethrin, tetramethylfluthrin ([2,3,5,6-tetrafluoro-4-(methoxymethyl)phenyl]methyl 2,2,3,3-tetramethylcyclopropanecarboxylate), tetraniliprole, thiacloprid, thiamethoxam, thiodicarb, thiosultap-sodium, tioazafen (3-phenyl-5-(2-thienyl)-1,2,4-oxadiazole), tolfenpyrad, tralomethrin, triazamate, trichlorfon, triflumezopyrim (2,4-dioxo-1-(5-pyrimidinylmethyl)-3-[3-(trifluoromethyl)phenyl]-2*H*-pyrido[1,2-*a*]pyrimidinium inner salt), triflumuron, tyclopyrazoflor, zeta-cypermethrin, *Bacillus thuringiensis* delta-endotoxins, entomopathogenic bacteria, entomopathogenic viruses or entomopathogenic fungi.
- Of note are insecticides such as abamectin, acetamiprid, acrinathrin, acynonapyr, afidopyropen, amitraz, avermectin, azadirachtin, benfuracarb, bensultap, bifenthrin, buprofezin, broflanilide, cadusafos, carbaryl, cartap, chlorantraniliprole, chloroprallethrin, chlorfenapyr, chlorpyrifos, clothianidin, cyantraniliprole, cyclaniliprole, cycloprothrin, cyfluthrin, beta-cyfluthrin, cyhalothrin, gamma-cyhalothrin, lambda-cyhalothrin, cypermethrin, alpha-cypermethrin, zeta-cypermethrin, cyromazine, deltamethrin, dieldrin, dinotefuran, diofenolan, emamectin, endosulfan, epsilon-metofluthrin, esfenvalerate, ethiprole, etofenprox, etoxazole, fenitrothion, fenothiocarb, fenoxycarb, fenvalerate, fipronil, flometoquin, fluxametamide, flonicamid, flubendiamide, fluensulfone, flufenoxuron, flufenoxystrobin, flufensulfone, flupiprole, flupyrimin, flupyradifurone, fluvalinate, formetanate, fosthiazate, gamma-cyhalothrin, heptafluthrin, hexaflumuron, hydramethylnon, imidacloprid, indoxacarb, isocycloseram, kappa-tefluthrin, lambda-cyhalothrin, lufenuron,

meperfluthrin, metaflumizone, methiodicarb, methomyl, methoprene, methoxyfenozide, metofluthrin, monofluorothrin, nitenpyram, nithiazine, novaluron, oxamyl, pyflubumide, pymetrozine, pyrethrin, pyridaben, pyridalyl, pyriminostrobin, pyriproxyfen, ryanodine, spinetoram, spinosad, spirotetramat, sulfoxaflor, tebufenozide, tetramethrin, tetramethylfluthrin, thiacloprid, thiamethoxam, thiodicarb, thiosultap-sodium, tralomethrin, triazamate, triflumezopyrim, triflumuron, tyclopyrazoflor, zeta-cypermethrin, *Bacillus thuringiensis* delta-endotoxins, all strains of *Bacillus thuringiensis* and all strains of nucleopolyhedrovirus.

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 MVP-II® bioinsecticides prepared by the CellCap® process (CellCap®, MVP® and MVP-II® 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, nucleopolyhedrovirus (NPV) such as *Helicoverpa zea* nucleopolyhedrovirus (HzNPV), *Anagrapha falcifera* nucleopolyhedrovirus (AfNPV); and granulosis virus (GV) such as *Cydia pomonella* granulosis virus (CpGV).

One embodiment of biological agents for mixing with compounds of this disclosure include one or a combination of (i) a bacterium of the genus *Actinomyces*, *Agrobacterium*, *Arthrobacter*, *Alcaligenes*, *Aureobacterium*, *Azobacter*, *Bacillus*, *Beijerinckia*, *Bradyrhizobium*, *Brevibacillus*, *Burkholderia*, *Chromobacterium*, *Clostridium*, *Clavibacter*, *Comamonas*, *Corynebacterium*, *Curtobacterium*, *Enterobacter*, *Flavobacterium*, *Gluconobacter*, *Hydrogenophaga*, *Klebsiella*, *Methylobacterium*, *Paenibacillus*, *Pasteuria*, *Photorhabdus*, *Phyllobacterium*, *Pseudomonas*, *Rhizobium*, *Serratia*, *Sphingobacterium*, *Stenotrophomonas*, *Streptomyces*, *Variovorax*, or *Xenorhabdus*, for example a bacterium of *Bacillus amyloliquefaciens*, *Bacillus cereus*, *Bacillus firmus*, *Bacillus licheniformis*, *Bacillus pumilus*, *Bacillus sphaericus*, *Bacillus subtilis*, *Bacillus thuringiensis*, *Bradyrhizobium japonicum*, *Chromobacterium subtsugae*, *Pasteuria nishizawae*, *Pasteuria penitans*, *Pasteuria usage*, *Pseudomonas fluorescens*, and *Streptomyces lydicus*; (ii) a fungus such as green muscardine fungus; (iii) a virus including baculovirus, nucleopolyhedrovirus such as *Helicoverpa zea* nucleopolyhedrovirus, *Anagrapha falcifera* nucleopolyhedrovirus; granulosis virus such as *Cydia pomonella* granulosis virus.

Of particular note is such a combination where the other invertebrate pest control active ingredient belongs to a different chemical class or has a different site of action than compounds of Formula 1. In certain instances, a combination with at least one other invertebrate pest control 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 disclosure can further comprise a biologically effective amount of at least one additional invertebrate pest control active ingredient having a similar spectrum of control but belonging to a different chemical class or having a different site of action. These additional biologically

5 active compounds or agents include, but are not limited to, acetylcholinesterase (AChE) inhibitors such as the carbamates methomyl, oxamyl, thiodicarb, triazamate, and the organophosphates chlorpyrifos; GABA-gated chloride channel antagonists such as the cyclodienes dieldrin and endosulfan, and the phenylpyrazoles ethiprole and fipronil; sodium

10 channel modulators such as the pyrethroids bifenthrin, cyfluthrin, *beta*-cyfluthrin, cyhalothrin, *lambda*-cyhalothrin, cypermethrin, deltamethrin, dimefluthrin, esfenvalerate, metofluthrin and profluthrin; nicotinic acetylcholinereceptor (nAChR) agonists such as the neonicotinoids acetamiprid, clothianidin, dinotefuran, imidacloprid, nitenpyram, nithiazine, thiacloprid, and thiamethoxam, and sulfoxaflor; nicotinic acetylcholine receptor (nAChR) allosteric activators

15 such as the spinosyns spinetoram and spinosad; chloride channel activators such as the avermectins abamectin and emamectin; juvenile hormone mimics such as diofenolan, methoprene, fenoxycarb and pyriproxyfen; selective homopteran feeding blockers such as pymetrozine and flonicamid; mite growth inhibitors such as etoxazole; inhibitors of mitochondrial ATP synthase such as propargite; uncouplers of oxidative phosphorylation via disruption of the proton gradient such as chlorfenapyr; nicotinic acetylcholine receptor

20 (nAChR) channel blockers such as the nereistoxin analogs cartap; inhibitors of chitin biosynthesis such as the benzoylureas flufenoxuron, hexaflumuron, lufenuron, novaluron, noviflumuron and triflumuron, and buprofezin; dipteran moulting disrupters such as cyromazine; ecdysone receptor agonists such as the diacylhydrazines methoxyfenozide and tebufenozide; octopamine receptor agonists such as amitraz; mitochondrial complex III

25 electron transport inhibitors such as hydramethylnon; mitochondrial complex I electron transport inhibitors such as pyridaben; voltage-dependent sodium channel blockers such as indoxacarb; inhibitors of acetyl CoA carboxylase such as the tetrone and tetramic acids spirodiclofen, spiromesifen and spirotetramat; mitochondrial complex II electron transport inhibitors such as the β -ketonitriles cyenopyrafen and cyflumetofen; ryanidine receptor

30 modulators such as the anthranilic diamides chlorantraniliprole, cyantraniliprole and cyantraniliprole, diamides such as flubendiamide, and ryanodine receptor ligands such as ryanodine; compounds wherein the target site responsible for biological activity is unknown or uncharacterized such as azadirachtin, bifenazate, pyridalyl, pyrifluquinazon and triflumezopyrim; microbial disrupters of insect midgut membranes such as *Bacillus*

35 *thuringensis* and the delta-endotoxins they produce and *Bacillus sphaericus*; and biological

agents including nucleopolyhedroviruses (NPV) and other naturally occurring or genetically modified insecticidal viruses.

Further examples of biologically active compounds or agents with which compounds of this disclosure can be formulated are: fungicides such as acibenzolar-S-methyl, aldimorph, ametoctradin, aminopyrifin, amisulbrom, anilazine, azaconazole, azoxystrobin, benalaxyl (including benalaxyl-M), benodanil, benomyl, benthiavalicarb (including benthiavalicarb-isopropyl), benzovindiflupyr, bethoxazin, binapacryl, biphenyl, bitertanol, bixafen, blastocidin-S, boscalid, bromuconazole, bupirimate, buthiobate, carboxin, carpropamid, captan, captan, carbendazim, chloroneb, chlorothalonil, chlozolinate, copper hydroxide, copper oxychloride, copper sulfate, coumoxystrobin, cyazofamid, cyflufenamid, cymoxanil, cyproconazole, cyprodinil, dichlobentiaxox, dichlofluanid, diclocymet, diclomezine, dicloran, diethofencarb, difenoconazole, diflumetorim, dimethirimol, dimethomorph, dimoxystrobin, diniconazole (including diniconazole-M), dinocap, dipymetitrone, dithianon, dithiolanes, dodemorph, dodine, econazole, etaconazole, edifenphos, enoxastrobin (also known as enestroburin), epoxiconazole, ethaboxam, ethirimol, etridiazole, famoxadone, fenamidone, fenaminstrobin, fenarimol, fenbuconazole, fenfuram, fenhexamide, fenoxanil, fenciclonil, fencicloxamid, fenpropidin, fenpropimorph, fenpyrazamine, fentin acetate, fentin hydroxide, ferbam, ferimzone, flometoquin, florylpicoxamid, fluopimomide, fluazinam, fludioxonil, fluoxystrobin, fluindapyr, flumorph, fluopicolide, fluopyram, fluoxapiprolin, fluoxastrobin, fluquinconazole, flusilazole, flusulfamide, flutianil, flutolanil, flutriafol, fluxapyroxad, folpet, fthalide (also known as phthalide), fuberidazole, furalaxyl, furametpyr, hexaconazole, hymexazole, guazatine, imazalil, imibenconazole, iminoctadine albesilate, iminoctadine triacetate, inpyrfluxam, iodicarb, ipconazole, ipfentrifluconazole, ipflufenquin, isofetamid, iprobenfos, iprodione, iprovalicarb, isoflucypram, isoprothiolane, isopyrazam, isotianil, kasugamycin, kresoxim-methyl, lancotrione, mancozeb, mandipropamid, mandestrobin, maneb, mapanipyrin, mefentrifluconazole, mepronil, meptyldinocap, metalaxyl (including metalaxyl-M/mefenoxam), metconazole, methasulfocarb, metiram, metominostrobin, metyltetraprole, metrafenone, myclobutanil, naftitine, neo-asozin (ferric methanearsonate), nuarimol, oclithionone, ofurace, orysastrobin, oxadixyl, oxathiapiprolin, oxolinic acid, oxpoconazole, oxycarboxin, oxytetracycline, penconazole, pencycuron, penflufen, penthiopyrad, perflurazate, phosphorous acid (including salts thereof, e.g., fosetyl-aluminum), picoxystrobin, piperazin, polyoxin, probenazole, prochloraz, procymidone, propamocarb, propiconazole, propineb, proquinazid, prothiocarb, prothioconazole, pydiflumetofen (Adepidyn[®]), pyraclostrobin, pyrametostrobin, pyrapropoyne, pyraoxystrobin, pyraziflumid, pyrazophos, pyribencarb, pyributacarb, pyridachlometyl, pyrifenoxy, pyriofenone, perisoxazole, pyrimethanil, pyrifenoxy, pyrrolnitrin, pyroquilon,

quinconazole, quinmethionate, quinofumelin, quinoxifen, quintozone, silthiofam, sedaxane, simeconazole, spiroxamine, streptomycin, sulfur, tebuconazole, tebufloquin, tecloftalam, tecloftalam, tecnazene, terbinafine, tetraconazole, thiabendazole, thifluzamide, thiophanate, thiophanate-methyl, thiram, tiadinil, tolclofos-methyl, tolprocarb, tolyfluanid, triadimefon, triadimenol, triarimol, triazoxide, tribasic copper sulfate, triclopyricarb, tridemorph, trifloxystrobin, triflumizole, trimoprhamide, tricyclazole, trifloxystrobin, triforine, triticonazole, uniconazole, validamycin, valifenalate (also known as valifenal), vinclozolin, zineb, ziram, zoxamide and 1-[4-[4-[5-(2,6-difluorophenyl)-4,5-dihydro-3-isoxazolyl]-2-thiazolyl]-1-piperidinyl]-2-[5-methyl-3-(trifluoromethyl)-1H-pyrazol-1-yl]ethanone;

nematocides such as fluopyram, spirotetramat, thiodicarb, fosthiazate, abamectin, iprodione, fluensulfone, dimethyl disulfide, tioazafen, 1,3-dichloropropene (1,3-D), metam (sodium and potassium), dazomet, chloropicrin, fenamiphos, ethoprophos, cadusaphos, terbufos, imicyafos, oxamyl, carbofuran, tioazafen, *Bacillus firmus* and *Pasteuria nishizawae*; bactericides such as streptomycin; acaricides such as amitraz, chinomethionat, chlorobenzilate, cyhexatin, dicofol, dienochlor, etoxazole, fenazaquin, fenbutatin oxide, fenpropathrin, fenpyroximate, hexythiazox, propargite, pyridaben and tebufenpyrad.

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

Compounds of this disclosure and compositions thereof can be applied to plants genetically transformed to express proteins toxic to invertebrate pests (such as *Bacillus thuringiensis* delta-endotoxins). Such an application may provide a broader spectrum of plant protection and be advantageous for resistance management. The exogenously applied invertebrate pest control compounds of this disclosure in combination with the expressed toxin proteins may provide an enhanced effect.

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.

Compounds of this disclosure can be combined or formulated with polynucleotides including, but not limited to, DNA, RNA, and/or chemically modified nucleotides influencing

the amount of a particular target through down regulation, interference, suppression or silencing of the genetically derived transcript that render an insecticidal effect.

For embodiments where one or more of these various mixing partners are used, the weight ratio of these various mixing partners (in total) to the compound of Formula 1 is typically between about 1:3000 and about 3000:1. Of note are weight ratios between about 1:300 and about 300:1 (for example ratios between about 1:30 and about 30:1). One skilled in the art can easily determine through simple experimentation the biologically effective amounts of active ingredients necessary for the desired spectrum of biological activity. It will be evident that including these additional components can expand the spectrum of invertebrate pests controlled beyond the spectrum controlled by the compound of Formula 1 alone.

Invertebrate pests are controlled in agronomic and nonagronomic applications by applying one or more compounds of this disclosure, typically in the form of a composition, in a biologically effective amount, to the environment of the pests, including the agronomic and/or nonagronomic locus of infestation, to the area to be protected, or directly on the pests to be controlled.

Thus the present disclosure comprises a method for controlling an invertebrate pest in agronomic and/or nonagronomic applications, comprising contacting the invertebrate pest or its environment with a biologically effective amount of one or more of the compounds of the disclosure, or with a composition comprising at least one such compound or a composition comprising at least one such compound and a biologically effective amount of at least one additional biologically active compound or agent. Examples of suitable compositions comprising a compound of the disclosure and a biologically effective amount of at least one additional biologically active compound or agent include granular compositions wherein the additional active compound is present on the same granule as the compound of the disclosure or on granules separate from those of the compound of the disclosure.

To achieve contact with a compound or composition of the disclosure to protect a field crop from invertebrate pests, the compound or composition is typically applied to the seed of the crop before planting, to the foliage (e.g., leaves, stems, flowers, fruits) of crop plants, or to the soil or other growth medium before or after the crop is planted.

One embodiment of a method of contact is by spraying. Alternatively, a granular composition comprising a compound of the disclosure can be applied to the plant foliage or the soil. Compounds of this disclosure can also be effectively delivered through plant uptake by contacting the plant with a composition comprising a compound of this disclosure applied as a soil drench of a liquid formulation, a granular formulation to the soil, a nursery box treatment or a dip of transplants. Of note is a composition of the present disclosure in the form of a soil drench liquid formulation. Also of note is a method for controlling an invertebrate

pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of a compound of the present disclosure or with a composition comprising a biologically effective amount of a compound of the present disclosure. Of further note is this method wherein the environment is soil and the composition is applied to the soil as a soil drench formulation. Of further note is that compounds of this disclosure are also effective by localized application to the locus of infestation. Other methods of contact include application of a compound or a composition of the disclosure by direct and residual sprays, aerial sprays, gels, seed coatings, microencapsulations, systemic uptake, baits, ear tags, boluses, foggers, fumigants, aerosols, dusts and many others. One embodiment of a method of contact is a dimensionally stable fertilizer granule, stick or tablet comprising a compound or composition of the disclosure. The compounds of this disclosure can also be impregnated into materials for fabricating invertebrate control devices (e.g., insect netting).

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

Genetically modified plant and seed cultivars which can be treated according to the disclosure 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 and seeds can be genetically modified to exhibit traits of, for example, herbicide tolerance, insect-resistance, modified oil profiles or drought tolerance. Useful genetically modified plants and seeds containing single gene transformation events or combinations of transformation events are listed in Table Z. Additional information for the genetic modifications listed in Table Z can be obtained from the following databases:

<http://www2.oecd.org/biotech/byidentifier.aspx>

<http://www.aphis.usda.gov>

<http://gmoinfo.jrc.ec.europa.eu>

The following abbreviations are used in Table Z which follows: tol. is tolerance, res. is resistance, SU is sulfonylurea, ALS is acetolactate synthase, HPPD is 4-Hydroxyphenylpyruvate Dioxygenase, NA is Not Available?

Table Z

Crop	Event Name	Event Code	Trait(s)	Gene(s)
------	------------	------------	----------	---------

Alfalfa	J101	MON-00101-8	Glyphosate tol.	cp4 epsps (aroA:CP4)
Alfalfa	J163	MON-ØØ163-7	Glyphosate tol.	cp4 epsps (aroA:CP4)
Canola*	23-18-17 (Event 18)	CGN-89465-2	High lauric acid oil	te
Canola*	23-198 (Event 23)	CGN-89465-2	High lauric acid oil	te
Canola*	61061	DP-Ø61Ø61-7	Glyphosate tol.	gat4621
Canola*	73496	DP-Ø73496-4	Glyphosate tol.	gat4621
Canola*	GT200 (RT200)	MON-89249-2	Glyphosate tol.	cp4 epsps (aroA:CP4); goxv247
Canola*	GT73 (RT73)	MON-ØØØ73-7	Glyphosate tol.	cp4 epsps (aroA:CP4); goxv247
Canola*	HCN10 (Topas 19/2)	NA	Glufosinate tol.	bar
Canola*	HCN28 (T45)	ACS-BNØØ8-2	Glufosinate tol.	pat (syn)
Canola*	HCN92 (Topas 19/2)	ACS-BNØØ7-1	Glufosinate tol.	bar
Canola*	MON88302	MON-883Ø2-9	Glyphosate tol.	cp4 epsps (aroA:CP4)
Canola*	MPS961	NA	Phytate breakdown	phyA
Canola*	MPS962	NA	Phytate breakdown	phyA
Canola*	MPS963	NA	Phytate breakdown	phyA
Canola*	MPS964	NA	Phytate breakdown	phyA
Canola*	MPS965	NA	Phytate breakdown	phyA
Canola*	MS1 (B91-4)	ACS-BNØØ4-7	Glufosinate tol.	bar
Canola*	MS8	ACS-BNØØ5-8	Glufosinate tol.	bar
Canola*	OXY-235	ACS-BNØ11-5	Oxynil tol.	bxn
Canola*	PHY14	NA	Glufosinate tol.	bar
Canola*	PHY23	NA	Glufosinate tol.	bar
Canola*	PHY35	NA	Glufosinate tol.	bar
Canola*	PHY36	NA	Glufosinate tol.	bar
Canola*	RF1 (B93-101)	ACS-BNØØ1-4	Glufosinate tol.	bar
Canola*	RF2 (B94-2)	ACS-BNØØ2-5	Glufosinate tol.	bar
Canola*	RF3	ACS-BNØØ3-6	Glufosinate tol.	bar
Bean	EMBRAPA 5.1	EMB-PV051-1	Disease res.	ac1 (sense and antisense)
Brinjal (Eggplant)	EE-1		Insect res.	cry1Ac
Carnation	11 (7442)	FLO-07442-4	SU tol.; modified flower color	surB; dfr; hfl (f3'5'h)
Carnation	11363 (1363A)	FLO-11363-1	SU tol.; modified flower color	surB; dfr; bp40 (f3'5'h)
Carnation	1226A (11226)	FLO-11226-8	SU tol.; modified flower color	surB; dfr; bp40 (f3'5'h)
Carnation	123.2.2 (40619)	FLO-4Ø619-7	SU tol.; modified flower color	surB; dfr; hfl (f3'5'h)
Carnation	123.2.38 (40644)	FLO-4Ø644-4	SU tol.; modified flower color	surB; dfr; hfl (f3'5'h)

Carnation	123.8.12	FLO-40689-6	SU tol.; modified flower color	surB; dfr; bp40 (f3'5'h)
Carnation	123.8.8 (40685)	FLO-40685-1	SU tol.; modified flower color	surB; dfr; bp40 (f3'5'h)
Carnation	1351A (11351)	FLO-11351-7	SU tol.; modified flower color	surB; dfr; bp40 (f3'5'h)
Carnation	1400A (11400)	FLO-11400-2	SU tol.; modified flower color	surB; dfr; bp40 (f3'5'h)
Carnation	15	FLO-00015-2	SU tol.; modified flower color	surB; dfr; hfl (f3'5'h)
Carnation	16	FLO-00016-3	SU tol.; modified flower color	surB; dfr; hfl (f3'5'h)
Carnation	4	FLO-00004-9	SU tol.; modified flower color	surB; dfr; hfl (f3'5'h)
Carnation	66	FLO-00066-8	SU tol.; delayed senescence	surB; acc
Carnation	959A (11959)	FLO-11959-3	SU tol.; modified flower color	surB; dfr; bp40 (f3'5'h)
Carnation	988A (11988)	FLO-11988-7	SU tol.; modified flower color	surB; dfr; bp40 (f3'5'h)
Carnation	26407	IFD-26497-2	SU tol.; modified flower color	surB; dfr; bp40 (f3'5'h)
Carnation	25958	IFD-25958-3	SU tol.; modified flower color	surB; dfr; bp40 (f3'5'h)
Chicory	RM3-3	NA	Glufosinate tol.	bar
Chicory	RM3-4	NA	Glufosinate tol.	bar
Chicory	RM3-6	NA	Glufosinate tol.	bar
Cotton	19-51a	DD-01951A-7	ALS herbicide tol.	S4-HrA
Cotton	281-24-236	DAS-24236-5	Glufosinate tol.; insect res.	pat (syn); cry1F
Cotton	3006-210-23	DAS-21023-5	Glufosinate tol.; insect res.	pat (syn); cry1Ac
Cotton	31707	NA	Oxynil tol.; insect res.	bxn; cry1Ac
Cotton	31803	NA	Oxynil tol.; insect res.	bxn; cry1Ac
Cotton	31807	NA	Oxynil tol.; insect res.	bxn; cry1Ac
Cotton	31808	NA	Oxynil tol.; insect res.	bxn; cry1Ac
Cotton	42317	NA	Oxynil tol.; insect res.	bxn; cry1Ac
Cotton	BNLA-601	NA	Insect res.	cry1Ac
Cotton	BXN10211	BXN10211-9	Oxynil tol.	bxn; cry1Ac
Cotton	BXN10215	BXN10215-4	Oxynil tol.	bxn; cry1Ac
Cotton	BXN10222	BXN10222-2	Oxynil tol.	bxn; cry1Ac
Cotton	BXN10224	BXN10224-4	Oxynil tol.	bxn; cry1Ac
Cotton	COT102	SYN-IR102-7	Insect res.	vip3A(a)
Cotton	COT67B	SYN-IR67B-1	Insect res.	cry1Ab
Cotton	COT202		Insect res.	vip3A
Cotton	Event 1	NA	Insect res.	cry1Ac
Cotton	GMF Cry1A	GTL-GMF311-7	Insect res.	cry1Ab-Ac
Cotton	GHB119	BCS-GH005-8	Insect res.	cry2Ae

Cotton	GHB614	BCS-GH002-5	Glyphosate tol.	2mepsps
Cotton	GK12	NA	Insect res.	cry1Ab-Ac
Cotton	LLCotton25	ACS-GH001-3	Glufosinate tol.	bar
Cotton	MLS 9124	NA	Insect res.	cry1C
Cotton	MON1076	MON-89924-2	Insect res.	cry1Ac
Cotton	MON1445	MON-01445-2	Glyphosate tol.	cp4 epsps (aroA:CP4)
Cotton	MON15985	MON-15985-7	Insect res.	cry1Ac; cry2Ab2
Cotton	MON1698	MON-89383-1	Glyphosate tol.	cp4 epsps (aroA:CP4)
Cotton	MON531	MON-00531-6	Insect res.	cry1Ac
Cotton	MON757	MON-00757-7	Insect res.	cry1Ac
Cotton	MON88913	MON-88913-8	Glyphosate tol.	cp4 epsps (aroA:CP4)
Cotton	Nqwe Chi 6 Bt	NA	Insect res.	NA?
Cotton	SKG321	NA	Insect res.	cry1A; CpTI
Cotton	T303-3	BCS-GH003-6	Insect res.; glufosinate tol.	cry1Ab; bar
Cotton	T304-40	BCS-GH004-7	Insect res.; glufosinate tol.	cry1Ab; bar
Cotton	CE43-67B		Insect res.	cry1Ab
Cotton	CE46-02A		Insect res.	cry1Ab
Cotton	CE44-69D		Insect res.	cry1Ab
Cotton	1143-14A		Insect res.	cry1Ab
Cotton	1143-51B		Insect res.	cry1Ab
Cotton	T342-142		Insect res.	cry1Ab
Cotton	PV-GHGT07 (1445)		Glyphosate tol.	cp4 epsps (aroA:CP4)
Cotton	EE-GH3		Glyphosate tol.	mepsps
Cotton	EE-GH5		Insect res.	cry1Ab
Cotton	MON88701	MON-88701-3	Dicamba & glufosinate tol.	Modified dmo; bar
Cotton	OsCr11		Anti-allergy	Modified Cry j
Creeping Bentgrass	ASR368	SMG-36800-2	Glyphosate tol.	cp4 epsps (aroA:CP4)
Eucalyptus	20-C		Salt tol.	codA
Eucalyptus	12-5C		Salt tol.	codA
Eucalyptus	12-5B		Salt tol.	codA
Eucalyptus	107-1		Salt tol.	codA
Eucalyptus	1/9/2001		Salt tol.	codA
Eucalyptus	2/1/2001		Salt tol.	codA
Eucalyptus			Cold tol.	des9
Flax	FP967	CDC-FL001-2	ALS herbicide tol.	als
Lentil	RH44		Imidazolinone tol.	als
Maize	3272	SYN-E3272-5	Modified alpha-amylase	amy797E
Maize	5307	SYN-05307-1	Insect res.	ecry3.1Ab

Maize	59122	DAS-59122-7	Insect res.; glufosinate tol.	cry34Ab1; cry35Ab1;
Maize	676	PH-000676-7	Glufosinate tol.; pollination control	pat
Maize	678	PH-000678-9	Glufosinate tol.; pollination control	pat; dam
Maize	680	PH-000680-2	Glufosinate tol.; pollination control	pat; dam
Maize	98140	DP-098140-6	Glyphosate tol.; ALS herbicide tol.	gat4621; zm-hra
Maize	Bt10	NA	Insect res.; glufosinate tol.	cry1Ab; pat
Maize	Bt176 (176)	SYN-EV176-9	Insect res.; glufosinate tol.	cry1Ab; bar
Maize	BVLA430101	NA	Phytate breakdown	phyA2
Maize	CBH-351	ACS-ZM004-3	Insect res.; glufosinate tol.	cry9C; bar
Maize	DAS40278-9	DAS40278-9	2,4-D tol.	aad-1
Maize	DBT418	DKB-89614-9	Insect res.; glufosinate tol.	cry1Ac; pinII; bar
Maize	DLL25 (B16)	DKB-89790-5	Glufosinate tol.	bar
Maize	GA21	MON-00021-9	Glyphosate tol.	mepsps
Maize	GG25		Glyphosate tol.	mepsps
Maize	GJ11		Glyphosate tol.	mepsps
Maize	FI117		Glyphosate tol.	mepsps
Maize	GAT-ZM1		Glufosinate tol.	pat
Maize	LY038	REN-00038-3	Increased lysine	cordapA
Maize	MIR162	SYN-IR162-4	Insect res.	vip3Aa20
Maize	MIR604	SYN-IR604-5	Insect res.	mcry3A
Maize	MON801 (MON80100)	MON801	Insect res.; glyphosate tol.	cry1Ab; cp4 epsps (aroA:CP4); goxv247
Maize	MON802	MON-80200-7	Insect res.; glyphosate tol.	cry1Ab; cp4 epsps (aroA:CP4); goxv247
Maize	MON809	PH-MON-809-2	Insect res.; glyphosate tol.	cry1Ab; cp4 epsps (aroA:CP4); goxv247
Maize	MON810	MON-00810-6	Insect res.; glyphosate tol.	cry1Ab; cp4 epsps (aroA:CP4); goxv247
Maize	MON832	NA	Glyphosate tol.	cp4 epsps (aroA:CP4); goxv247
Maize	MON863	MON-00863-5	Insect res.	cry3Bb1
Maize	MON87427	MON-87427-7	Glyphosate tol.	cp4 epsps (aroA:CP4)
Maize	MON87460	MON-87460-4	Drought tol.	cspB
Maize	MON88017	MON-88017-3	Insect res.; glyphosate tol.	cry3Bb1; cp4 epsps (aroA:CP4)
Maize	MON89034	MON-89034-3	Insect res.	cry2Ab2; cry1A.105
Maize	MS3	ACS-ZM001-9	Glufosinate tol.; pollination control	bar; bamase
Maize	MS6	ACS-ZM005-4	Glufosinate tol.; pollination control	bar; bamase
Maize	NK603	MON-00603-6	Glyphosate tol.	cp4 epsps (aroA:CP4)
Maize	T14	ACS-ZM002-1	Glufosinate tol.	pat (syn)

Maize	T25	ACS-ZM003-2	Glufosinate tol.	pat (syn)
Maize	TC1507	DAS-01507-1	Insect res.; glufosinate tol.	cry1Fa2; pat
Maize	TC6275	DAS-06275-8	Insect res.; glufosinate tol.	mocry 1F; bar
Maize	VIP1034		Insect res.; glufosinate tol.	vip3A; pat
Maize	43A47	DP-043A47-3	Insect res.; glufosinate tol.	cry1F; cry34Ab1; cry35Ab1; pat
Maize	40416	DP-040416-8	Insect res.; glufosinate tol.	cry1F; cry34Ab1; cry35Ab1; pat
Maize	32316	DP-032316-8	Insect res.; glufosinate tol.	cry1F; cry34Ab1; cry35Ab1; pat
Maize	4114	DP-004114-3	Insect res.; glufosinate tol.	cry1F; cry34Ab1; cry35Ab1; pat
Melon	Melon A	NA	Delayed ripening/senescence	sam-k
Melon	Melon B	NA	Delayed ripening/senescence	sam-k
Papaya	55-1	CUH-CP551-8	Disease res.	prsv cp
Papaya	63-1	CUH-CP631-7	Disease res.	prsv cp
Papaya	Huanong No. 1	NA	Disease res.	prsv rep
Papaya	X17-2	UFL-X17CP-6	Disease res.	prsv cp
Petunia	Petunia-CHS	NA	Modified product quality	CHS suppression
Plum	C-5	ARS-PLMC5-6	Disease res.	ppv cp
Canola**	ZSR500	NA	Glyphosate tol.	cp4 epsps (aroA:CP4); goxv247
Canola**	ZSR502	NA	Glyphosate tol.	cp4 epsps (aroA:CP4); goxv247
Canola**	ZSR503	NA	Glyphosate tol.	cp4 epsps (aroA:CP4); goxv247
Poplar	Bt poplar	NA	Insect res.	cry1Ac; API
Poplar	Hybrid poplar clone 741	NA	Insect res.	cry1Ac; API
Poplar	trg300-1		High cellulose	AaXEG2
Poplar	trg300-2		High cellulose	AaXEG2
Potato	1210 amk	NA	Insect res.	cry3A
Potato	2904/1 kgs	NA	Insect res.	cry3A
Canola**	ZSR500	NA	Glyphosate tol.	cp4 epsps (aroA:CP4); goxv247
Canola**	ZSR502	NA	Glyphosate tol.	cp4 epsps (aroA:CP4); goxv247
Potato	ATBT04-27	NMK-89367-8	Insect res.	cry3A
Potato	ATBT04-30	NMK-89613-2	Insect res.	cry3A
Potato	ATBT04-31	NMK-89170-9	Insect res.	cry3A
Potato	ATBT04-36	NMK-89279-1	Insect res.	cry3A
Potato	ATBT04-6	NMK-89761-6	Insect res.	cry3A
Potato	BT06	NMK-89812-3	Insect res.	cry3A
Potato	BT10	NMK-89175-5	Insect res.	cry3A
Potato	BT12	NMK-89601-8	Insect res.	cry3A

Potato	BT16	NMK-89167-6	Insect res.	cry3A
Potato	BT17	NMK-89593-9	Insect res.	cry3A
Potato	BT18	NMK-89906-7	Insect res.	cry3A
Potato	BT23	NMK-89675-1	Insect res.	cry3A
Potato	EH92-527-1	BPS-25271-9	Modified starch/carbohydrate	gbss (antisense)
Potato	HLMT15-15	NA	Insect & disease res.	cry3A; pvv cp
Potato	HLMT15-3	NA	Insect & disease res.	cry3A; pvv cp
Potato	HLMT15-46	NA	Insect & disease res.	cry3A; pvv cp
Potato	RBMT15-101	NMK-89653-6	Insect & disease res.	cry3A; pvv cp
Potato	RBMT21-129	NMK-89684-1	Insect & disease res.	cry3A; plrv orf1; plrv orf2
Potato	RBMT21-152	NA	Insect & disease res.	cry3A; plrv orf1; plrv orf2
Potato	RBMT21-350	NMK-89185-6	Insect & disease res.	cry3A; plrv orf1; plrv orf2
Potato	RBMT22-082	NMK-89896-6	Insect & disease res.; Glyphosate tol.	cry3A; plrv orf1; plrv orf2; cp4 epsps (aroA:CP4)
Potato	RBMT22-186	NA	Insect & disease res.; Glyphosate tol.	cry3A; plrv orf1; plrv orf2; cp4 epsps (aroA:CP4)
Potato	RBMT22-238	NA	Insect & disease res.; Glyphosate tol.	cry3A; plrv orf1; plrv orf2; cp4 epsps (aroA:CP4)
Potato	RBMT22-262	NA	Insect & disease res.; Glyphosate tol.	cry3A; plrv orf1; plrv orf2; cp4 epsps (aroA:CP4)
Potato	SEMT15-02	NMK-89935-9	Insect & disease res.	cry3A; pvv cp
Potato	SEMT15-07	NA	Insect & disease res.	cry3A; pvv cp
Potato	SEMT15-15	NMK-89930-4	Insect & disease res.	cry3A; pvv cp
Potato	SPBT02-5	NMK-89576-1	Insect res.	cry3A
Potato	SPBT02-7	NMK-89724-5	Insect res.	cry3A
Rice	7Crp#242-95-7		Anti-allergy	7crp
Rice	7Crp#10	NA	Anti-allergy	7crp
Rice	GM Shanyou 63	NA	Insect res.	cry1Ab; cry1Ac
Rice	Huahui-1/TT51-1	NA	Insect res.	cry1Ab; cry1Ac
Rice	LLRICE06	ACS-OS001-4	Glufosinate tol.	bar
Rice	LLRICE601	BCS-OS003-7	Glufosinate tol.	bar
Rice	LLRICE62	ACS-OS002-5	Glufosinate tol.	bar
Rice	Tarom molaii + cry1Ab	NA	Insect res.	cry1Ab (truncated)
Rice	GAT-OS2		Glufosinate tol.	bar
Rice	GAT-OS3		Glufosinate tol.	bar
Rice	PE-7		Insect res.	Cry1Ac
Rice	7Crp#10	NA	Anti-allergy	7crp

Rice	KPD627-8		High tryptophan	OASA1D
Rice	KPD722-4		High tryptophan	OASA1D
Rice	KA317		High tryptophan	OASA1D
Rice	HW5		High tryptophan	OASA1D
Rice	HW1		High tryptophan	OASA1D
Rice	B-4-1-18		Erect leaves semidwarf	Δ OsBRI1
Rice	G-3-3-22		Semidwarf	OSGA2ox1
Rice	AD77		Disease res.	DEF
Rice	AD51		Disease res.	DEF
Rice	AD48		Disease res.	DEF
Rice	AD41		Disease res.	DEF
Rice	13pNasNaatAprt1		Low iron tol.	HvNAS1; HvNAAT-A; APRT
Rice	13pAprt1		Low iron tol.	APRT
Rice	gHvNAS1-gHvNAAT-1		Low iron tol.	HvNAS1; HvNAAT-A; HvNAAT-B
Rice	gHvIDS3-1		Low iron tol.	HvIDS3
Rice	gHvNAAT1		Low iron tol.	HvNAAT-A; HvNAAT-B
Rice	gHvNAS1-1		Low iron tol.	HvNAS1
Rice	NIA-OS006-4		Disease res.	WRKY45
Rice	NIA-OS005-3		Disease res.	WRKY45
Rice	NIA-OS004-2		Disease res.	WRKY45
Rice	NIA-OS003-1		Disease res.	WRKY45
Rice	NIA-OS002-9		Disease res.	WRKY45
Rice	NIA-OS001-8		Disease res.	WRKY45
Rice	OsCr11		Anti-allergy	Modified Cry j
Rice	17053		Glyphosate tol.	cp4 epsps (aroA:CP4)
Rice	17314		Glyphosate tol.	cp4 epsps (aroA:CP4)
Rose	WKS82 / 130-4-1	IFD-52401-4	Modified flower color	5AT; bp40 (f3'5'h)
Rose	WKS92 / 130-9-1	IFD-52901-9	Modified flower color	5AT; bp40 (f3'5'h)
Soybean	260-05 (G94-1, G94-19, G168)	NA	Modified oil/fatty acid	gm-fad2-1 (silencing locus)
Soybean	A2704-12	ACS-GM005-3	Glufosinate tol.	pat
Soybean	A2704-21	ACS-GM004-2	Glufosinate tol.	pat
Soybean	A5547-127	ACS-GM006-4	Glufosinate tol.	pat
Soybean	A5547-35	ACS-GM008-6	Glufosinate tol.	pat
Soybean	CV127	BPS-CV127-9	Imidazolinone tol.	csr1-2
Soybean	DAS68416-4	DAS68416-4	Glufosinate tol.	pat
Soybean	DP305423	DP-305423-1	Modified oil/fatty acid; ALS herbicide tol.	gm-fad2-1 (silencing locus); gm-hra
Soybean	DP356043	DP-356043-5	Modified oil/fatty acid; glyphosate tol.	gm-fad2-1 (silencing locus); gat4601

Soybean	FG72	MST-FG072-3	Glyphosate & HPPD tol.	2mepsps; hppdPF W336
Soybean	GTS 40-3-2 (40-3-2)	MON-04032-6	Glyphosate tol.	cp4 epsps (aroA:CP4)
Soybean	GU262	ACS-GM003-1	Glufosinate tol.	pat
Soybean	MON87701	MON-87701-2	Insect res.	cry1Ac
Soybean	MON87705	MON-87705-6	Modified oil/fatty acid; glyphosate tol.	fatb1-A (sense & antisense); fad2-1A (sense & antisense); cp4 epsps (aroA:CP4)
Soybean	MON87708	MON-87708-9	Dicamba & glyphosate tol.	dmo; cp4 epsps (aroA:CP4)
Soybean	MON87769	MON-87769-7	Modified oil/fatty acid; glyphosate tol.	Pj.D6D; Nc.Fad3; cp4 epsps (aroA:CP4)
Soybean	MON89788	MON-89788-1	Glyphosate tol.	cp4 epsps (aroA:CP4)
Soybean	W62	ACS-GM002-9	Glufosinate tol.	bar
Soybean	W98	ACS-GM001-8	Glufosinate tol.	bar
Soybean	MON87754	MON-87754-1	High oil	dgat2A
Soybean	DAS21606	DAS-21606	Aryloxyalkanoate & glufosinate tol.	Modified aad-12; pat
Soybean	DAS44406	DAS-44406-6	Aryloxyalkanoate, glyphosate & glufosinate tol.	Modified aad-12; 2mepsps; pat
Soybean	SYHT04R	SYN-0004R-8	Mesotrione tol.	Modified avhppd
Soybean	9582.814.19.1		Insect res. & glufosinate tol.	cry1Ac, cry1F, PAT
Squash	CZW3	SEM-ØCZW3-2	Disease res.	cmv cp, zymv cp, wmv cp
Squash	ZW20	SEM-ØZW20-7	Disease res.	zymv cp, wmv cp
Sugar Beet	GTSB77 (T9100152)	SY-GTSB77-8	Glyphosate tol.	cp4 epsps (aroA:CP4); goxv247
Sugar Beet	H7-1	KM-000H71-4	Glyphosate tol.	cp4 epsps (aroA:CP4)
Sugar Beet	T120-7	ACS-BV001-3	Glufosinate tol.	pat
Sugar Beet	T227-1		Glyphosate tol.	cp4 epsps (aroA:CP4)
Sugarcane	NXI-1T		Drought tol.	EcbetA
Sunflower	X81359		Imidazolinone tol.	als
Sweet Pepper	PK-SP01	NA	Disease res.	cmv cp
Tobacco	C/F/93/08-02	NA	Oxynil tol.	bxn
Tobacco	Vector 21-41	NA	Reduced nicotine	NtQPT1 (antisense)
Tomato	1345-4	NA	Delayed ripening/senescence	acc (truncated)
Tomato	35-1-N	NA	Delayed ripening/senescence	sam-k
Tomato	5345	NA	Insect res.	cry1Ac
Tomato	8338	CGN-89322-3	Delayed ripening/senescence	accd
Tomato	B	SYN-0000B-6	Delayed ripening/senescence	pg (sense or antisense)
Tomato	Da	SYN-0000DA-9	Delayed ripening/senescence	pg (sense or antisense)

Sunflower	X81359		Imidazolinone tol.	als
Tomato	Da Dong No 9	NA	Modified product	NA
Tomato	F (1401F, h38F, 11013F, 7913F)	SYN-0000F-1	Delayed ripening/senescence	pg (sense or antisense)
Tomato	FLA VR SAVR™	CGN-89564-2	Delayed ripening/senescence	pg (sense or antisense)
Tomato	Huafan No 1	NA	Delayed ripening/senescence	anti-efe
Tomato	PK-TM8805R (8805R)	NA	Disease res.	cmv cp
Wheat	MON71800	MON-71800-3	Glyphosate tol.	cp4 epsps (aroA:CP4)

* Argentine, ** Polish, # Eggplant

Treatment of genetically modified plants and seeds with compounds of the disclosure may result in 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 disclosure on genetically modified plants and seeds.

Compounds of this disclosure are also useful in seed treatments for protecting seeds from invertebrate pests. 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 disclosure, which is typically formulated as a composition of the disclosure. This seed treatment protects the seed from invertebrate soil pests 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 disclosure or a second active ingredient within the developing plant. Seed treatments can be applied to all types of seeds, including those from which plants genetically transformed to express specialized traits will germinate. Representative examples include those expressing proteins toxic to invertebrate pests, such as *Bacillus thuringiensis* toxin or those expressing herbicide resistance such as glyphosate acetyltransferase, which provides resistance to glyphosate. Seed treatments with compounds of this disclosure can also increase vigor of plants growing from the treated seed.

One method of seed treatment is by spraying or dusting the seed with a compound of the disclosure (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 disclosure comprises a biologically effective amount of a compound of Formula 1, an *N*-oxide or salt thereof, and a film former or adhesive agent. Seed 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.

Compounds of Formula 1 and their compositions, both alone and in combination with other insecticides and fungicides, 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.

Other insecticides with which compounds of Formula 1 can be formulated to provide mixtures useful in seed treatment include abamectin, acetamiprid, acrinathrin, amitraz, avermectin, azadirachtin, bensultap, bifenthrin, buprofezin, carbaryl, carbofuran, cartap, chlorantraniliprole, chlorfenapyr, chlorpyrifos, clothianidin, cyantraniliprole, 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, flufenoxuron, fluvalinate, formetanate, fosthiazate, hexaflumuron, hydramethylnon, imidacloprid, indoxacarb, lufenuron, metaflumizone, methiocarb, methomyl, methoprene, methoxyfenozide, nitenpyram, nithiazine, novaluron, oxamyl, pymetrozine, pyrethrin, pyridaben, pyridalyl, pyriproxyfen, ryanodine, spinetoram, spinosad, spirotetramat, spiromesifen, spirotetramat, sulfoxaflor, tebufenozide, tetramethrin, thiacloprid, thiamethoxam, thiodicarb, thiosultap-sodium, tralomethrin, triazamate, triflumuron, *Bacillus thuringiensis* delta-endotoxins, all strains of *Bacillus thuringiensis* and all strains of nuclear polyhedrosis viruses.

Fungicides with which compounds of Formula 1 can be formulated to provide mixtures useful in seed treatment include amisulbrom, azoxystrobin, boscalid, carbendazim, carboxin, cymoxanil, cyproconazole, difenoconazole, dimethomorph, fluazinam, fludioxonil, fluquinconazole, fluopicolide, fluoxastrobin, flutriafol, fluxapyroxad, ipconazole, iprodione, metalaxyl, mefenoxam, metconazole, myclobutanil, paclobutrazole, penflufen, picoxystrobin, prothioconazole, pyraclostrobin, sedaxane, silthiofam, tebuconazole, thiabendazole, thiophanate-methyl, thiram, trifloxystrobin and triticonazole.

Compositions comprising compounds of Formula 1 useful for seed treatment can further comprise bacteria such as *Bacillus pumilus* (e.g., strain GB34) and *Bacillus firmus* (e.g., isolate 1582), rhizobia inoculants/extenders, isoflavonoids and lipo-chitooligosaccharides.

The treated seed typically comprises a compound of the present disclosure in an amount from about 0.1 g to 1 kg per 100 kg of seed (i.e. from about 0.0001 to 1% by weight of the

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

The compounds of this disclosure can be incorporated into a bait composition that is consumed by an invertebrate pest or used within a device such as a trap, bait station, and the like. Such a bait composition can be in the form of granules which comprise (a) active ingredients, namely a biologically effective amount of a compound of Formula 1, an *N*-oxide, or salt thereof; (b) one or more food materials; optionally (c) an attractant, and optionally (d) one or more humectants. Of note are granules or bait compositions which comprise between about 0.001-5% active ingredients, about 40-99% food material and/or attractant; and optionally about 0.05-10% humectants, which are effective in controlling soil invertebrate pests at very low application rates, particularly at doses of active ingredient that are lethal by ingestion rather than by direct contact. Some food materials can function both as a food source and an attractant. Food materials include carbohydrates, proteins and lipids. Examples of food materials are vegetable flour, sugar, starches, animal fat, vegetable oil, yeast extracts and milk solids. Examples of attractants are odorants and flavorants, such as fruit or plant extracts, perfume, or other animal or plant component, pheromones or other agents known to attract a target invertebrate pest. Examples of humectants, i.e. moisture retaining agents, are glycols and other polyols, glycerine and sorbitol. Of note is a bait composition (and a method utilizing such a bait composition) used to control at least one invertebrate pest selected from the group consisting of ants, termites and cockroaches. A device for controlling an invertebrate pest can comprise the present bait composition and a housing adapted to receive the bait composition, wherein the housing has at least one opening sized to permit the invertebrate pest to pass through the opening so the invertebrate pest can gain access to the bait composition from a location outside the housing, and wherein the housing is further adapted to be placed in or near a locus of potential or known activity for the invertebrate pest.

The compounds of this disclosure can be applied without other adjuvants, but most often application will be of a formulation comprising one or more active ingredients with suitable carriers, diluents, and surfactants and possibly in combination with a food depending on the contemplated end use. One method of application involves spraying a water dispersion or refined oil solution of a compound of the present disclosure. Combinations with spray oils, spray oil concentrations, spreader stickers, adjuvants, other solvents, and piperonyl butoxide often enhance compound efficacy. For nonagronomic uses such sprays can be applied from

spray containers such as a can, a bottle or other container, either by means of a pump or by releasing it from a pressurized container, e.g., a pressurized aerosol spray can. Such spray compositions can take various forms, for example, sprays, mists, foams, fumes or fog. Such spray compositions thus can further comprise propellants, foaming agents, etc. as the case may be. Of note is a spray composition comprising a biologically effective amount of a compound or a composition of the present disclosure and a carrier. One embodiment of such a spray composition comprises a biologically effective amount of a compound or a composition of the present disclosure and a propellant. Representative propellants include, but are not limited to, methane, ethane, propane, butane, isobutane, butene, pentane, isopentane, neopentane, pentene, hydrofluorocarbons, chlorofluorocarbons, dimethyl ether, and mixtures of the foregoing. Of note is a spray composition (and a method utilizing such a spray composition dispensed from a spray container) used to control at least one invertebrate pest selected from the group consisting of mosquitoes, black flies, stable flies, deer flies, horse flies, wasps, yellow jackets, hornets, ticks, spiders, ants, gnats, and the like, including individually or in combinations.

One embodiment of the present disclosure relates to a method for controlling invertebrate pests, comprising diluting the pesticidal composition of the present disclosure (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 pesticide) with water, and optionally adding an adjuvant to form a diluted composition, and contacting the invertebrate pest 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 pesticidal composition can provide sufficient efficacy for controlling invertebrate pests, 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 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).

Among the spray adjuvants, oils including crop oils, crop oil concentrates, vegetable oil concentrates and methylated seed oil concentrates are most commonly used to improve the

efficacy of pesticides, possibly by means of promoting more even and uniform spray deposits. In situations where phytotoxicity potentially caused by oils or other water-immiscible liquids are of concern, spray compositions prepared from the composition of the present disclosure will generally not contain oil-based spray adjuvants. However, in situations where
5 phytotoxicity caused by oil-based spray adjuvants is commercially insignificant, spray compositions prepared from the composition of the present composition can also contain oil-based spray adjuvants, which can potentially further increase control of invertebrate pests, as well as rainfastness.

Products identified as “crop oil” typically contain 95 to 98% paraffin or naphtha-based
10 petroleum oil and 1 to 2% of one or more surfactants functioning as emulsifiers. Products identified as “crop oil concentrates” typically consist of 80 to 85% of emulsifiable petroleum-based oil and 15 to 20% of nonionic surfactants. Products correctly identified as “vegetable oil concentrates” typically consist of 80 to 85% of vegetable oil (i.e. seed or fruit oil, most commonly from cotton, linseed, soybean or sunflower) and 15 to 20% of nonionic surfactants.
15 Adjuvant performance can be improved by replacing the vegetable oil with methyl esters of fatty acids that are typically derived from vegetable oils. Examples of methylated seed oil concentrates include MSO[®] Concentrate (UAP-Loveland Products, Inc.) and Premium MSO Methylated Spray Oil (Helena Chemical Company).

The amount of adjuvants added to spray mixtures generally does not exceed about 2.5%
20 by volume, and more typically the amount is from about 0.1 to about 1% by volume. The application rates of adjuvants added to spray mixtures are typically between about 1 to 5 L per hectare. Representative examples of spray adjuvants include: Adigor[®] (Syngenta) 47% methylated rapeseed oil in liquid hydrocarbons, Silwet[®] (Helena Chemical Company) polyalkyleneoxide modified heptamethyltrisiloxane and Assist[®] (BASF) 17% surfactant
25 blend in 83% paraffin based mineral oil.

Nonagronomic applications include protecting an animal, particularly a vertebrate, more particularly a homeothermic vertebrate (e.g., mammal or bird) and most particularly a mammal, from an invertebrate parasitic pest by administering a parasitically effective (i.e. biologically effective) amount of a compound of the disclosure, typically in the form of a
30 composition formulated for veterinary use, to the animal to be protected. Therefore of note is a method for protecting an animal comprising administering to the animal a parasitically effective amount of a compound of the disclosure. As referred to in the present disclosure and claims, the terms “parasitidal” and “parasitically” refers to observable effects on an invertebrate parasite pest to provide protection of an animal from the pest. Parasitidal effects
35 typically relate to diminishing the occurrence or activity of the target invertebrate parasitic pest. Such effects on the pest include necrosis, death, retarded growth, diminished mobility

or lessened ability to remain on or in the host animal, reduced feeding and inhibition of reproduction. These effects on invertebrate parasite pests provide control (including prevention, reduction or elimination) of parasitic infestation or infection of the animal. Examples of invertebrate parasitic pests controlled by administering a parasitically effective amount of a compound of the disclosure to an animal to be protected include ectoparasites (arthropods, acarines, etc) and endoparasites (helminths, e.g., nematodes, trematodes, cestodes, acanthocephalans, etc.). In particular, the compounds of this disclosure are effective against ectoparasites including: flies such as *Haematobia (Lyperosia) irritans* (horn fly), *Stomoxys calcitrans* (stable fly), *Simulium* spp. (blackfly), *Glossina* spp. (tsetse flies), *Hydrotaea irritans* (head fly), *Musca autumnalis* (face fly), *Musca domestica* (house fly), *Morellia simplex* (sweat fly), *Tabanus* spp. (horse fly), *Hypoderma bovis*, *Hypoderma lineatum*, *Lucilia sericata*, *Lucilia cuprina* (green blowfly), *Calliphora* spp. (blowfly), *Protophormia* spp., *Oestrus ovis* (nasal botfly), *Culicoides* spp. (midges), *Hippobosca equine*, *Gastrophilus intestinalis*, *Gastrophilus haemorrhoidalis* and *Gastrophilus nasalis*; lice such as *Bovicola (Damalinia) bovis*, *Bovicola equi*, *Haematopinus asini*, *Felicola subrostratus*, *Heterodoxus spiniger*, *Lignonathus setosus* and *Trichodectes canis*; keds such as *Melophagus ovinus*; mites such as *Psoroptes* spp., *Sarcoptes scabiei*, *Chorioptes bovis*, *Demodex equi*, *Cheyletiella* spp., *Notoedres cati*, *Trombicula* spp. and *Otodectes cyanotis* (ear mites); ticks such as *Ixodes* spp., *Boophilus* spp., *Rhipicephalus* spp., *Amblyomma* spp., *Dermacentor* spp., *Hyalomma* spp. and *Haemaphysalis* spp.; and fleas such as *Ctenocephalides felis* (cat flea) and *Ctenocephalides canis* (dog flea).

Nonagronomic applications in the veterinary sector are by conventional means such as by enteral administration in the form of, for example, tablets, capsules, drinks, drenching preparations, granulates, pastes, boli, feed-through procedures, or suppositories; or by parenteral administration, such as by injection (including intramuscular, subcutaneous, intravenous, intraperitoneal) or implants; by nasal administration; by topical administration, for example, in the form of immersion or dipping, spraying, washing, coating with powder, or application to a small area of the animal, and through articles such as neck collars, ear tags, tail bands, limb bands or halters which comprise compounds or compositions of the present disclosure.

Typically a parasiticide composition according to the present disclosure comprises a mixture of a compound of Formula 1, an *N*-oxide or a salt thereof, with one or more pharmaceutically or veterinarily acceptable carriers comprising excipients and auxiliaries selected with regard to the intended route of administration (e.g., oral, topical or parenteral administration such as injection) and in accordance with standard practice. In addition, a suitable carrier is selected on the basis of compatibility with the one or more active ingredients

in the composition, including such considerations as stability relative to pH and moisture content. Therefore of note is a composition for protecting an animal from an invertebrate parasitic pest comprising a parasitically effective amount of a compound of the disclosure and at least one carrier.

5 For parenteral administration including intravenous, intramuscular and subcutaneous injection, a compound of the present disclosure can be formulated in suspension, solution or emulsion in oily or aqueous vehicles, and may contain adjuncts such as suspending, stabilizing and/or dispersing agents. Pharmaceutical compositions for injection include aqueous solutions of water-soluble forms of active ingredients (e.g., a salt of an active compound),
10 preferably in physiologically compatible buffers containing other excipients or auxiliaries as are known in the art of pharmaceutical formulation.

For oral administration in the form of solutions (the most readily available form for absorption), emulsions, suspensions, pastes, gels, capsules, tablets, boluses powders, granules, rumen-retention and feed/water/lick blocks, a compound of the present disclosure can be
15 formulated with binders/fillers known in the art to be suitable for oral administration compositions, such as sugars (e.g., lactose, sucrose, mannitol, sorbitol), starch (e.g., maize starch, wheat starch, rice starch, potato starch), cellulose and derivatives (e.g., methylcellulose, carboxymethylcellulose, ethylhydroxycellulose), protein derivatives (e.g., zein, gelatin), and synthetic polymers (e.g., polyvinyl alcohol, polyvinylpyrrolidone). If desired, lubricants (e.g.,
20 magnesium stearate), disintegrating agents (e.g., cross-linked polyvinylpyrrolidinone, agar, alginic acid) and dyes or pigments can be added. Pastes and gels often also contain adhesives (e.g., acacia, alginic acid, bentonite, cellulose, xanthan gum, colloidal magnesium aluminum silicate) to aid in keeping the composition in contact with the oral cavity and not being easily ejected.

25 If the parasitocidal compositions are in the form of feed concentrates, the carrier is typically selected from high-performance feed, feed cereals or protein concentrates. Such feed concentrate-containing compositions can, in addition to the parasitocidal active ingredients, comprise additives promoting animal health or growth, improving quality of meat from animals for slaughter or otherwise useful to animal husbandry. These additives can include,
30 for example, vitamins, antibiotics, chemotherapeutics, bacteriostats, fungistats, coccidiostats and hormones.

Compounds of the present disclosure have been discovered to have favorable pharmacokinetic and pharmacodynamic properties providing systemic availability from oral administration and ingestion. Therefore after ingestion by the animal to be protected,
35 parasitocidally effective concentrations of compounds of the disclosure in the bloodstream protect the treated animal from blood-sucking pests such as fleas, ticks and lice. Therefore of

note is a composition for protecting an animal from an invertebrate parasite pest in a form for oral administration (i.e. comprising, in addition to a parasitically effective amount of a compound of the disclosure, one or more carriers selected from binders and fillers suitable for oral administration and feed concentrate carriers).

5 Formulations for topical administration are typically in the form of a powder, cream, suspension, spray, emulsion, foam, paste, aerosol, ointment, salve or gel. More typically a topical formulation is a water-soluble solution, which can be in the form of a concentrate that is diluted before use. Parasitically compositions suitable for topical administration typically comprise a compound of the present disclosure and one or more topically suitable carriers. In
10 applications of a parasitically composition topically to the exterior of an animal as a line or spot (i.e. "spot-on" treatment), the active ingredient migrates over the surface of the animal to cover most or all of its external surface area. As a result, the treated animal is particularly protected from invertebrate pests that feed off the epidermis of the animal such as ticks, fleas and lice. Therefore formulations for topical localized administration often comprise at least
15 one organic solvent to facilitate transport of the active ingredient over the skin and/or penetration into the epidermis of the animal. Solvents commonly used as carriers in such formulations include propylene glycol, paraffins, aromatics, esters such as isopropyl myristate, glycol ethers, and alcohols such as ethanol and *n*-propanol.

The rate of application required for effective control (i.e. "biologically effective amount") will depend on such factors as the species of invertebrate to be controlled, the pest's
20 life cycle, life stage, its size, location, time of year, host crop or animal, feeding behavior, mating behavior, ambient moisture, temperature, and the like. Under normal circumstances, application rates of about 0.01 to 2 kg of active ingredients per hectare are sufficient to control pests in agronomic ecosystems, but as little as 0.0001 kg/hectare may be sufficient or as much
25 as 8 kg/hectare may be required. For nonagronomic applications, effective use rates will range from about 1.0 to 50 mg/square meter but as little as 0.1 mg/square meter may be sufficient or as much as 150 mg/square meter may be required. One skilled in the art can easily determine the biologically effective amount necessary for the desired level of invertebrate pest control.

In general for veterinary use, a compound of Formula 1, an *N*-oxide or a salt thereof, is
30 administered in a parasitically effective amount to an animal to be protected from invertebrate parasite pests. A parasitically effective amount is the amount of active ingredient needed to achieve an observable effect diminishing the occurrence or activity of the target invertebrate parasite pest. One skilled in the art will appreciate that the parasitically effective dose can vary for the various compounds and compositions of the present disclosure,
35 the desired parasitically effect and duration, the target invertebrate pest species, the animal to be

protected, the mode of application and the like, and the amount needed to achieve a particular result can be determined through simple experimentation.

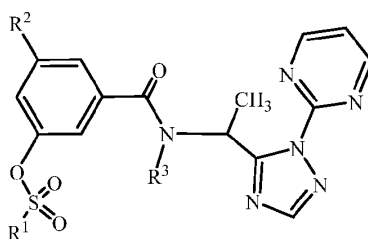
For oral administration to homeothermic animals, the daily dosage of a compound of the present disclosure typically ranges from about 0.01 mg/kg to about 100 mg/kg, more typically
5 from about 0.5 mg/kg to about 100 mg/kg, of animal body weight. For topical (e.g., dermal) administration, dips and sprays typically contain from about 0.5 ppm to about 5000 ppm, more typically from about 1 ppm to about 3000 ppm, of a compound of the present disclosure.

The compounds of this disclosure prepared by the methods described herein are shown in Index Table A. Me means methyl, Et means ethyl and *c*-Pr means *cyclo*-propyl. The
10 abbreviation "Cmpd. No." stands for "Compound Number", and the abbreviation "Ex." stands for "Example" and is followed by a number indicating in which example the compound is prepared. The abbreviation "m.p." stands for melting point. A wavy line or "-" in a structure fragment denotes the attachment point of the fragment to the remainder of the molecule. The numerical value reported in the column "MS" is the molecular weight of the highest isotopic
15 abundance positively charged parent ion (M+1) formed by addition of H⁺ (molecular weight of 1) to the molecule having the highest isotopic abundance, or the highest isotopic abundance negatively charged ion (M-1) formed by loss of H⁺ (molecular weight of 1). The presence of molecular ions containing one or more higher atomic weight isotopes of lower abundance (e.g., ³⁷Cl, ⁸¹Br) is not reported. The reported MS peaks were observed by mass spectrometry
20 using electrospray ionization (ESI) or atmospheric pressure chemical ionization (APCI).

INDEX TABLE A

25

30



Cmpd. No.	R ¹	R ²	R ³	M+1
1	Ph	CF ₃	H	519.38
2	CF ₃	CF ₃	H	510.99
3	CF ₃	H	H	443.36
4	CF ₃	Cl	H	477.25
5	Ph	Cl	H	485.32
6	Ph	H	H	451.3
7	CF ₂ H	H	H	425.25
8*	CF ₃	Cl	H	477.26
9**	CF ₃	Cl	H	477.26
10	CF ₃	Cl	CH ₂ (c-Pr)	531.4
11	CF ₃	CF ₃	CH ₂ (c-Pr)	565.47
12*	CF ₃	CF ₃	H	511.19
13**	CF ₃	CF ₃	H	511.19
14	CF ₃	F	H	461.31
15	CF ₃	Br	H	521.22
16	CF ₃	OSO ₂ CF ₃	H	591.28
20	CF ₃	Cl	CO ₂ Me	535.13
21	CH ₂ SO ₂ Me	CF ₃	H	535.14
22	CH ₂ CH ₂ OMe	CF ₃	H	501.19
23	CH ₂ (c-Pr)	Cl	H	463.1
24	2-Cl-Ph	CF ₃	H	553.2
25	3-Cl-5-Cl-Ph	CF ₃	H	587.22
26	3-CF ₃ -Ph	CF ₃	H	587.15
27	CF ₃	CF ₃	Et	539.21
28	CH ₂ CF ₃	CF ₃	H	525.21
29	CH ₂ (c-Pr)	CF ₃	H	497.26
30	CF ₃	Cl	CH ₂ Ph	567.21
31	CH ₂ SO ₂ Me	Cl	H	501.4
32	CH ₂ CO ₂ Et	CF ₃	H	529.19
33	CF ₃	CF ₃	CH ₂ Ph	601.25
34	4-OMe-Ph	CF ₃	H	549.31

35	2-CF3-Ph	CF3	H	587.26
36	4-CF3-Ph	CF3	H	587.34
37	4-OCF3-Ph	CF3	H	603.31
38	CF2H	CF3	H	493.19
39	CF2H	Cl	H	459.18
40	3-Cl-Ph	CF3	H	553.24
41	2-OMe-Ph	CF3	H	549.25
42	4-CN-Ph	CF3	H	544.24
43	3-Pyridyl	CF3	H	520.16
44	2-F-6-F-Ph	CF3	H	555.21
45	CF3	Me	H	457.26
46	CF3	NO2	H	488.2
47	CH2Cl	Cl	H	457.14
48	CF3	CF3	CO2Me	569.23
49	CH2CH2OMe	Cl	H	467.16
50	CF3	Cl	Et	505.19
51	CH2Cl	CF3	H	491.16
52	CH2CF3	Cl	H	491.13
72	CF3	Cl	CH3	491.32

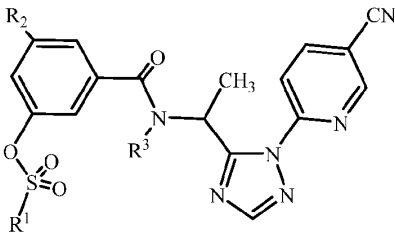
*Compounds 8 and 12 are (-) enantiomers with an optical rotation at 0.2%, MeOH of (-)101.2 and (-)92.6, respectively.

**Compounds 9 and 13 are (+) enantiomers with an optical rotation at 0.2%, MeOH of (+)84.32 and (+)114.1, respectively.

5

INDEX TABLE B

10

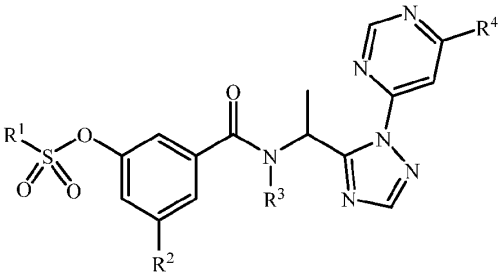


15

Cmpd.	R ¹	R ²	R ³	M+1
-------	----------------	----------------	----------------	-----

No.				
17	CF ₂ H	H	H	449.34
18	CF ₂ H	Cl	H	483.27
19	CF ₃	CF ₃	H	535.3
53	CH ₂ SO ₂ Me	Cl	H	525.12
54	CH ₂ Cl	CF ₃	H	515.17
55	CF ₃	OSO ₂ CF ₃	H	615.08
56	CF ₃	F	H	485.32
57	CH ₂ (c-Pr)	Cl	H	487.22
58	CH ₂ CF ₃	CF ₃	H	549.23
59	CH ₂ CO ₂ Et	CF ₃	H	553.2
60	CH ₂ SO ₂ Me	CF ₃	H	559.23
61	CH ₂ (c-Pr)	CF ₃	H	521.21
62	CH ₂ CH ₂ OMe	CF ₃	H	525.22
63	CF ₂ H	CF ₃	H	517.18
64	CF ₂ H	Cl	H	483.17
65	CH ₂ CH ₂ OMe	Cl	H	491.27
66	CH ₂ Cl	Cl	H	481.2
67	CF ₃	Br	H	544.88

INDEX TABLE C



Cmpd. No.	R ¹	R ²	R ³	R ⁴	M+1
68*	CF ₃	CF ₃	H	CONH ₂	554.2
69**	CF ₃	CF ₃	H	CONHMe	568.27
70*	CF ₃	CF ₃	H	CONHMe	568.28

71***	CF3	CF3	H	CONH2	554.01
-------	-----	-----	---	-------	--------

*Compounds 68 and 70 are (-) enantiomers (R-enantiomer) with an optical rotation at 0.2%, MeOH of (-)70.28 and (-)72.52, respectively.

**Compound 69 is a (+) enantiomer (S-enantiomer) with an optical rotation at 0.2%, MeOH of (+)75.48.

5 ***Compound 71 is a mixture of (+) and (-) enantiomers at a ratio of 70:30, respectively and with an optical rotation at 0.2%, MeOH of (+) 26.28.

The following Tests demonstrate the control efficacy of compounds of this disclosure on specific pests. “Control efficacy” represents inhibition of invertebrate pest development (including mortality) that causes significantly reduced feeding. The pest control protection
10 afforded by the compounds is not limited, however, to these species. See Index Table A for compound descriptions.

BIOLOGICAL EXAMPLES

Formulation and Spray Methodology for Tests A-H

15 Test compounds were formulated using a solution containing 10% acetone, 90% water and 300 ppm Activator 90[®] non-ionic surfactant (Loveland Products, Loveland, Colorado, USA). The formulated compounds were applied in 1 mL of liquid through an atomized nozzle positioned 1.27 cm (0.5 inches) above the top of each test unit. Test compounds were sprayed at the rates indicated, and each test was replicated three times.

20 Test A

For evaluating control of Diamond Back Moth (*Plutella xylostella* L.) through contact and/or systemic means, each test unit consisted of a small open container with a 10- to 12-day-old mustard plant inside.

25 Test compounds were formulated and sprayed at 250, 50, 10 and 2 ppm with three replications as described above. After spraying, the test units were allowed to dry for 1 hour before they were infested with 30-50 neonate larvae. A black, screened cap was placed on the top of each container. The test units were held for six days in a growth chamber at 24-25 °C and 70% relative humidity. Plant feeding damage was then visually assessed based on foliage consumed, and larvae were assessed for mortality.

30 Of the compounds of Formula 1 tested at 250 ppm, the following provided very good to excellent levels of control efficacy (20% or less feeding damage): 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 23, 27, 29, 30, 32, 33, 45, 46, 47, 48, 49, 50, 51, 52, 54, 56, 58, 59, 61, 62, 67, 68, 69, 70, and 72.

Of the compounds of Formula 1 tested at 50 ppm, the following provided very good to excellent levels of control efficacy (20% or less feeding damage): 2, 3, 4, 5, 6, 9, 10, 11, 13, 14, 15, 17, 18, 19, 20, 23, 27, 29, 30, 33, 34, 35, 36, 37, 38, 39, 48, 50, 51, 56, 58, 59, 61, 63, 64, 67, 68, 69, and 72.

- 5 Of the compounds of Formula 1 tested at 10 ppm, the following provided very good to excellent levels of control efficacy (20% or less feeding damage): 2, 3, 4, 5, 9, 10, 11, 13, 14, 15, 18, 19, 20, 23, 27, 29, 33, 38, 50, 56, 63, 64, 67, and 72.

- 10 Of the compounds of Formula 1 tested at 2 ppm, the following provided very good to excellent levels of control efficacy (20% or less feeding damage): 2, 4, 9, 10, 11, 13, 15, 19, 27, 29, 50, 56, 67, and 72.

Test B

For evaluating control of fall armyworm (*Spodoptera frugiperda* (J.E. Smith)) the test unit consisted of a small open container with a 4- to 5-day-old corn (maize) plant inside. This was pre-infested with 10 to 15 one-day-old larvae on a piece of insect diet.

- 15 Test compounds were formulated and sprayed at 250, 50, 10, and 2 ppm with three replications as described above. After spraying of the formulated test compound, the test units were maintained in a growth chamber for 6 days at 25 °C and 70% relative humidity. Plant feeding damage was then visually assessed based on foliage consumed, and larvae were assessed for mortality.

- 20 Of the compounds of Formula 1 tested at 250 ppm, the following provided very good to excellent levels of control efficacy (20% or less feeding damage): 2, 3, 4, 5, 6, 9, 13, 14, 15, 16, 17, 18, 19, 20, 27, 33, 48, 50, 51, 56, 67, and 72.

- 25 Of the compounds of Formula 1 tested at 50 ppm, the following provided very good to excellent levels of control efficacy (20% or less feeding damage): 2, 4, 5, 9, 10, 11, 13, 14, 15, 17, 18, 19, 27, 33, 37, 38, 39, 48, 50, 56, 61, 62, 63, 67, and 72.

Of the compounds of Formula 1 tested at 10 ppm, the following provided very good to excellent levels of control efficacy (20% or less feeding damage): 2, 4, 9, 10, 11, 13, 15, 18, 19, 27, 50, 67, and 72.

- 30 Of the compounds of Formula 1 tested at 2 ppm, the following provided very good to excellent levels of control efficacy (20% or less feeding damage): 2, 13, and 19.

Test C

For evaluating control of Corn Planthopper (*Peregrinus maidis* (Ashmead)) through contact and/or systemic means, the test unit consisted of a small open container with a 3- to 4-

day-old corn (maize) plant inside. White sand was added to the top of the soil prior to application of the test compound.

Test compounds were formulated and sprayed at 250 and 50 ppm with three replications as described above. After spraying of the formulated test compound, the test units were allowed to dry for 1 h before they were post-infested with ~15–20 nymphs (18-to-21-day-old). A black, screened cap was placed on the top of each test unit, and the test units were held for 6 days in a growth chamber at 22 to 24 °C and 50–70% relative humidity. Each test unit was then visually assessed for insect mortality.

Of the compounds of Formula 1 tested at 250 ppm, the following resulted in at least 80% mortality: 3, 4, 9, 10, 11, 13, 27, 50, and 72.

Of the compounds of Formula 1 tested at 50 ppm, the following resulted in at least 80% mortality: 9, 10, 11, 13, and 72.

Test D

For evaluating control of Green Peach Aphid (*Myzus persicae* (Sulzer)) through contact and/or systemic means, the test unit consisted of a small open container with a 12- to 15-day-old radish plant inside. Prior to compound application, each test unit was pre-infested by placing on a leaf of the test plant 30–40 aphids on a piece of leaf excised from a culture plant (cut-leaf method). The aphids moved onto the test plant as the leaf piece desiccated. After pre-infestation, the soil of the test unit was covered with a layer of sand.

Test compounds were formulated and sprayed at 250 and 50 ppm with three replications as described above. After spraying of the formulated test compound, each test unit was allowed to dry for 1 hour and then a black, screened cap was placed on top. The test units were held for 6 days in a growth chamber at 19–21 °C and 50–70% relative humidity. Each test unit was then visually assessed for insect mortality.

Of the compounds of Formula 1 tested at 250 ppm, the following resulted in at least 80% mortality: 4, 9, 11, 13, 50, and 72.

Of the compounds of Formula 1 tested at 50 ppm, the following resulted in at least 80% mortality: 4.

Test E

For evaluating control of cotton melon aphid (*Aphis gossypii* (Glover)) through contact and/or systemic means, the test unit consisted of a small open container with a 5-day-old okra plant inside. This was pre-infested with 30–40 insects on a piece of leaf according to the cut-leaf method, and the soil of the test unit was covered with a layer of sand.

Test compounds were formulated and sprayed at 250, 50, 10, and 2 ppm with three replications as described above. After spraying, the test units were maintained in a growth

chamber for 6 days at 19 °C and 70% relative humidity. Each test unit was then visually assessed for insect mortality.

Of the compounds of Formula 1 tested at 250 ppm, the following resulted in at least 80% mortality: 2, 3, 4, 6, 7, 9, 10, 11, 12, 13, 14, 15, 20, 23, 27, 28, 29, 30, 32, 33, 38, 39, 46, 47,
5 48, 50, 51, 52, 68, 69, and 72.

Of the compounds of Formula 1 tested at 50 ppm, the following resulted in at least 80% mortality: 2, 3, 4, 7, 9, 10, 11, 13, 14, 15, 20, 27, 29, 30, 33, 46, 48, 50, 51, 69, and 72.

Of the compounds of Formula 1 tested at 10 ppm, the following resulted in at least 80% mortality: 2, 4, 10, 11, 13, and 72.

10 Of the compounds of Formula 1 tested at 2 ppm, the following resulted in at least 80% mortality: 2, 4, 10, 11, 13, and 72.

Test F

For evaluating control of Western Flower Thrips (*Frankliniella occidentalis* Pergande)
15 through contact and/or systemic means, each test unit consisted of a small open container with a 5- to 7-day-old Soleil bean plant inside.

Test compounds were formulated and sprayed at 250 and 50 ppm with three replications as described above. After spraying, the test units were allowed to dry for 1 hour and then 22 to 27 adult thrips were added to each unit which were then capped with screened lid. The test
20 units were held for 7 days at 25 °C and 45-55% relative humidity. Each test unit was then visually assessed for plant damage and insect mortality.

Of the compounds of Formula 1 tested at 250 ppm, the following provided very good to excellent levels of control efficacy (20% or less feeding damage): 2, 3, 4, 9, 11, 13, 14, 20, 23, 27, 29, 33, 46, 50, 51, 59, and 72.

25 Of the compounds of Formula 1 tested at 50 ppm, the following provided very good to excellent levels of control efficacy (20% or less feeding damage): 2, 4, 9, 11, 13, 27, 33, and 50.

Test G

30 For evaluating control of Neotropical Brown Stink Bug (*Euschistus heros* Pergande) through contact and/or systemic means, each test unit consisted of a petri dish with 1cm fresh green bean pieces.

Test compounds were formulated and sprayed at 250 and 50 ppm with three replications
35 as described above. Prior to application, each unit was infested with ten immature insects, and

after spraying, the test units were allowed to dry for 1 hour and held for five days at 25 °C and 45-55% relative humidity. Each test unit was then visually assessed for insect mortality.

Of the compounds of Formula **1** tested at 250 ppm, the following provided very good to excellent levels of control efficacy (20% or less feeding damage): 2, 3, 4 and 13,

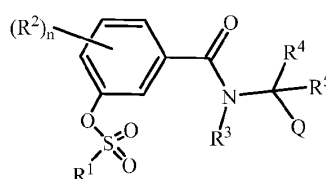
- 5 Of the compounds of Formula **1** tested at 50 ppm, the following provided very good to excellent levels of control efficacy (20% or less feeding damage): 2, 4 and 13.

CLAIMS

What is claimed is:

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

5 for controlling invertebrate pests:



1

10

wherein

R¹ is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₆ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is substituted with one or more R⁶; or

15 R¹ is phenyl optionally substituted with 1 to 3 R⁶, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and from 1 to 3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and up to 3 nitrogen atoms, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each 5- to 6-membered heteroaromatic ring is optionally substituted with one or more R⁶;

20 with the proviso that when R¹ is C₁-C₆ alkyl then R⁶ is other than C₁-C₆ alkyl;

R² is hydrogen, halogen, cyano, nitro; or

R² is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₇ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶; or

25 R² is phenyl, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and from 1 to 3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and up to 3 nitrogen atoms, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each phenyl or heteroaromatic ring is optionally substituted with one or more R⁶; or

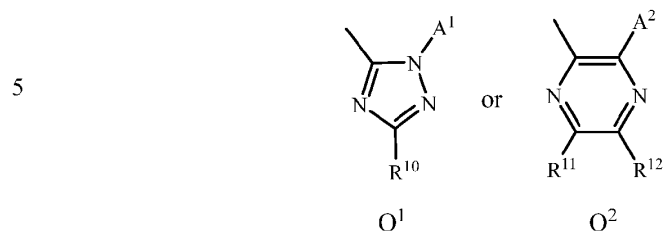
30 R² is C(O)R⁷, C(O)OR⁷, C(O)NR⁷R⁸, NR⁷R⁸, OR⁷, NHC(O)NR⁷R⁸, OC(O)R⁷, OC(O)OR⁷, S(O)_pR⁷, SO₂NR⁷R⁸, or OS(O)₂R⁹;

R³ is hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₆ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶; or

R³ is C(O)R⁷, C(O)OR⁷, NR⁷R⁸, OR⁷, S(O)_pR⁷ or SO₂NR⁷R⁸;

- R⁴ is H, C₁-C₆ alkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₆ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶;
- R⁵ is hydrogen or C₁-C₄ alkyl; or R⁴ and R⁵ can be taken together to form a 3-6 membered carbocyclic ring;
- R⁶ is halogen, cyano, nitro; or
- R⁶ is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₇ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more X¹; or
- R⁶ is phenyl, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and up to 3 nitrogen atoms, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, or a 3-to 6-membered non-aromatic heterocyclic ring containing ring members selected from carbon atoms and 1 to 5 heteroatoms independently selected from up to 2 oxygen, up to 2 sulfur, and up to 2 nitrogen atoms, wherein each phenyl, 5-to 6-membered heteroaromatic ring or 3-to 6-membered non-aromatic heterocyclic ring is optionally substituted with one or more X¹; or
- R⁶ is C(O)R⁷, C(O)OR⁷, C(O)NR⁷R⁸, NR⁷R⁸, OR⁷, NHC(O)NR⁷R⁸, OC(O)R⁷, OC(O)OR⁷, S(O)pR⁷, SO₂NR⁷R⁸, or OS(O)₂R⁹;
- R⁷ is hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₇ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶; or
- R⁷ is phenyl, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and up to 3 nitrogen atoms, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each phenyl or 5-to 6-membered heteroaromatic ring is optionally substituted with one or more R⁶;
- R⁸ is hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, or C₂-C₆ alkynyl, wherein each alkyl, alkenyl, or alkynyl is optionally substituted with one or more R⁶;
- R⁹ is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₇ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶; or
- R⁹ is phenyl, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and 1-3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and 1-3 nitrogen, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each phenyl or 5-to 6-membered heteroaromatic ring is optionally substituted with one or more R⁶;
- n is 0-4;
- p is 0-2;

Q is



- 10 A¹ and A² are a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and 1-3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and 1-3 nitrogen, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each 5-to 6-membered heteroaromatic ring is optionally substituted with one or more R⁶;
- 15 R¹⁰, R¹¹ and R¹² are hydrogen, halogen, cyano, nitro; or
 R¹⁰, R¹¹ and R¹² are C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₇ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶; or
 R¹⁰, R¹¹ and R¹² are phenyl optionally substituted with 1-3 R⁶, or a 5-membered
- 20 heteroaromatic ring containing ring members selected from carbon atoms and 1-3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and 1-3 nitrogen, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each 5-to 6-membered heteroaromatic ring is optionally substituted with one or more R⁶;
- 25 or
 R¹⁰, R¹¹ and R¹² are C(O)R⁷, C(O)OR⁷, C(O)NR⁷R⁸, NR⁷R⁸, OR⁷, NHC(O)NR⁷R⁸, OC(O)R⁷, OC(O)OR⁷, S(O)_pR⁷, SO₂NR⁷R⁸, or OS(O)₂R⁹;
 X¹ is hydrogen, halogen, cyano, nitro, OH, CHO, CO₂H, CO(C₁-C₄ alkyl), CO₂(C₁-C₄ alkyl), C(O)NH(C₁-C₄ alkyl), C(O)N(C₁-C₄ alkyl)₂, NH(C₁-C₄ alkyl), N(C₁-C₄ alkyl)₂,
 30 O(C₁-C₄ alkyl), O(C₁-C₄ haloalkyl), NHC(O)NH(C₁-C₄ alkyl), NHC(O)N(C₁-C₄ alkyl)₂, OC(O)(C₁-C₄ alkyl), OCO₂(C₁-C₄ alkyl), S(O)_p(C₁-C₄ alkyl), S(O)_p(C₁-C₄ haloalkyl), SO₂NH(C₁-C₄ alkyl), SO₂N(C₁-C₄ alkyl)₂, OS(O)₂(C₁-C₄ haloalkyl); or
 X¹ is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₃-C₇ cycloalkyl or C₄-C₈
- 35 cycloalkylalkyl; wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more halogen, cyano, nitro, OH, CHO, CO₂H, CO(C₁-C₄ alkyl), CO₂(C₁-C₄

- alkyl), C(O)NH(C₁-C₄ alkyl), C(O)N(C₁-C₄ alkyl)₂, NH(C₁-C₄ alkyl), N(C₁-C₄ alkyl)₂, O(C₁-C₄ alkyl), O(C₁-C₄ haloalkyl), NHC(O)NH(C₁-C₄ alkyl), NHC(O)N(C₁-C₄ alkyl)₂, OC(O)(C₁-C₄ alkyl), OCO₂(C₁-C₄ alkyl), S(O)_p(C₁-C₄ alkyl), S(O)_p(C₁-C₄ haloalkyl), SO₂NH(C₁-C₄ alkyl), SO₂N(C₁-C₄ alkyl)₂, or OS(O)₂(C₁-C₄ haloalkyl); or
- X¹ is phenyl, or a 5-membered heteroaromatic ring containing ring members selected from carbon atoms and 1-3 heteroatoms independently selected from 1 oxygen, 1 sulfur, and 1-3 nitrogen, or a 6-membered heteroaromatic ring containing ring members selected from carbon atoms and 1 to 2 nitrogen atoms, wherein each phenyl or 5-to 6-membered heteroaromatic ring is optionally substituted with one or more halogen, cyano, nitro, OH, CHO, CO₂H, CO(C₁-C₄ alkyl), CO₂(C₁-C₄ alkyl), C(O)NH(C₁-C₄ alkyl), C(O)N(C₁-C₄ alkyl)₂, NH(C₁-C₄ alkyl), N(C₁-C₄ alkyl)₂, O(C₁-C₄ alkyl), O(C₁-C₄ haloalkyl), NHC(O)NH(C₁-C₄ alkyl), NHC(O)N(C₁-C₄ alkyl)₂, OC(O)(C₁-C₄ alkyl), OCO₂(C₁-C₄ alkyl), S(O)_p(C₁-C₄ alkyl), S(O)_p(C₁-C₄ haloalkyl), SO₂NH(C₁-C₄ alkyl), SO₂N(C₁-C₄ alkyl)₂, or OS(O)₂(C₁-C₄ haloalkyl).
2. The compound of claim 1 wherein:
R¹ is C₁-C₆ alkyl, C₂-C₆ alkenyl, or C₂-C₆ alkynyl, wherein each alkyl, alkenyl, or alkynyl is substituted with one or more R⁶; or R¹ is phenyl optionally substituted with 1 to 3 R⁶; or R¹ is pyrimidine optionally substituted with one or more R⁶.
3. The compound of claim 1 or 2 wherein:
R² is hydrogen, halogen, cyano, nitro; or
R² is C₁-C₆ alkyl wherein each C₁-C₆ alkyl is optionally substituted with one or more R⁶; or R² is C(O)R⁷, C(O)OR⁷, C(O)NR⁷R⁸, NR⁷R⁸, OR⁷, S(O)_pR⁷, SO₂NR⁷R⁸, or OS(O)₂R⁹.
4. The compound of claim 1 or any one of the preceding claims wherein:
R³ is hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₆ cycloalkyl, wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶.
5. The compound of claim 1 or any one of the preceding claims wherein:
R⁴ is C₁-C₆ alkyl optionally substituted with one or more R⁶.
6. The compound of claim 1 or any one of the preceding claims wherein:
R⁵ is H.
7. The compound of claim 1 or any one of the preceding claims wherein:
R⁶ is C₁-C₆ alkyl or C₃-C₇ cycloalkyl, wherein each alkyl or cycloalkyl is optionally substituted with one or substituents selected from halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄

haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl.

8. The compound of claim 1 or any one of the preceding claims wherein:

- 5 A¹ and A² are pyridine, pyrimidine, pyrazine or pyridazine optionally substituted with halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C(O)R⁷, C(O)OR⁷, C(O)NR⁷R⁸,
 10 NR⁷R⁸, OR⁷, NHC(O)NR⁷R⁸, OC(O)R⁷, OC(O)OR⁷, S(O)pR⁷, SO₂NR⁷R⁸, or OS(O)₂R⁹;
 R¹⁰, R¹¹ and R¹² are hydrogen, halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl,
 15 haloalkylsulfonyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl.

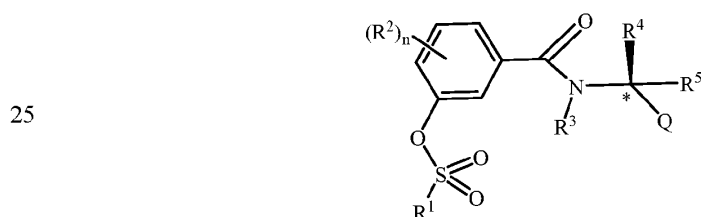
9. The compound of claim 1 or of any one of the preceding claims wherein:

Q is Q¹.

10. The compound of claim 1 or of any one of the preceding claims wherein:

Q is Q².

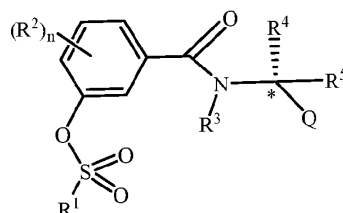
- 20 11. The compound of claim 1 or any of the preceding Embodiments, wherein the compound of Formula 1 is a compound of Formula 1':



Formula 1'

- 30 12. The compound of claim 1 or any of the preceding Embodiments, wherein the compound of Formula 1 is a compound of Formula 1'':

123



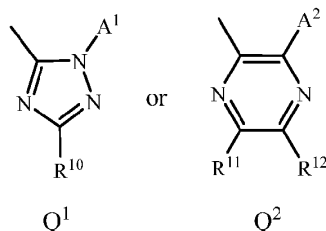
Formula 1''

13. The compound of Claim 1 wherein

- 10 R^1 is C_1 - C_6 alkyl wherein each alkyl is substituted with one or more R^6 ; or
 R^1 is phenyl optionally substituted with 1-3 R^6 ; or
 R^1 is pyrimidine optionally substituted with one or more R^6 ;
 R^2 is hydrogen, halogen, cyano, nitro; or
 R^2 is C_1 - C_6 alkyl wherein each C_1 - C_6 alkyl is optionally substituted with one or more R^6 ;
 15 or
 R^2 is $C(O)R^7$, $C(O)OR^7$, $C(O)NR^7R^8$, NR^7R^8 , OR^7 , $S(O)_pR^7$, $SO_2NR^7R^8$, or $OS(O)_2R^9$;
 R^3 hydrogen, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, or C_3 - C_6 cycloalkyl, wherein
 each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R^6 ;
 R^4 is C_1 - C_6 alkyl optionally substituted with one or more R^6 ;
 20 R^5 is hydrogen;
 R^6 is halogen, cyano, nitro, CN, $C(O)R^7$, $C(O)OR^7$, $C(O)NR^7R^8$, NR^7R^8 , OR^7 ,
 $NHC(O)NR^7R^8$, $OC(O)R^7$, $OC(O)OR^7$, $S(O)_pR^7$, $SO_2NR^7R^8$, $OS(O)_2R^9$, or
 R^6 is C_1 - C_6 alkyl or C_3 - C_7 cycloalkyl, wherein each alkyl or cycloalkyl is optionally
 substituted with one or substituents selected from, halogen, cyano, nitro, C_1 - C_4 alkyl, C_1 - C_4
 25 haloalkyl, C_1 - C_4 alkoxy, C_1 - C_4 haloalkoxy, C_1 - C_4 alkylamino, C_1 - C_4 dialkylamino, C_1 - C_4
 C_4 alkylthio, C_1 - C_4 haloalkylthio, C_1 - C_4 alkylsulfinyl, C_1 - C_4 haloalkylsulfinyl, C_1 - C_4
 alkylsulfinyl, C_1 - C_4 haloalkylsulfinyl, C_1 - C_4 alkylsulfonyl or C_1 - C_4 haloalkylsulfonyl;
 R^7 , R^8 and R^9 are hydrogen, C_1 - C_4 alkyl or C_1 - C_4 haloalkyl;

124

Q is

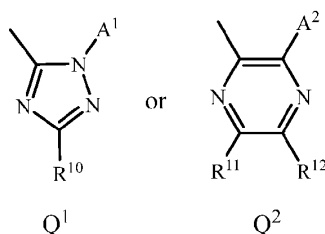


- A¹ and A² are pyridine, pyrimidine, pyrazine, pyridazine, or thiazole optionally substituted
 5 with halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄
 haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio,
 C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl,
 C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl;
 R¹⁰, R¹¹ and R¹² are hydrogen, halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄
 10 alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄
 haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄
 haloalkylsulfonyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl.

14. The compound of Formula 1 wherein

- R¹ is C₁-C₆ alkyl wherein each alkyl is substituted with one or more R⁶; or
 15 R¹ is phenyl optionally substituted with 1-3 R⁶;
 R² is hydrogen, halogen, cyano, nitro; or
 R² is C₁-C₆ alkyl wherein each C₁-C₆ alkyl is optionally substituted with one or more R⁶;
 or R² is C(O)R⁷, C(O)OR⁷, C(O)NR⁷R⁸, NR⁷R⁸, OR⁷, S(O)_pR⁷, SO₂NR⁷R⁸, or OS(O)₂R⁹;
 R³ hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, or C₃-C₆ cycloalkyl, wherein each
 20 alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R⁶;
 R⁴ is C₁-C₆ alkyl optionally substituted with one or more R⁶;
 R⁵ is hydrogen;
 R⁶ is halogen, cyano, nitro, CN, C(O)R⁷, C(O)OR⁷, C(O)NR⁷R⁸, NR⁷R⁸, OR⁷,
 NHC(O)NR⁷R⁸, OC(O)R⁷, OC(O)OR⁷, S(O)_pR⁷, SO₂NR⁷R⁸, OS(O)₂R⁹, or
 25 R⁶ is C₁-C₆ alkyl or C₃-C₇ cycloalkyl, wherein each alkyl or cycloalkyl is optionally
 substituted with one or substituents selected from , halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄
 haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-
 C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄
 alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl;
 30 R⁷, R⁸ and R⁹ are hydrogen, C₁-C₄ alkyl or C₁-C₄ haloalkyl;
 Q is

125



- A^1 and A^2 are pyridine, pyrimidine, pyrazine, pyridazine, or thiazole optionally substituted with halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonate or C₁-C₄ haloalkylsulfonate;
- R^{10} , R^{11} and R^{12} are hydrogen, halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonate or C₁-C₄ haloalkylsulfonate.

15. The compound of Formula 1 wherein

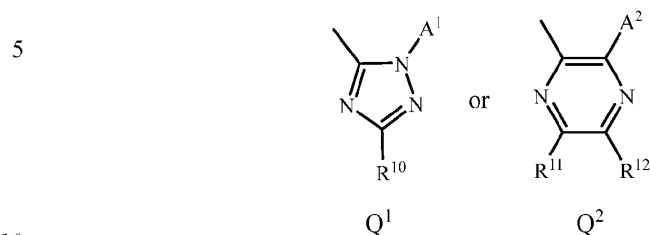
- R^1 is C₁-C₄ alkyl wherein each alkyl is substituted with one or more halogen, cyano, nitro, C₃-C₆ cycloalkylalkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonate or C₁-C₄ haloalkylsulfonate; or R^1 is phenyl optionally substituted with 1-3 halogen, cyano, nitro, C₃-C₆ cycloalkylalkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonate or C₁-C₄ haloalkylsulfonate;
- R^2 is halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonate or C₁-C₄ haloalkylsulfonate;
- R^3 is hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₃-C₆ cycloalkyl, or C₄-C₇ alkylcycloalkyl wherein each alkyl, alkenyl, alkynyl or cycloalkyl is optionally substituted with one or more R^6 ;

126

R⁴ is H, C₁-C₆ alkyl or C₃-C₆ cycloalkyl;

R⁵ is hydrogen;

Q is



A¹ and A² are pyridine, pyrimidine, pyrazine, pyridazine, or thiazole optionally substituted with halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl;

R¹⁰, R¹¹ and R¹² are hydrogen, halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₁-C₄ alkylamino, C₁-C₄ dialkylamino, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₁-C₄ alkylsulfinyl, C₁-C₄ haloalkylsulfinyl, C₁-C₄ alkylsulfonyl, C₁-C₄ haloalkylsulfonyl, C₁-C₄ alkylsulfonyl or C₁-C₄ haloalkylsulfonyl.

20

16. The compound of claim 1 wherein

R¹ is CF₃, or phenyl optionally substituted with 1-3 halogen, cyano, CF₃, OCH₃ or OCF₃;

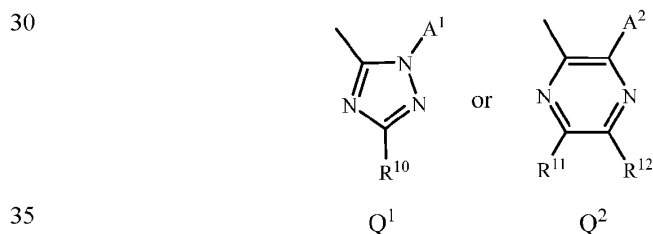
R² is halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy or C₁-C₄ haloalkoxy;

R³ is hydrogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₃-C₆ cycloalkyl, or C₄-C₇ alkylcycloalkyl;

R⁴ is C₁-C₃ alkyl;

R⁵ is hydrogen;

Q is



A¹ and A² are pyridine or pyrimidine, optionally substituted with halogen, cyano, nitro, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₁-C₄ alkoxy or C₁-C₄ haloalkoxy; R¹⁰, R¹¹ and R¹² are hydrogen.

- 5 17. The compound of claim 1 wherein the compound is selected from the group consisting of:
- 3-[(Phenylsulfonyl)oxy]-N-[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]-5-(trifluoromethyl)benzamide;
- 10 3-[[[1-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate;
- 3-[[[1-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate;
- 3-Chloro-5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate;
- 15 3-Chloro-5-[(phenylsulfonyl)oxy]-N-[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]benzamide;
- 3-[(Phenylsulfonyl)oxy]-N-[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]benzamide;
- 20 3-[[[1-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1-difluoromethanesulfonate;
- (*S*) 3-Chloro-5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate; (-) enantiomer;
- (*R*) 3-Chloro-5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate; (+) enantiomer;
- 25 3-Chloro-5-[(cyclopropylmethyl)[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate;
- 3-[(Cyclopropylmethyl)[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate;
- 30 (*S*) 3-[[[1-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate; (-) enantiomer;
- (*R*) 3-[[[1-[1-(2-Pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate; (+) enantiomer;
- 35 3-Fluoro-5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate;

- 3-Bromo-5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl
1,1,1-trifluoromethanesulfonate;
1,1'-[5-[[[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-1,3-
phenylene] bis(1,1,1-trifluoromethanesulfonate);
5 3-[[[1-[1-(5-cyano-2-pyridinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]phenyl
1,1-difluoromethanesulfonate;
3-Chloro-5-[[[1-[1-(5-cyano-2-pyridinyl)-1H-1,2,4-triazol-5-
yl]ethyl]amino]carbonyl]phenyl 1,1-difluoromethanesulfonate;
3-[[[1-[1-(5-cyano-2-pyridinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-
10 (trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate;
3-[[ethyl[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-yl]ethyl]amino]carbonyl]-5-
(trifluoromethyl)phenyl 1,1,1-trifluoromethanesulfonate;
3-chloro-5-[[ethyl[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-
yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate;
15 3-[[[(1S)-1-[1-[6-(Aminocarbonyl)-4-pyrimidinyl]-1H-1,2,4-triazol-5-
yl]ethyl]amino]carbonyl]-5-(trifluoromethyl)phenyl 1,1,1-
trifluoromethanesulfonate; and
3-chloro-5-[[methyl[1-[1-(2-pyrimidinyl)-1H-1,2,4-triazol-5-
yl]ethyl]amino]carbonyl]phenyl 1,1,1-trifluoromethanesulfonate.
- 20 18. A composition comprising a compound of Claim 1 or any one of the preceding
claims and at least one additional component selected from surfactants, solid diluents and
liquid diluents, said composition optionally further comprising at least one additional
biologically active compound or agent.
- 25 19. The composition of Claim 18 wherein the at least one additional biologically
active compound or agent is selected from abamectin, acephate, acequinocyl, acetamiprid,
acrinathrin, afidopyrophen, amidoflomet, amitraz, avermectin, azadirachtin, azinphos-methyl,
benfuracarb, bensultap, bifenthrin, bifentazate, bistrifluron, borate, buprofezin, carbaryl,
carbofuran, cartap, carzol, chlorantraniliprole, chlorfenapyr, chlorfluazuron, chlorpyrifos,
chlorpyrifos-methyl, chromafenozide, clofentezin, clothianidin, cyantraniliprole,
30 cyclaniliprole, cycloprothrin, cycloxyaprid, cyflumetofen, cyfluthrin, beta-cyfluthrin,
cyhalothrin, gamma-cyhalothrin, lambda-cyhalothrin, cypermethrin, alpha-cypermethrin,
zeta-cypermethrin, cyromazine, deltamethrin, diafenthiuron, diazinon, dieldrin,
diflubenzuron, dimefluthrin, dimehypo, dimethoate, dinotefuran, diofenolan, emamectin,
endosulfan, esfenvalerate, ethiprole, etofenprox, etoxazole, fenbutatin oxide, fenitrothion,
35 fenothiocarb, fenoxycarb, fenpropathrin, fenvalerate, fipronil, flometoquin, flonicamid,

flubendiamide, flucythrinate, flufenimer, flufenoxuron, flufenoxystrobin, fluensulfone, fluopyram, flupyradifurone, fluvalinate, tau-fluvalinate, fonophos, formetanate, fosthiazate, halofenozide, heptafluthrin, hexaflumuron, hexythiazox, hydramethylnon, imidacloprid, indoxacarb, insecticidal soaps, isofenphos, lufenuron, malathion, meperfluthrin, 5 metaflumizone, metaldehyde, methamidophos, methidathion, methiocarb, methomyl, methoprene, methoxychlor, methoxyfenozide, metofluthrin, monocrotophos, monofluorothrin, nicotine, nitenpyram, nithiazine, novaluron, noviflumuron, oxamyl, parathion, parathion-methyl, permethrin, phorate, phosalone, phosmet, phosphamidon, pirimicarb, profenofos, profluthrin, propargite, protrifenbute, pyflubumide, pymetrozine, 10 pyrafluprole, pyrethrin, pyridaben, pyridalyl, pyrifluquinazon, pyriminostrobin, pyriprole, pyriproxyfen, rotenone, ryanodine, silafluofen, spinetoram, spinosad, spirotetramat, sulprofos, sulfoxaflor, tebufenozide, tebufenpyrad, teflubenzuron, tefluthrin, tetrachlorvinphos, tetramethrin, tetramethylfluthrin, thiacloprid, thiamethoxam, thiodicarb, thiosultap-sodium, tioxazafen, tolfenpyrad, tralomethrin, 15 triazamate, trichlorfon, triflumezopyrim, triflumuron, *Bacillus thuringiensis* delta-endotoxins, entomopathogenic bacteria, entomopathogenic viruses and entomopathogenic fungi.

20. A method for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of a compound of 20 Claim 1 or any one of the preceding claims.

21. A treated seed comprising a compound of Claim 1 in an amount of from about 0.0001 to 1% by weight of the seed before treatment.