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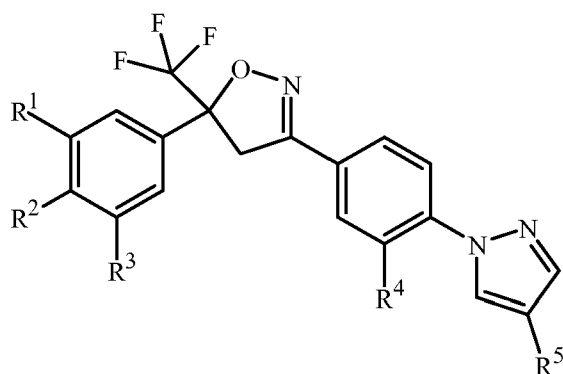
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(54) Title: PYRAZOLE-SUBSTITUTED ISOXAZOLINE INSECTICIDES



(1)

(57) Abstract: Disclosed are compounds of Formula (1), including all stereoisomers, *N*-oxides, and salts thereof, wherein R^1 is F, Cl, Br, CF_3 , $OCHF_2$, OCF_3 or OCH_2CF_3 ; R^2 is H, F, Cl, Br, CH_3 , cyano, CF_3 , CHF_2 , $OCHF_2$, OCF_3 or OCH_2CF_3 ; R^3 is H, F, Cl, Br or CF_3 ; R^4 is cyano or $C(S)NH_2$; R^5 is F, Cl, Br, I, cyano, $C(S)NH_2$ or $C(O)NHR^6$; and R^6 is H; or R^6 is C_1 - C_3 alkyl, cyclopropyl or cyclopropylmethyl, each optionally substituted with halogen and further optionally substituted with 1 or 2 CH_3 ; or R^6 is 1-(trifluoromethyl)cyclopropyl. Also disclosed are compositions containing the compounds of Formula (1) and methods for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of a compound or a composition of the invention.

TITLE

PYRAZOLE-SUBSTITUTED ISOXAZOLINE INSECTICIDES

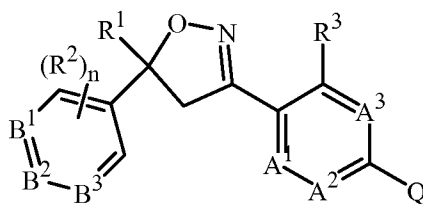
FIELD OF THE INVENTION

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

BACKGROUND OF THE INVENTION

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
 10 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 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
 15 toxic, environmentally safer or have different sites of action.

PCT Patent Publication WO 2007/075459 discloses isoxazoline derivatives of Formula
 i as insecticides



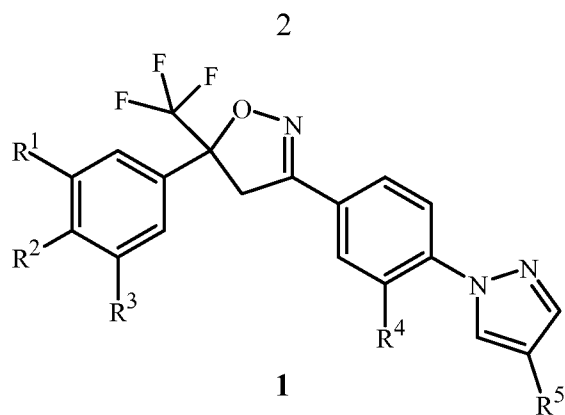
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wherein, *inter alia*, A¹, A², A³, B¹, B² and B³ are independently CR³ or N, R¹ is alkyl
 20 substituted with halogen, R³ is H, halogen or cyano, and Q is an optionally substituted 5- or
 6-membered saturated or unsaturated heterocyclic ring.

The isoxazolines of the present invention are not disclosed in this publication.

SUMMARY OF THE INVENTION

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



wherein

R¹ is F, Cl, Br, CF₃, OCHF₂, OCF₃ or OCH₂CF₃;

5 R² is H, F, Cl, Br, CH₃, cyano, CF₃, CHF₂, OCHF₂, OCF₃ or OCH₂CF₃;

R³ is H, F, Cl, Br or CF₃;

R⁴ is cyano or C(S)NH₂;

R⁵ is F, Cl, Br, I, cyano, C(S)NH₂ or C(O)NHR⁶; and

10 R⁶ is H; or R⁶ is C₁–C₃ alkyl, cyclopropyl or cyclopropylmethyl, each optionally substituted with halogen and further optionally substituted with 1 or 2 CH₃; or R⁶ is 1-(trifluoromethyl)cyclopropyl.

This invention 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 invention also provides a composition for controlling an invertebrate pest 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 additional biologically active compound or agent.

20 This invention further provides a spray composition for controlling an invertebrate pest comprising a biologically effective amount of a compound of Formula 1, an *N*-oxide or a salt thereof, or the compositions described above, and a propellant. This invention also provides a bait composition for controlling an invertebrate pest comprising a biologically effective amount of a compound of Formula 1, an *N*-oxide or a salt thereof, or the compositions described in the embodiments above, one or more food materials, optionally an attractant, and optionally a humectant.

30 This invention further provides a trap 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 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.

This invention provides 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, an *N*-oxide or a salt thereof, (e.g., as a composition described herein). This invention 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 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 invention 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 invention also relates to the treated seed. This invention 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).

DETAILS OF THE INVENTION

As used herein, the terms “comprises,” “comprising,” “includes,” “including,” “has,” “having,” “contains” or “containing,” or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a composition, a mixture, process, method, article, or apparatus 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, method, article, or apparatus. Further, unless expressly stated to the contrary, “or” refers to an inclusive or and not to an exclusive or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

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

As referred to in this disclosure, the term “invertebrate pest” includes arthropods, gastropods and nematodes 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 all of the helminths, such as: roundworms, heartworms, and phytophagous nematodes (Nematoda), flukes (Tematoda), Acanthocephala, and tapeworms (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.

The term "agronomic" refers to the production of field crops such as for food and fiber and includes the growth of corn, soybeans and other legumes, rice, cereal (e.g., wheat, oats, barley, rye, rice, maize), 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 (berries, cherries) and other specialty crops (e.g., canola, sunflower, olives). The term "nonagronomic" refers to other than field crops, such as horticultural crops (e.g., greenhouse, nursery or ornamental plants not grown in a field), residential, agricultural, commercial and industrial structures, turf (e.g., sod farm, pasture, golf course, lawn, sports field, etc.), wood products, stored product, agro-forestry and vegetation management, public health (i.e. human) and animal health (e.g., domesticated animals such as pets, livestock and poultry, undomesticated animals such as wildlife) applications.

In the above recitations, the term "alkyl" includes straight-chain or branched alkyl, such as methyl, ethyl, *n*-propyl or *i*-propyl.

The term "cyclopropylmethyl" denotes cyclopropyl substitution on a methyl moiety.

The term "halogen" includes fluorine, chlorine, bromine or iodine.

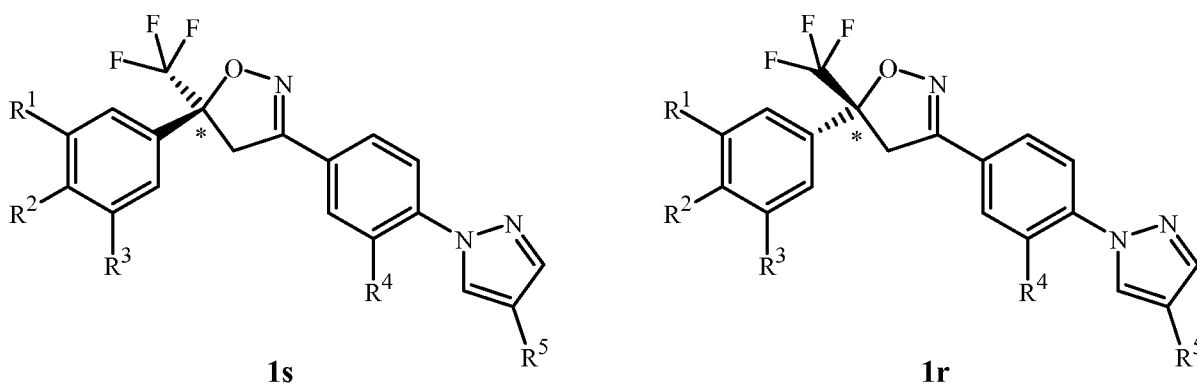
The total number of carbon atoms in a substituent group is indicated by the "C_i-C_j" prefix where i and j are numbers from 1 to 3. For example, C₁-C₃ alkyl designates methyl through propyl.

When a radical (e.g., alkyl in the definition of R⁶) is "optionally substituted" with listed substituents without the number of substituents on the radical stated, then the radical may be unsubstituted or the radical may be substituted with a number of substituents ranging from 1 up to the number of the available positions on the radical, and the attached substituents are independently selected from the substituents listed.

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 invention can exist as one or more stereoisomers. The various stereoisomers include enantiomers, diastereomers and atropisomers. 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. The compounds of the invention may be present as a mixture of stereoisomers, individual stereoisomers or as an optically active form. For example, two possible enantiomers of Formula 1 are depicted as Formula 1s and Formula 1r involving the isoxazoline chiral center identified with an asterisk (*). Analogously, other chiral centers are possible at R⁶.



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. Constant width lines indicate bonds with a direction opposite or neutral relative to bonds shown with solid or dashed wedges; constant width lines also depict bonds in molecules or parts of molecules in which no particular stereoconfiguration is intended to be specified.

The more biologically active enantiomer is believed to be Formula 1s. Formula 1s has the (*S*) configuration at the chiral carbon, and Formula 1r has the (*R*) configuration at the chiral carbon.

This invention comprises racemic mixtures, for example, equal amounts of the enantiomers of Formulae 1s and 1r. In addition, this invention 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 1s and Formula 1r.

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).

Of note are the compositions of this invention having at least a 50% enantiomeric excess; also of note are the compositions of this invention having at least a 75% enantiomeric excess; also of note are the compositions of this invention having at least a 90% enantiomeric excess; and of further note are the compositions of this invention having at least a 94% enantiomeric excess of the more active isomer. Of particular note are enantiomerically pure embodiments of the more active isomer.

Compounds of Formula 1 can comprise additional chiral centers. For example, substituent R⁶ may itself contain chiral centers. This invention comprises racemic mixtures as well as enriched and essentially pure stereoconfigurations at these additional chiral centers.

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

One skilled in the art recognizes that because in the environment and under physiological conditions salts of chemical compounds are in equilibrium with their corresponding nonsalt forms, salts share the biological utility of the nonsalt forms. Thus a wide variety of salts of the compounds of Formula 1 are useful for control of invertebrate pests. The salts of the compounds of Formula 1 include acid-addition salts with inorganic or organic acids such as hydrobromic, hydrochloric, nitric, phosphoric, sulfuric, acetic, butyric, fumaric, lactic, maleic, malonic, oxalic, propionic, salicylic, tartaric, 4-toluenesulfonic or valeric acids. Accordingly, the present invention comprises compounds selected from Formula 1, *N*-oxides and suitable salts thereof.

Embodiments of the present invention as described in the Summary of the Invention include (where Formula 1 as used in the following Embodiments includes *N*-oxides and salts thereof):

Embodiment 1. A compound of Formula 1 wherein R^1 is $OCHF_2$, OCF_3 or OCH_2CF_3 .

Embodiment 2. A compound of Formula 1 wherein R^1 is F, Cl, Br or CF_3 .

Embodiment 3. A compound of Embodiment 2 wherein R^1 is Cl, Br or CF_3 .

Embodiment 4. A compound of Embodiment 2 wherein R^1 is F.

Embodiment 5. A compound of Embodiment 3 wherein R^1 is Cl.

Embodiment 6. A compound of Embodiment 3 wherein R^1 is Br.

Embodiment 7. A compound of Embodiment 3 wherein R^1 is CF_3 .

Embodiment 8. A compound of Formula 1 wherein R^2 is $OCHF_2$, OCF_3 or OCH_2CF_3 .

Embodiment 9. A compound of Formula 1 wherein R^2 is H, F, Cl, Br, CH_3 , cyano or CF_3 .

Embodiment 9a. A compound of Formula 1 wherein R^2 is H, F, Cl, Br, CH_3 , cyano, CHF_2 or CF_3 .

Embodiment 10. A compound of Embodiment 9 wherein R^2 is H, F or Cl.

Embodiment 11. A compound of Embodiment 10 wherein R^2 is H.

Embodiment 12. A compound of Embodiment 10 wherein R^2 is F.

Embodiment 13. A compound of Embodiment 10 wherein R^2 is Cl.

Embodiment 14. A compound of Embodiment 9 wherein R^2 is Br.

Embodiment 15. A compound of Embodiment 9 wherein R^2 is CH_3 .

Embodiment 16. A compound of Embodiment 9 wherein R^2 is cyano.

Embodiment 17. A compound of Embodiment 9 wherein R^2 is CF_3 .

Embodiment 17a. A compound of Embodiment 9a wherein R^2 is CHF_2 .

Embodiment 18. A compound of Formula 1 wherein R^3 is H, Cl, Br or CF_3 .

Embodiment 19. A compound of Embodiment 18 wherein R^3 is H.

Embodiment 20. A compound of Embodiment 18 wherein R^3 is Cl.

Embodiment 21. A compound of Embodiment 18 wherein R^3 is Br.

Embodiment 22. A compound of Embodiment 18 wherein R^3 is CF_3 .

Embodiment 23. A compound of Formula 1 wherein R^3 is F.

Embodiment 24. A compound of Formula 1 wherein R^4 is cyano.

Embodiment 25. A compound of Formula 1 wherein R^4 is $C(S)NH_2$.

Embodiment 25a. A compound of Formula 1 wherein R^5 is cyano or $C(O)NHR^6$.

Embodiment 26. A compound of Formula 1 wherein R^5 is F.

Embodiment 27. A compound of Formula 1 wherein R^5 is Cl.

Embodiment 28. A compound of Formula 1 wherein R^5 is Br.

Embodiment 29. A compound of Formula 1 wherein R^5 is I.

Embodiment 30. A compound of Formula 1 wherein R^5 is cyano.

Embodiment 31. A compound of Formula 1 wherein R^5 is $C(S)NH_2$.

Embodiment 32. A compound of Formula 1 wherein R^5 is $C(O)NHR^6$.

Embodiment 33. A compound of Formula 1 or Embodiment 32 wherein R^6 is H.

Embodiment 34. A compound of Formula 1 or Embodiment 32 wherein R^6 is C_1-C_3

5 alkyl, cyclopropyl or cyclopropylmethyl, each optionally substituted with
 halogen and further optionally substituted with 1 or 2 CH_3 .

Embodiment 35. A compound of Embodiment 34 wherein R^6 is C_1-C_3 alkyl
 optionally substituted with halogen and further optionally substituted with 1 or 2
 CH_3 .

10 Embodiment 36. A compound of Embodiment 34 wherein R^6 is cyclopropyl optionally
 substituted with halogen and further optionally substituted with 1 or 2 CH_3 .

Embodiment 37. A compound of Embodiment 34 wherein R^6 is cyclopropylmethyl
 optionally substituted with halogen and further optionally substituted with 1 or 2
 CH_3 .

15 Embodiment 38. A compound of Embodiment 35 wherein R^6 is CH_2CF_3 .

Embodiment 39. A compound of Embodiment 36 wherein R^6 is cyclopropyl.

Embodiment 40. A compound of Embodiment 37 wherein R^6 is cyclopropylmethyl.

Embodiments of this invention, including Embodiments 1–40 above as well as any other
embodiments described herein, can be combined in any manner, and the descriptions of
20 variables in the embodiments pertain not only to the compounds of Formula 1 but also to the
 starting compounds and intermediate compounds useful for preparing the compounds of
 Formula 1. In addition, embodiments of this invention, including Embodiments 1–40 above
 as well as any other embodiments described herein, and any combination thereof, pertain to
 the compositions and methods of the present invention.

25 Combinations of Embodiments 1–40 are illustrated by:

Embodiment A. A compound of Formula 1 wherein

R^1 is Cl, Br or CF_3 ;

R^2 is H, F or Cl; and

R^3 is H, Cl, Br or CF_3 .

30 Embodiment B. A compound of Embodiment A wherein
 R^2 is H.

Embodiment C. A compound of Embodiment B wherein
 R^1 and R^3 are Cl.

Embodiment D. A compound of Embodiment B wherein
35 R^1 and R^3 are Br.

Embodiment E. A compound of Embodiment B wherein
 R^1 and R^3 are CF_3 .

Embodiment F. A compound of Embodiment A wherein

R¹ and R³ are Cl; and

R² is F.

Embodiment G. A compound of Embodiment A wherein

R¹, R² and R³ are Cl.

5 Embodiment H. A compound of Embodiment A wherein

R¹ is CF₃; and

R² and R³ are H.

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

1-[2-cyano-4-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carbonitrile,

1-[2-cyano-4-[4,5-dihydro-5-(3,4,5-trichlorophenyl)-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carbonitrile,

1-[2-cyano-4-[5-(3,5-dichloro-4-fluorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carbonitrile,

1-[2-cyano-4-[4,5-dihydro-5-(trifluoromethyl)-5-[3-(trifluoromethyl)phenyl]-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carbonitrile,

1-[4-[5-[3,5-bis(trifluoromethyl)phenyl]-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]-2-cyanophenyl]-1*H*-pyrazole-4-carbonitrile,

1-[2-cyano-4-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-*N*-(2,2,2-trifluoroethyl)-1*H*-pyrazole-4-carboxamide,

2-(4-chloro-1*H*-pyrazol-1-yl)-5-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]benzonitrile,

2-(4-bromo-1*H*-pyrazol-1-yl)-5-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]benzonitrile,

1-[4-[5-[3-chloro-5-(trifluoromethoxy)phenyl]-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]-2-cyanophenyl]-1*H*-pyrazole-4-carbonitrile, and

1-[2-cyano-4-[5-[3,5-dichloro-4-(difluoromethyl)phenyl]-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carbonitrile.

10 Of note is that compounds of this invention are characterized by favorable metabolic 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
15 pests by controlling invertebrate pests are embodiments of the invention. Compounds of this invention 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 invention are compositions comprising a compound of any of the preceding Embodiments, 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.

Further noteworthy as embodiments of the present invention are compositions for controlling an invertebrate pest comprising a biologically effective amount of a compound of any of the preceding Embodiments, 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 a biologically effective amount of at least one additional biologically active compound or agent. Embodiments of the invention further include methods for controlling an invertebrate pest comprising contacting the invertebrate pest or its 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 invention also include methods for protecting a seed from an invertebrate pest comprising contacting the seed with a biologically effective amount of a compound of any of the preceding Embodiments.

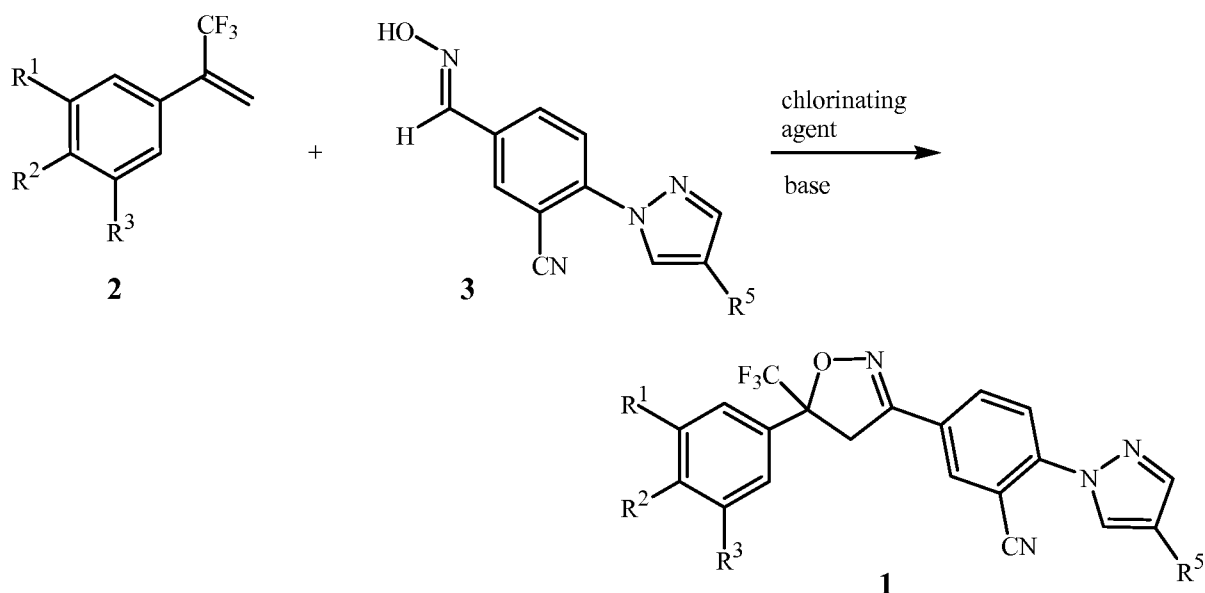
Embodiments of the invention also include methods for protecting an animal from an invertebrate parasitic pest comprising administering to the animal a parasitocidally effective amount of a compound of any of the preceding Embodiments.

One or more of the following methods and variations as described in Schemes 1–5 can be used to prepare the compounds of Formula 1. The definitions of R¹, R², R³, R⁴ and R⁵ in the compounds of Formulae 1–9 below are as defined above in the Summary of the Invention unless otherwise noted. Compounds of Formulae 1a, 1b and 1c are various subsets of compounds of Formula 1, and all substituents for Formulae 1a, 1b and 1c are as defined above for Formula 1 unless otherwise noted.

Compounds of Formula 1 can be prepared by the cycloaddition of compounds of Formula 2 with nitrile oxides derived from oximes of Formula 3 as outlined in Scheme 1. In this method, an oxime of Formula 3 is treated with a chlorinating reagent such as sodium hypochlorite, *N*-chlorosuccinimide, or chloramine-T to give a hydroxamoyl chloride intermediate. In the presence of a base (e.g., pyridine or triethylamine), the hydroxamoyl chloride dehydrochlorinates to form the intermediate nitrile oxide. This nitrile oxide intermediate generated in situ reacts with a styrene of Formula 2 to form a cycloaddition product of Formula 1. Typical solvents include tetrahydrofuran, diethyl ether, dichloromethane, dioxane, and toluene. Typical reaction temperatures range from room temperature to the reflux temperature of the solvent. General procedures for cycloaddition of

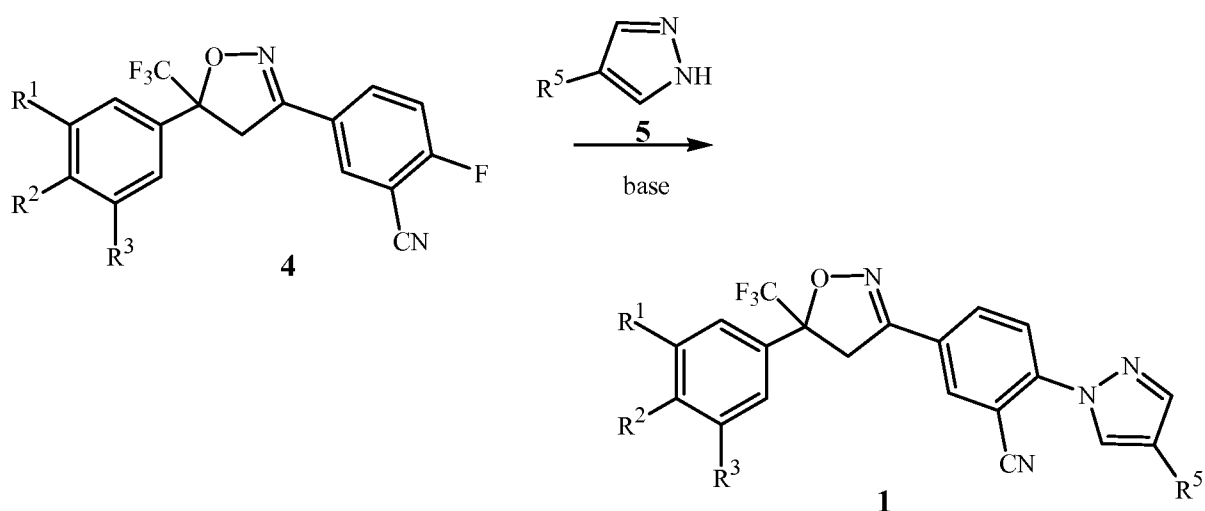
nitrile oxides with olefins are well described in the chemical literature (see, for instance, *Synthesis* **1982**, 6, 508-509 and *Tetrahedron* **2000**, 56, 1057-1064).

Scheme 1



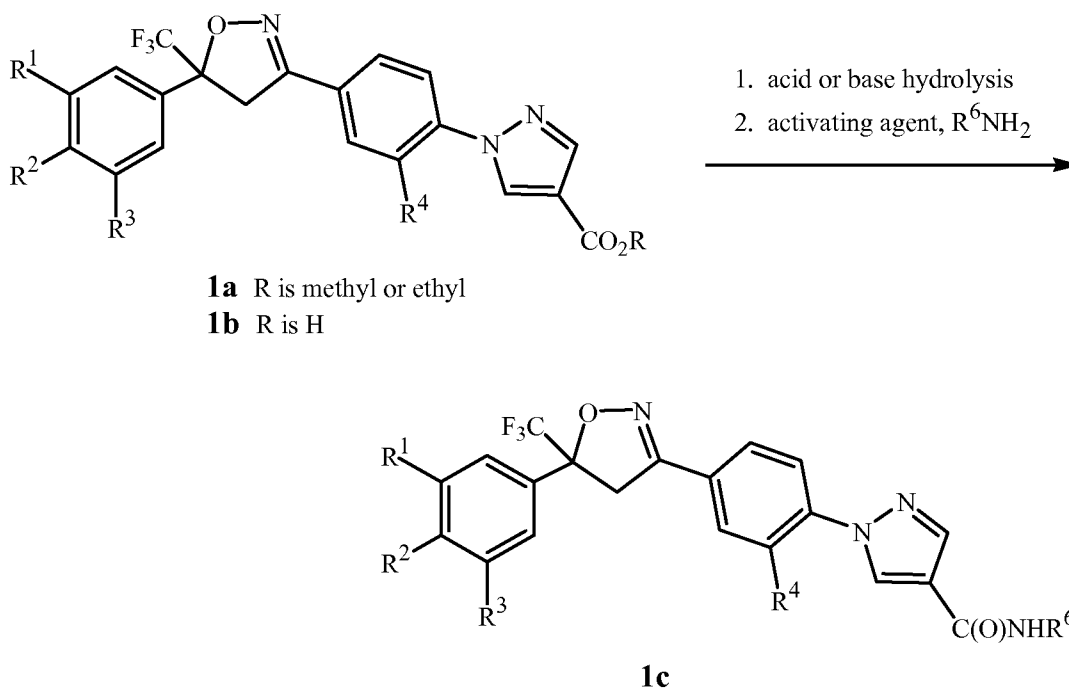
Compounds of Formula **1** can also be prepared by direct displacement of fluoride from aromatic fluorides of Formula **4** with pyrazole **5** as shown in Scheme 2. The reaction is typically run in a polar aprotic solvent such as *N,N*-dimethylformamide or *N,N*-dimethylacetamide in the presence of an inorganic base such as sodium or potassium carbonate. Pyrazoles of Formula **5** are commercially available or can be prepared by known methods, see, for example, *Monatsch Chemie* **1993**, 124, 199-207 and *J. Org. Chem.* **1963**, 28, 2755-2758. The method of Scheme 2 is illustrated in Step F of Synthesis Example 1.

Scheme 2



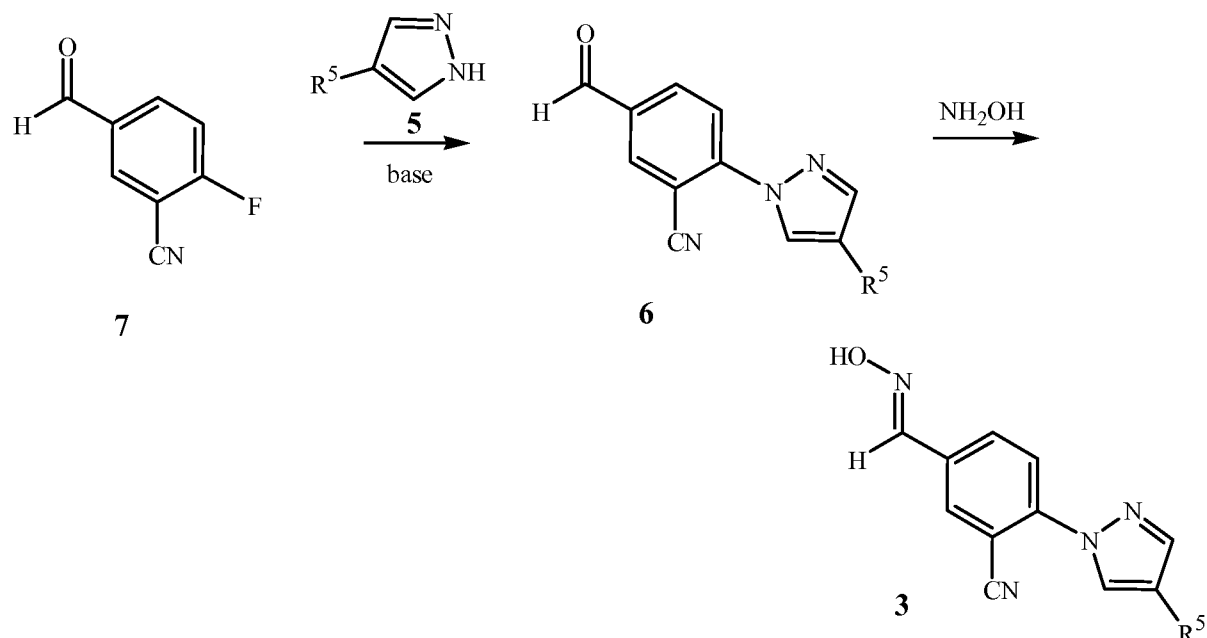
Compounds of Formula **1c** (compounds of Formula **1** wherein R^5 is $C(O)NHR^6$) can be prepared from compounds of Formula **1a** (compounds of Formula **1** wherein R^5 is a carboxylic acid ester) as shown in Scheme 3. In this method, hydrolysis of ester **1a** can be accomplished by a wide variety of acidic or basic reagents, including, for example, an alkali metal hydroxide in a mixed organic/aqueous solvent medium, heated as necessary, and followed by neutralization and extraction to isolate the carboxylic acid **1b**. The carboxylic acid **1b** can then be treated with an activating agent, for example, oxalyl chloride or thionyl chloride, to form an intermediate acid chloride which can be coupled with an appropriate R^6NH_2 amine, either in excess or in the presence of an acid scavenging agent, to form the corresponding amide **1c**. One skilled in the art will appreciate that a wide variety of well known reagents and conditions can accomplish the transformation of ester **1a** to amide **1c**.

Scheme 3



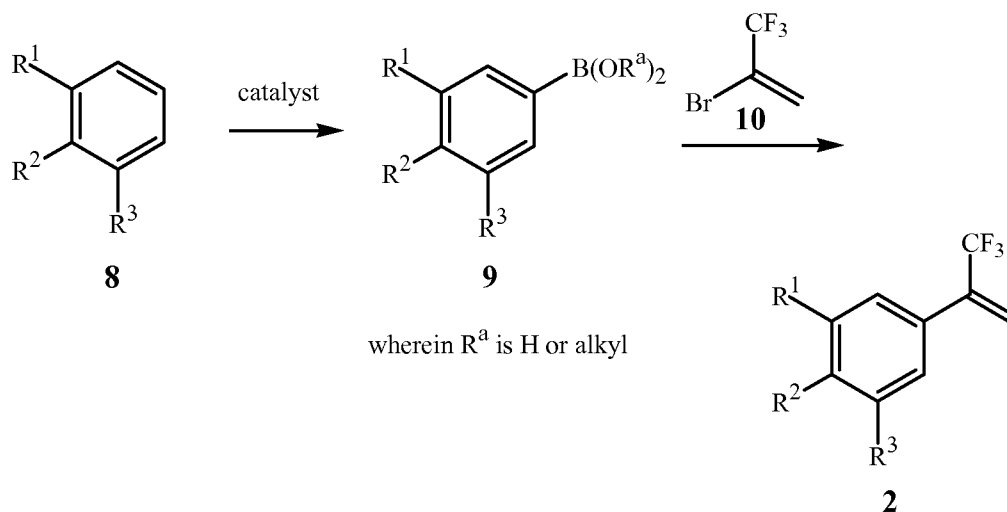
The oxime of Formula **3** can be prepared by reaction of the corresponding aldehyde of Formula **6** with hydroxylamine according to methods known in the art (see, for example, *Bioorg. Med. Chem. Lett.* **1997**, 7(21), 2813-2818) as shown in Scheme 4. The aldehyde of Formula **6** can be prepared by the reaction of commercially available 3-cyano-4-fluorobenzaldehyde (**7**) with pyrazole **5** analogous to the method of Scheme 2.

Scheme 4



Styrenes of Formula **2** can be prepared by the palladium-catalyzed coupling of commercially available 2-bromo-3,3,3-trifluoropropene (**10**) with aryl boronic acids and boronic esters of Formula **9** (wherein R^a is H or alkyl) as outlined in Scheme 5. General procedures for this reaction are described in *J. Fluorine Chem.* **1999**, 95, 167-170. Many boronic acids and boronic esters are commercially available. Alternatively, cyclic dioxaborolanes of Formula **9** (wherein both R^a are taken together as $C(CH_3)_2C(CH_3)_2$) can be prepared from substituted benzenes of Formula **8** by the method described in *Angew. Chem.* **2002**, 114, 3182-3184 and illustrated in Step B of Synthesis Example 1. Substituted benzenes of Formula **8** are either commercially available or can be prepared by methods well known in the art.

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Scheme 5

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 particular sequence presented to prepare the compounds of Formula 1. For example, compounds of Formula 3 wherein R^4 or R^5 is $C(S)NH_2$ may not be compatible with the reaction conditions of the method of Scheme 1. One skilled in the art would recognize that in this instance the compounds of Formula 1 wherein R^4 or R^5 is $C(S)NH_2$ can be prepared by the cycloaddition of compounds of Formula 3 wherein R^4 or R^5 is cyano, followed by the transformation of the cyano group to the $C(S)NH_2$ group as described in *Organic Syntheses* **1955**, Coll. Vol. 3, 609.

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

Without further elaboration, it is believed that one skilled in the art using the preceding description can utilize the present invention to its fullest extent. The following Examples are, therefore, to be construed as merely illustrative, and not limiting of the disclosure in any

way whatsoever. Steps in the following Examples illustrate a procedure for each step in an overall synthetic transformation, and the starting material for each step may not have necessarily been prepared by a particular preparative run whose procedure is described in other Examples or Steps. Percentages are by weight except for chromatographic solvent mixtures or where otherwise indicated. Parts and percentages for chromatographic solvent mixtures are by volume unless otherwise indicated. ¹H NMR spectra are reported in ppm downfield from tetramethylsilane; “s” means singlet, “d” means doublet, “t” means triplet, “q” means quartet, “m” means multiplet and “dd” means doublet of doublets.

SYNTHESIS EXAMPLE 1

Preparation of 1-[2-cyano-4-[5-(3,5-dichloro-4-fluorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carbonitrile

Step A: Preparation of 2,6-bis(1-methylethyl)-*N*-(2-pyridinylmethylene)benzenamine

2,6-Diisopropylphenylamine (8.27 g, 46.7 mmol) was added to a solution of 2-pyridinecarboxaldehyde (5.0 g, 47 mmol) in toluene (200 mL) in a round bottom flask equipped with a Dean-Stark trap, followed by the addition of a catalytic amount of *p*-toluenesulfonic acid (0.10 g). The reaction mixture was heated to reflux for 18 h to remove water as an azeotrope. The reaction mixture was then washed once with water (100 mL), and the toluene was removed under reduced pressure. The resulting residue was purified by chromatography on silica gel by elution with ethyl acetate/hexane to provide the title compound as a yellowish-green solid (7.17 g). ¹H NMR (CDCl₃) δ 8.72-8.73 (m, 1H), 8.31 (s, 1H), 8.27 (d, 1H), 7.84 (t, 1H), 7.38-7.42 (m, 1H), 7.12-7.18 (m, 3H), 2.97 (q, 2H), 1.17 (d, 12 H).

Step B: Preparation of 2-(3,5-dichloro-4-fluorophenyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane

4,4,4',4',5,5,5',5'-Octamethyl[2,2'-bi-1,3,2-dioxaborolane] (10.0 g, 39.4 mmol), 2,6-bis(1-methylethyl)-*N*-(2-pyridinylmethylene)benzenamine (0.40 g, 1.5 mmol), and di- μ -chlorobis[(1,2,5,6- η)-1,5-cyclooctadiene]diiridium (0.50 g, 1.0 mmol) were added to a solution of 1,3-dichloro-2-fluorobenzene (10.0 g, 60.6 mmol) in heptane (200 mL). The reaction mixture turned from yellow to forest green to brick red within the first minute. The reaction mixture was heated to reflux for 18 h. The mixture was then partitioned between ethyl acetate and water, and the aqueous extract was washed twice with ethyl acetate. The organic extracts were combined, dried over MgSO₄, and concentrated under reduced pressure. The solid residue was purified by chromatography on silica gel by elution with ethyl acetate/hexane to afford the title compound as a solid (11.0 g). ¹H NMR (CDCl₃) δ 7.72 (d, 2H), 1.33 (s, 12H).

Step C: Preparation of 1,3-dichloro-2-fluoro-5-[1-(trifluoromethyl)ethenyl]benzene

2-(3,5-Dichloro-4-fluorophenyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (11.0 g, 37.8 mmol) and 2-bromo-3,3,3-trifluoropropene (8.0 g, 46 mmol) were added to a mixture of tetrahydrofuran (30 mL), ethylene glycol dimethyl ether (30 mL), and 4 M potassium hydroxide aqueous solution (30 mL) in a 200 mL Fisher-Porter sealed tube, followed by the addition of tetrakis(triphenylphosphine)palladium(0) (264 mg, 0.229 mmol). The reaction mixture was heated at 75 °C for 6 h. The reaction mixture was then partitioned between ether and water, and the aqueous layer was separated and washed twice with diethyl ether. The combined organic extracts were dried over MgSO₄ and concentrated under reduced pressure. The residual oily solid was purified by chromatography on silica gel by elution with ethyl acetate/hexane to afford the title compound as an oil (8.33 g). ¹H NMR (CDCl₃) δ 7.40 (d, 2H), 6.04 (s, 1H), 5.79 (s, 1H).

Step D: Preparation of 2-fluoro-5-[(hydroxyimino)methyl]benzonitrile

Hydroxylamine (10.0 mL, 50% by weight aqueous solution, 152 mmol) was added to a solution of 4-fluoro-3-cyanobenzaldehyde (15.81 g, 106.1 mmol) in ethanol (200 mL). The reaction mixture was stirred vigorously for 3 h at room temperature. The volatiles were evaporated under reduced pressure to give an oily aqueous liquid, which was partitioned between ethyl acetate and water. The aqueous extract was washed twice with ethyl acetate. The organic extracts were combined, dried over MgSO₄, and concentrated under reduced pressure. The residual solid was purified by chromatography on silica gel by elution with ethyl acetate/hexane to afford the title compound as a white solid (15.0 g). ¹H NMR ((CD₃)₂SO) δ 11.53 (s, 1H), 9.71 (s, 1H), 8.16 (s, 1H), 7.53 (t, 1H), 7.44 (m, 1H).

Step E: Preparation of 5-[5-(3,5-dichloro-4-fluorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]-2-fluorobenzonitrile

Aqueous sodium hypochlorite solution (50 mL) was added to a solution of 2-fluoro-5-[(hydroxyimino)methyl]benzonitrile (2.0 g, 12 mmol), 1,3-dichloro-2-fluoro-5-[1-(trifluoromethyl)ethenyl]benzene (4.0 g, 15 mmol) and tetrahydrofuran (50 mL). The reaction changed color from yellow to orange to chartreuse. The reaction mixture was stirred at room temperature for 3 h and then partitioned between ethyl acetate and water. The aqueous extract was extracted twice with ethyl acetate, and the combined organic extracts were dried over MgSO₄ and concentrated under reduced pressure. The residual waxy oil was purified by chromatography on silica gel eluted with ethyl acetate/hexane to afford the title compound as a waxy solid (1.1 g). ¹H NMR (CDCl₃) δ 7.97 (m, 1H), 7.91 (d, 1H), 7.55 (d, 2H), 7.31 (t, 1H), 4.05 (d, 1H), 3.66 (d, 1H).

Step F: Preparation of 1-[2-cyano-4-[5-(3,5-dichloro-4-fluorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carbonitrile

5 5-[5-(3,5-dichloro-4-fluorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]-2-fluorobenzonitrile (0.21 g, 0.5 mmol) was added to a mixture of potassium carbonate (0.28 g, 2 mmol) and 4-cyanopyrazole (47 mg, 0.5 mmol) in acetonitrile (2 mL). The reaction mixture was sealed and heated in a microwave reactor at 140 °C for 30 min. The reaction mixture was then cooled and added to silica gel, and the solvent was removed under reduced pressure. The resulting free-flowing solid was eluted with ethyl acetate/hexane through a silica gel column to afford the title compound, a compound of this invention, as an off-white solid. ¹H NMR (CDCl₃) δ 8.63 (s, 1H), 8.10-8.15 (m, 3H), 7.93 (d, 1H), 7.59 (d, 2H), 4.14 (d, 1H), 3.76 (d, 1H).

SYNTHESIS EXAMPLE 2

15 Preparation of 1-[2-cyano-4-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-*N*-(2,2,2-trifluoroethyl)-1*H*-pyrazole-4-carboxamide

Step A: Preparation of ethyl 1-[2-cyano-4-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carboxylate

20 5-[5-(3,5-Dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]-2-fluorobenzonitrile (0.81 g, 2 mmol), prepared by a sequence analogous to Steps A-E of Synthesis Example 1, was added to a mixture of potassium carbonate (0.256 g, 4 mmol) and ethyl 4-pyrazolecarboxylate (0.31 g, 2.2 mmol) in acetonitrile (20 mL). The reaction mixture was stirred vigorously for 72 h at 80 °C. The reaction mixture was then added to silica gel, and the solvent was removed under reduced pressure. The resulting free-flowing solid was eluted with ethyl acetate/hexane to afford the title compound as an off-white solid (0.30 g). ¹H NMR (CDCl₃) δ 8.63 (s, 1H), 8.2 (s, 1H), 8.05 (m, 2H), 7.9 (d, 1H), 7.5 (m, 1H), 4.35 (q, 2H), 4.35 (d, 1H), 3.75 (d, 1H), 1.38 (t, 3H).

30 Step B: Preparation of 1-[2-cyano-4-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carboxylic acid

Ethyl 1-[2-cyano-4-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carboxylate (0.57 g, 1.1 mmol) was added to a solution of 1 N NaOH (2.2 mL) in methanol (5 mL) and stirred for 2 h at 55 °C. Tetrahydrofuran (5 mL) was added and heating was continued 6 h. 1 N hydrochloric acid (2.2 mL) was added, the solvent was evaporated under nitrogen, and the sample was chromatographed over silica gel eluted with ethyl acetate/hexane to afford the title compound as a white solid (0.2 g). ¹H

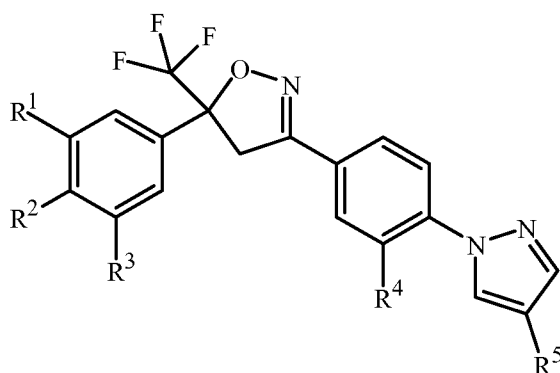
NMR ((CD₃)₂SO) δ 12.86 (broad s, 1H), 9.03 (s, 1H), 8.32 (s, 1H), 8.18-8.25 (m, 2H), 8.06 (d, 1H), 7.8 (s, 1H), 7.6 (s, 2H), 4.35 (q, 2H), 4.47 (dd, 2H).

Step C: Preparation of 1-[2-cyano-4-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-*N*-(2,2,2-trifluoroethyl)-1*H*-pyrazole-4-carboxamide

1-[2-Cyano-4-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carboxylic acid (0.2 g 0.4 mmol) was dissolved in anhydrous 1,2-dichloroethane (5 mL), followed by the addition of oxalyl chloride (0.2 mL, 2.4 mmol) and *N,N*-dimethylformamide (one drop). The reaction mixture was stirred at 25 °C for 1 hr and then divided in three equal portions. To one of these portions was added 0.2 g polymer-bound 4-(dimethylamino)pyridine and 2,2,2-trifluoroethylamine hydrochloride (20 mg, 0.15 mmol), and the reaction mixture was shaken for 72 h. The reaction mixture was then filtered, and the polymer was rinsed with successive portions of dichloromethane, diethyl ether and dichloromethane. The combined solvents were removed under reduced pressure to afford the title compound, a compound of this invention, as an off-white solid (27 mg). ¹H NMR (CDCl₃) δ 8.70 (s, 1H), 8.25 (s, 1H), 8.03-8.08 (m, 2H), 7.89-7.93 (dd, 2H), 7.6 (s, 2H), 4.12 (d, 1H), 3.87 (m, 2H), 3.74 (d, 1H).

By the procedures described herein together with methods known in the art, the following compounds of Table 1 can be prepared.

TABLE 1



R⁴ is cyano

R ¹	R ²	R ³	R ⁵	R ¹	R ²	R ³	R ⁵
Cl	H	Cl	F	Cl	H	Cl	Cl
Cl	Cl	Cl	F	Cl	Cl	Cl	Cl

R ¹	R ²	R ³	R ⁵	R ¹	R ²	R ³	R ⁵
Cl	F	Cl	F	Cl	F	Cl	Cl
Br	H	Br	F	Br	H	Br	Cl
CF ₃	H	H	F	CF ₃	H	H	Cl
CF ₃	H	CF ₃	F	CF ₃	H	CF ₃	Cl
Cl	CHF ₂	Cl	F	Cl	CHF ₂	Cl	Cl
OCF ₃	H	Cl	F	OCF ₃	H	Cl	Cl
Cl	H	Cl	Br	Cl	H	Cl	I
Cl	Cl	Cl	Br	Cl	Cl	Cl	I
Cl	F	Cl	Br	Cl	F	Cl	I
Br	H	Br	Br	Br	H	Br	I
CF ₃	H	H	Br	CF ₃	H	H	I
CF ₃	H	CF ₃	Br	CF ₃	H	CF ₃	I
Cl	CHF ₂	Cl	Br	Cl	CHF ₂	Cl	I
OCF ₃	H	Cl	Br	OCF ₃	H	Cl	I
Cl	H	Cl	cyano	Cl	H	Cl	C(S)NH ₂
Cl	Cl	Cl	cyano	Cl	Cl	Cl	C(S)NH ₂
Cl	F	Cl	cyano	Cl	F	Cl	C(S)NH ₂
Br	H	Br	cyano	Br	H	Br	C(S)NH ₂
CF ₃	H	H	cyano	CF ₃	H	H	C(S)NH ₂
CF ₃	H	CF ₃	cyano	CF ₃	H	CF ₃	C(S)NH ₂
Cl	CHF ₂	Cl	cyano	Cl	CHF ₂	Cl	C(S)NH ₂
OCF ₃	H	Cl	cyano	OCF ₃	H	Cl	C(S)NH ₂
Cl	H	Cl	C(O)NHCH ₃	Cl	H	Cl	C(O)NHCH ₂ CH ₃
Cl	Cl	Cl	C(O)NHCH ₃	Cl	Cl	Cl	C(O)NHCH ₂ CH ₃
Cl	F	Cl	C(O)NHCH ₃	Cl	F	Cl	C(O)NHCH ₂ CH ₃
Br	H	Br	C(O)NHCH ₃	Br	H	Br	C(O)NHCH ₂ CH ₃
CF ₃	H	H	C(O)NHCH ₃	CF ₃	H	H	C(O)NHCH ₂ CH ₃
CF ₃	H	CF ₃	C(O)NHCH ₃	CF ₃	H	CF ₃	C(O)NHCH ₂ CH ₃
Cl	CHF ₂	Cl	C(O)NHCH ₃	Cl	CHF ₂	Cl	C(O)NHCH ₂ CH ₃
OCF ₃	H	Cl	C(O)NHCH ₃	OCF ₃	H	Cl	C(O)NHCH ₂ CH ₃
Cl	H	Cl	C(O)NHCH(CH ₃) ₂	Cl	H	Cl	C(O)NHCH ₂ CF ₃
Cl	Cl	Cl	C(O)NHCH(CH ₃) ₂	Cl	Cl	Cl	C(O)NHCH ₂ CF ₃
Cl	F	Cl	C(O)NHCH(CH ₃) ₂	Cl	F	Cl	C(O)NHCH ₂ CF ₃
Br	H	Br	C(O)NHCH(CH ₃) ₂	Br	H	Br	C(O)NHCH ₂ CF ₃
CF ₃	H	H	C(O)NHCH(CH ₃) ₂	CF ₃	H	H	C(O)NHCH ₂ CF ₃
CF ₃	H	CF ₃	C(O)NHCH(CH ₃) ₂	CF ₃	H	CF ₃	C(O)NHCH ₂ CF ₃
Cl	CHF ₂	Cl	C(O)NHCH(CH ₃) ₂	Cl	CHF ₂	Cl	C(O)NHCH ₂ CF ₃

R ¹	R ²	R ³	R ⁵	R ¹	R ²	R ³	R ⁵
OCF ₃	H	Cl	C(O)NHCH(CH ₃) ₂	OCF ₃	H	Cl	C(O)NHCH ₂ CF ₃
Cl	H	Cl	C(O)NH(cyclopropyl)	Cl	H	Cl	C(O)NH(cyclopropylmethyl)
Cl	Cl	Cl	C(O)NH(cyclopropyl)	Cl	Cl	Cl	C(O)NH(cyclopropylmethyl)
Cl	F	Cl	C(O)NH(cyclopropyl)	Cl	F	Cl	C(O)NH(cyclopropylmethyl)
Br	H	Br	C(O)NH(cyclopropyl)	Br	H	Br	C(O)NH(cyclopropylmethyl)
CF ₃	H	H	C(O)NH(cyclopropyl)	CF ₃	H	H	C(O)NH(cyclopropylmethyl)
CF ₃	H	CF ₃	C(O)NH(cyclopropyl)	CF ₃	H	CF ₃	C(O)NH(cyclopropylmethyl)
Cl	CHF ₂	Cl	C(O)NH(cyclopropyl)	Cl	CHF ₂	Cl	C(O)NH(cyclopropylmethyl)
OCF ₃	H	Cl	C(O)NH(cyclopropyl)	OCF ₃	H	Cl	C(O)NH(cyclopropylmethyl)

R⁴ is C(S)NH₂

R ¹	R ²	R ³	R ⁵	R ¹	R ²	R ³	R ⁵
Cl	H	Cl	F	Cl	H	Cl	Cl
Cl	Cl	Cl	F	Cl	Cl	Cl	Cl
Cl	F	Cl	F	Cl	F	Cl	Cl
Br	H	Br	F	Br	H	Br	Cl
CF ₃	H	H	F	CF ₃	H	H	Cl
CF ₃	H	CF ₃	F	CF ₃	H	CF ₃	Cl
Cl	CHF ₂	Cl	F	Cl	CHF ₂	Cl	Cl
OCF ₃	H	Cl	F	OCF ₃	H	Cl	Cl
Cl	H	Cl	Br	Cl	H	Cl	I
Cl	Cl	Cl	Br	Cl	Cl	Cl	I
Cl	F	Cl	Br	Cl	F	Cl	I
Br	H	Br	Br	Br	H	Br	I
CF ₃	H	H	Br	CF ₃	H	H	I
CF ₃	H	CF ₃	Br	CF ₃	H	CF ₃	I
Cl	CHF ₂	Cl	Br	Cl	CHF ₂	Cl	I
OCF ₃	H	Cl	Br	OCF ₃	H	Cl	I
Cl	H	Cl	cyano	Cl	H	Cl	C(S)NH ₂
Cl	Cl	Cl	cyano	Cl	Cl	Cl	C(S)NH ₂
Cl	F	Cl	cyano	Cl	F	Cl	C(S)NH ₂
Br	H	Br	cyano	Br	H	Br	C(S)NH ₂
CF ₃	H	H	cyano	CF ₃	H	H	C(S)NH ₂
CF ₃	H	CF ₃	cyano	CF ₃	H	CF ₃	C(S)NH ₂
Cl	CHF ₂	Cl	cyano	Cl	CHF ₂	Cl	C(S)NH ₂
OCF ₃	H	Cl	cyano	OCF ₃	H	Cl	C(S)NH ₂

R ¹	R ²	R ³	R ⁵	R ¹	R ²	R ³	R ⁵
Cl	H	Cl	C(O)NHCH ₃	Cl	H	Cl	C(O)NHCH ₂ CH ₃
Cl	Cl	Cl	C(O)NHCH ₃	Cl	Cl	Cl	C(O)NHCH ₂ CH ₃
Cl	F	Cl	C(O)NHCH ₃	Cl	F	Cl	C(O)NHCH ₂ CH ₃
Br	H	Br	C(O)NHCH ₃	Br	H	Br	C(O)NHCH ₂ CH ₃
CF ₃	H	H	C(O)NHCH ₃	CF ₃	H	H	C(O)NHCH ₂ CH ₃
CF ₃	H	CF ₃	C(O)NHCH ₃	CF ₃	H	CF ₃	C(O)NHCH ₂ CH ₃
Cl	CHF ₂	Cl	C(O)NHCH ₃	Cl	CHF ₂	Cl	C(O)NHCH ₂ CH ₃
OCF ₃	H	Cl	C(O)NHCH ₃	OCF ₃	H	Cl	C(O)NHCH ₂ CH ₃
Cl	H	Cl	C(O)NHCH(CH ₃) ₂	Cl	H	Cl	C(O)NHCH ₂ CF ₃
Cl	Cl	Cl	C(O)NHCH(CH ₃) ₂	Cl	Cl	Cl	C(O)NHCH ₂ CF ₃
Cl	F	Cl	C(O)NHCH(CH ₃) ₂	Cl	F	Cl	C(O)NHCH ₂ CF ₃
Br	H	Br	C(O)NHCH(CH ₃) ₂	Br	H	Br	C(O)NHCH ₂ CF ₃
CF ₃	H	H	C(O)NHCH(CH ₃) ₂	CF ₃	H	H	C(O)NHCH ₂ CF ₃
CF ₃	H	CF ₃	C(O)NHCH(CH ₃) ₂	CF ₃	H	CF ₃	C(O)NHCH ₂ CF ₃
Cl	CHF ₂	Cl	C(O)NHCH(CH ₃) ₂	Cl	CHF ₂	Cl	C(O)NHCH ₂ CF ₃
OCF ₃	H	Cl	C(O)NHCH(CH ₃) ₂	OCF ₃	H	Cl	C(O)NHCH ₂ CF ₃
Cl	H	Cl	C(O)NH(cyclopropyl)	Cl	H	Cl	C(O)NH(cyclopropylmethyl)
Cl	Cl	Cl	C(O)NH(cyclopropyl)	Cl	Cl	Cl	C(O)NH(cyclopropylmethyl)
Cl	F	Cl	C(O)NH(cyclopropyl)	Cl	F	Cl	C(O)NH(cyclopropylmethyl)
Br	H	Br	C(O)NH(cyclopropyl)	Br	H	Br	C(O)NH(cyclopropylmethyl)
CF ₃	H	H	C(O)NH(cyclopropyl)	CF ₃	H	H	C(O)NH(cyclopropylmethyl)
CF ₃	H	CF ₃	C(O)NH(cyclopropyl)	CF ₃	H	CF ₃	C(O)NH(cyclopropylmethyl)
Cl	CHF ₂	Cl	C(O)NH(cyclopropyl)	Cl	CHF ₂	Cl	C(O)NH(cyclopropylmethyl)
OCF ₃	H	Cl	C(O)NH(cyclopropyl)	OCF ₃	H	Cl	C(O)NH(cyclopropylmethyl)

A compound of this invention 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 factors such as soil type, moisture and temperature.

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

The general types of nonaqueous liquid compositions are emulsifiable concentrate, microemulsifiable concentrate, dispersible concentrate and oil dispersion.

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

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

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

	Weight Percent		
	<u>Active 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), ethylene glycol, triethylene glycol, propylene glycol, dipropylene glycol, polypropylene glycol, propylene carbonate, butylene carbonate, paraffins (e.g., white mineral oils, normal paraffins, isoparaffins), alkylbenzenes, alkyl naphthalenes, glycerine, glycerol triacetate, sorbitol, triacetin, aromatic hydrocarbons, dearomatized aliphatics, alkylbenzenes, alkyl naphthalenes, ketones such as cyclohexanone, 2-heptanone, isophorone and 4-hydroxy-4-methyl-2-pentanone, acetates such as isoamyl acetate, hexyl acetate, heptyl acetate, octyl acetate, nonyl acetate, tridecyl acetate and isobornyl acetate, other esters such as alkylated lactate esters, dibasic esters and γ -butyrolactone, and alcohols, which can be linear, branched, saturated or unsaturated, such as methanol, ethanol, *n*-propanol, isopropyl alcohol, *n*-butanol, isobutyl alcohol, *n*-hexanol, 2-ethylhexanol, *n*-octanol, decanol, isodecyl alcohol, isooctadecanol, cetyl alcohol, lauryl alcohol, tridecyl alcohol, oleyl alcohol, cyclohexanol, tetrahydrofurfuryl alcohol, diacetone alcohol and benzyl alcohol. Liquid diluents also include glycerol esters of saturated and unsaturated fatty acids (typically C₆–C₂₂), such as plant seed and fruit oils (e.g., oils of olive, castor, linseed, sesame, corn (maize), peanut, sunflower, grapeseed, safflower, cottonseed, soybean, rapeseed, coconut and palm kernel), animal-sourced fats (e.g., beef tallow, pork tallow, lard, cod liver oil, fish oil), and mixtures thereof. Liquid diluents also include alkylated fatty acids (e.g.,

methyalted, ethyalted, butyalted) 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.

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

10 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;
15 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
20 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
25 glycerol fatty acid esters; other sorbitan derivatives such as sorbitan esters; polymeric surfactants such as random copolymers, block copolymers, alkyd peg (polyethylene glycol) resins, graft or comb polymers and star polymers; polyethylene glycols (pegs); polyethylene glycol fatty acid esters; silicone-based surfactants; and sugar-derivatives such as sucrose esters, alkyl polyglycosides and alkyl polysaccharides.

30 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
35 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
5 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;
10 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
15 including *McCutcheon's Emulsifiers and Detergents*, annual American and International Editions published by McCutcheon's Division, The Manufacturing Confectioner Publishing Co.; Sisely and Wood, *Encyclopedia of Surface Active Agents*, Chemical Publ. Co., Inc., New York, 1964; and A. S. Davidson and B. Milwidsky, *Synthetic Detergents*, Seventh Edition, John Wiley and Sons, New York, 1987.

Compositions of this invention may also contain formulation auxiliaries and additives, known to those skilled in the art as formulation aids (some of which may be considered to also function as solid diluents, liquid diluents or surfactants). Such formulation auxiliaries and additives may control: pH (buffers), foaming during processing (antifoams such polyorganosiloxanes), sedimentation of active ingredients (suspending agents), viscosity
25 (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
30 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
35 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
5 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,
10 "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.
15 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.,
20 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.,
25 *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 Table A. Without further elaboration, it is
30 believed that one skilled in the art using the preceding description can utilize the present invention to its fullest extent. The following Examples are, therefore, to be construed as merely illustrative, and not limiting of the disclosure in any way whatsoever. Percentages are by weight except where otherwise indicated.

Example AHigh Strength Concentrate

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

Example BWettable Powder

Compound 4	65.0%
dodecylphenol polyethylene glycol ether	2.0%
sodium ligninsulfonate	4.0%
sodium silicoaluminate	6.0%
montmorillonite (calcined)	23.0%

Example CGranule

Compound 7	10.0%
attapulgite granules (low volatile matter, 0.71/0.30 mm; U.S.S. No. 25–50 sieves)	90.0%

5

Example DExtruded Pellet

Compound 8	25.0%
anhydrous sodium sulfate	10.0%
crude calcium ligninsulfonate	5.0%
sodium alkylnaphthalenesulfonate	1.0%
calcium/magnesium bentonite	59.0%

Example EEmulsifiable Concentrate

Compound 1	10.0%
polyoxyethylene sorbitol hexoleate	20.0%
C ₆ –C ₁₀ fatty acid methyl ester	70.0%

Example FMicroemulsion

Compound 4	5.0%
polyvinylpyrrolidone-vinyl acetate copolymer	30.0%
alkylpolyglycoside	30.0%
glyceryl monooleate	15.0%
water	20.0%

Example GSeed Treatment

Compound 7	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 8	2.50%
pyrrolidone-styrene copolymer	4.80%
tristyrylphenyl 16-ethoxylate	2.30%
talc	0.80%
corn starch	5.00%
Nitrophoska [®] Permanent 15-9-15 slow-release fertilizer (BASF)	36.00%
kaolin	38.00%
water	10.60%

Compounds of this invention exhibit activity against a wide spectrum of invertebrate
5 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
10 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
15 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[®], 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 interact synergistically 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 interact synergistically 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 invention 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 invention 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 invention 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 invention 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 invention are suitable for systemic and/or non-systemic control of infestation or infection by parasites on animals. Compounds and compositions of the present invention are particularly suitable for combating external parasitic or disease transmitting pests. Compounds and compositions of the present invention 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 invention 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 fugiperda* 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*

inclusens 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 (*Cnaphalocerus medinalis*), grape leaffolder (*Desmia funeralis* Hübner), melon worm (*Diaphania nitidalis* Stoll), cabbage center grub (*Helluala 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), cabbage cluster caterpillar (*Crociodolomia 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 leaffolder (*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 orders Hemiptera and Homoptera 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 Fulgoroidae and Delphacidae, treehoppers from the family Membracidae, psyllids from the family Psyllidae, 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. Also included are 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., *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), 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 (*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., *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), 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 louse (*Pediculus humanus capitis* De Geer), body louse (*Pediculus humanus* Linnaeus), chicken body louse (*Menacanthus stramineus* Nitzsch), 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 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 Scutigeromorpha such as the house centipede (*Scutigera coleoptrata* Linnaeus). Compounds of the present invention also 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 invention 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 invention also have significant activity on members from the order Homoptera including: *Acyrtosiphon pisum* Harris (pea aphid), *Aphis craccivora* Koch (cowpea aphid), *Aphis fabae* Scopoli (black bean aphid), *Aphis gossypii* Glover (cotton aphid, 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* Paaserini (rosy apple aphid), *Eriosoma lanigerum* Hausmann (woolly apple aphid), *Hyalopterus pruni* Geoffroy (mealy plum aphid), *Lipaphis erysimi* Kaltenbach (turnip aphid), *Metopolophium dirrhodum* Walker (cereal 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 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 citricida* 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), *Macrolestes quadrilineatus* Forbes (aster leafhopper), *Nephotettix cincticeps* Uhler (green leafhopper), *Nephotettix nigropictus* Stål (rice leafhopper), *Nilaparvata lugens* Stål (brown planthopper), *Peregrinus maidis* Ashmead (corn planthopper), *Sogatella furcifera* Horvath (white-backed planthopper), *Sogatodes orizicola* Muir (rice delphacid), *Typhlocyba pomaria* McAtee white apple leafhopper, *Erythroneoura* 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 invention 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), *Corythuca gossypii* Fabricius (cotton lace bug), *Cyrtopeltis modesta* Distant (tomato bug),
5 *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), *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
10 (large milkweed bug), *Pseudatomoscelis seriatus* Reuter (cotton fleahopper). Other insect orders controlled by compounds of the invention 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),
15 *Epilachna varivestis* Mulsant (Mexican bean beetle) and wireworms of the genera *Agriotes*, *Athous* or *Limonius*).

Note that some contemporary classification systems place Homoptera as a suborder within the order Hemiptera.

Of note is use of compounds of this invention for controlling western flower thrip
20 (*Frankliniella occidentalis*). Of note is use of compounds of this invention for controlling potato leafhopper (*Empoasca fabae*). Of note is use of compounds of this invention for controlling green peach aphid (*Myzus persicae*). Of note is use of compounds of this invention for controlling diamondback moth (*Plutella xylostella*). Of note is use of compounds of this invention for controlling fall armyworm (*Spodoptera frugiperda*).

25 Compounds of this invention can also be mixed with one or more other biologically 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
30 or fungi to form a multi-component pesticide giving an even broader spectrum of agronomic and nonagronomic utility. Thus the present invention also pertains to a composition comprising a biologically effective amount of a compound of Formula 1, an *N*-oxide or salt thereof, and an effective amount of at least one additional biologically active compound or agent and can further comprise at least one of surfactants, solid diluents or liquid diluents.
35 For mixtures of the present invention, the other biologically active compounds or agents can be formulated together with 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.

Other biologically active compounds or agents useful in the compositions of the present invention can be selected from invertebrate pest control agents having a different mode of action or a different chemical class including macrocyclic lactones, neonicotinoids, octopamine receptor ligands, ryanodine receptor ligands, ecdysone agonists, sodium channel modulators, chitin synthesis inhibitors, nereisotoxin analogs, mitochondrial electron transport inhibitors, cholinesterase inhibitors, cyclodiene insecticides, molting inhibitors, GABA (γ -aminobutyric acid)-regulated chloride channel blockers, juvenile hormone mimics, lipid biosynthesis inhibitors and biological agents including nucleopolyhedro viruses (NPV), members of *Bacillus thuringiensis*, encapsulated delta-endotoxins of *Bacillus thuringiensis*, and other naturally occurring or genetically modified insecticidal viruses.

Of note are additional biologically active compounds or agents selected from insecticides of the group consisting of pyrethroids, carbamates, neonicotinoids, neuronal sodium channel blockers, insecticidal macrocyclic lactones, γ -aminobutyric acid antagonists, insecticidal ureas and juvenile hormone mimics, a member of *Bacillus thuringiensis*, a *Bacillus thuringiensis* delta-endotoxin, and a naturally occurring or a genetically modified viral insecticide.

Examples of such biologically active compounds or agents with which compounds of this invention can be formulated are: insecticides such as abamectin, acephate, acetamiprid, acetoprole, amidoflumet (S-1955), avermectin, azadirachtin, azinphos-methyl, bifenthrin, bifenazate, bistrifluron, buprofezin, carbofuran, cartap, chlorfenapyr, chlorfluazuron, chlorantraniliprole (DPX-E2Y45), chlorpyrifos, chlorpyrifos-methyl, chromafenozide, clothianidin, cyflumetofen, cyfluthrin, beta-cyfluthrin, cyhalothrin, gamma-cyhalothrin, lambda-cyhalothrin, cypermethrin, cyromazine, deltamethrin, diafenthiuron, diazinon, dieldrin, diflubenzuron, dimefluthrin, dimethoate, dinotefuran, diofenolan, emamectin, endosulfan, esfenvalerate, ethiprole, fenothiocarb, fenoxycarb, fenpropathrin, fenvalerate, fipronil, flonicamid, flubendiamide, flucythrinate, tau-fluvalinate, flufenerim (UR-50701), flufenoxuron, fonophos, halofenozide, hexaflumuron, hydramethylnon, imidacloprid, indoxacarb, isofenphos, lufenuron, malathion, metaflumizone, metaldehyde, methamidophos, methidathion, methomyl, methoprene, methoxychlor, metofluthrin, monocrotophos, methoxyfenozide, monocrotophos, nitenpyram, nithiazine, novaluron, noviflumuron (XDE-007), oxamyl, parathion, parathion-methyl, permethrin, phorate, phosalone, phosmet, phosphamidon, pirimicarb, profenofos, profluthrin, protrifenbute, pymetrozine, pyrafluprole, pyrethrin, pyridalyl, pyrifluquinazon, pyriprole, pyriproxifen, rotenone, ryanodine, spinetoram, spinosad, spirotetramat, spiromesifen (BSN 2060), spirotetramat, sulprofos, tebufenozide, teflubenzuron, tefluthrin, terbufos, tetrachlorvinphos, thiacloprid, thiamethoxam, thiodicarb, thiosultap-sodium, tolfenpyrad, tralomethrin,

triazamate, trichlorfon and triflumuron; fungicides such as acibenzolar, aldimorph, amisulbrom, azaconazole, azoxystrobin, benalaxyl, benomyl, benthiavalicarb, benthiavalicarb-isopropyl, binomial, biphenyl, bitertanol, blasticidin-S, Bordeaux mixture (Tribasic copper sulfate), boscalid/nicobifen, bromuconazole, bupirimate, buthiobate,
 5 carboxin, carpropamid, captafol, captan, carbendazim, chloroneb, chlorothalonil, chlozolate, clotrimazole, copper oxychloride, copper salts such as copper sulfate and copper hydroxide, cyazofamid, cyflunamid, cymoxanil, cyproconazole, cyprodinil, dichlofluanid, diclocymet, diclomezine, dicloran, diethofencarb, difenoconazole, dimethomorph, dimoxystrobin, diniconazole, diniconazole-M, dinocap, discostrobin,
 10 dithianon, dodemorph, dodine, econazole, etaconazole, edifenphos, epoxiconazole, ethaboxam, ethirimol, ethridiazole, famoxadone, fenamidone, fenarimol, fenbuconazole, fencaramid, fenfuram, fenhexamide, fenoxanil, fenpiclonil, fenpropidin, fenpropimorph, fentin acetate, fentin hydroxide, ferbam, ferfurazoate, ferimzone, fluazinam, fludioxonil, flumetover, fluopicolide, fluoxastrobin, fluquinconazole, fluquinconazole, flusilazole,
 15 flusulfamide, flutolanil, flutriafol, folpet, fosetyl-aluminum, fuberidazole, furalaxyl, furametapyr, hexaconazole, hymexazole, guazatine, imazalil, imibenconazole, iminoctadine, iodocarb, ipconazole, iprobenfos, iprodione, iprovalicarb, isoconazole, isoprothiolane, kasugamycin, kresoxim-methyl, mancozeb, mandipropamid, maneb, mapanipyrin, mefenoxam, mepronil, metalaxyl, metconazole, methasulfocarb, metiram,
 20 metominostrobin/fenominostrobin, mepanipyrim, metrafenone, miconazole, myclobutanil, neo-asozin (ferric methanearsonate), nuarimol, othilone, ofurace, orysastrobin, oxadixyl, oxolinic acid, oxpoconazole, oxycarboxin, paclobutrazol, penconazole, pencycuron, penthiopyrad, perfurazoate, phosphonic acid, phthalide, picobenzamid, picoxystrobin, polyoxin, probenazole, prochloraz, procymidone, propamocarb, propamocarb-hydrochloride,
 25 propiconazole, propineb, proquinazid, prothioconazole, pyraclostrobin, pryazophos, pyrifenoxy, pyrimethanil, pyrifenoxy, pyrovalaconazole, pyroquilon, quinconazole, quinoxifen, quintozone, silthiofam, simeconazole, spiroxamine, streptomycin, sulfur, tebuconazole, techrazene, tecloftalam, tecnazene, tetraconazole, thiabendazole, thifluzamide, thiophanate, thiophanate-methyl, thiram, tiadinil, tolclofos-methyl, tolyfluanid, triadimefon, triadimenol,
 30 triarimol, triazoxide, tridemorph, trimoprhamide, tricyclazole, trifloxystrobin, triforine, triticonazole, uniconazole, validamycin, vinclozolin, zineb, ziram, and zoxamide; nematocides such as aldicarb, imicyafos, oxamyl and fenamiphos; bactericides such as streptomycin; acaricides such as amitraz, chinomethionat, chlorobenzilate, cyhexatin, dicofol, dienochlor, etoxazole, fenazaquin, fenbutatin oxide, fenpropathrin, fenpyroximate,
 35 hexythiazox, propargite, pyridaben and tebufenpyrad; and biological agents including entomopathogenic bacteria, such as *Bacillus thuringiensis* subsp. *aizawai*, *Bacillus thuringiensis* subsp. *kurstaki*, and the encapsulated delta-endotoxins of *Bacillus thuringiensis* (e.g., Cellcap, MPV, MPVII); entomopathogenic fungi, such as green muscardine fungus;

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

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

General references for these agricultural protectants (i.e. insecticides, fungicides, nematocides, acaricides, herbicides and biological agents) include *The Pesticide Manual*,
10 *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.

Of note is a composition of the present invention wherein at least one additional biologically active compound or agent is selected from the group consisting of abamectin, acephate, acetamiprid, acetoprole, aldicarb, amidoflomet, amitraz, avermectin, azadirachtin,
15 azinphos-methyl, bifenthrin, bifenazate, bistrifluron, buprofezin, carbofuran, cartap, chinomethionat, chlorfenapyr, chlorfluazuron, chlorantraniliprole, chlorpyrifos, chlorpyrifos-methyl, chlorobenzilate, chromafenozide, clothianidin, cyflumetofen, cyfluthrin, beta-cyfluthrin, cyhalothrin, gamma-cyhalothrin, lambda-cyhalothrin, cyhexatin, cypermethrin, cyromazine, deltamethrin, diafenthiuron, diazinon, dicofol, dieldrin, dienochlor, diflubenzuron, dimefluthrin, dimethoate, dinotefuran, diofenolan, emamectin, endosulfan, esfenvalerate, ethiprole, etoxazole, fenamiphos, fenazaquin, fenbutatin oxide, fenothiocarb, fenoxycarb, fenpropathrin, fenpyroximate, fenvalerate, fipronil, flonicamid, flubendiamide, flucythrinate, tau-fluvalinate, flufenerim, flufenoxuron, fonophos,
25 halofenozide, hexaflumuron, hexythiazox, hydramethylnon, imicyafos, imidacloprid, indoxacarb, isofenphos, lufenuron, malathion, metaflumizone, metaldehyde, methamidophos, methidathion, methomyl, methoprene, methoxychlor, methoxyfenozide, metofluthrin, monocrotophos, nitenpyram, nithiazine, novaluron, noviflumuron, oxamyl, parathion, parathion-methyl, permethrin, phorate, phosalone, phosmet, phosphamidon, pirimicarb, profenofos, profluthrin, propargite, protrifenbute, pymetrozine, pyrafluprole, pyrethrin, pyridaben, pyridalyl, pyrifluquinazon, pyriprole, pyriproxyfen, rotenone, ryanodine, spinetoram, spinosad, spiridiclofen, spiromesifen, spirotetramat, sulprofos, tebufenozide, tebufenpyrad, teflubenzuron, tefluthrin, terbufos, tetrachlorvinphos, thiacloprid, thiamethoxam, thiodicarb, thiosultap-sodium, tolfenpyrad, tralomethrin,
30 triazamate, trichlorfon, triflumuron, *Bacillus thuringiensis* subsp. *aizawai*, *Bacillus thuringiensis* subsp. *kurstaki*, nucleopolyhedro viruses, encapsulated delta-endotoxins of *Bacillus thuringiensis*, baculoviruses, entomopathogenic bacteria, entomopathogenic viruses and entomopathogenic fungi. The compound 3-bromo-1-(3-chloro-2-pyridinyl)-N-[4-cyano-

2-methyl-6-[(methylamino)carbonyl]phenyl]-1*H*-pyrazole-5-carboxamide can be included in the group of insecticides listed above and is a compound of note as a mixture partner.

Also of note is a composition of the present invention wherein at least one additional biologically active compound or agent is selected from the group consisting of abamectin, acephate, acetamiprid, amidoflume (S-1955), avermectin, azadirachtin, azinphos-methyl, bifenthrin, bifenazate, buprofezin, carbofuran, cartap, chlorantraniliprole, chlorfenapyr, chlorfluazuron, chlorpyrifos, chlorpyrifos-methyl, chromafenozide, clothianidin, cyflumetofen, cyfluthrin, beta-cyfluthrin, cyhalothrin, lambda-cyhalothrin, cypermethrin, cyromazine, deltamethrin, diafenthiuron, diazinon, dieldrin, diflubenzuron, dimefluthrin, dimethoate, dinotefuran, diofenolan, emamectin, endosulfan, esfenvalerate, ethiprole, fenothiocarb, fenoxycarb, fenpropathrin, fenvalerate, fipronil, flonicamid, flubendiamide, flucythrinate, tau-fluvalinate, flufenoxuron, fonophos, halofenozide, hexaflumuron, hydramethylnon, imidacloprid, indoxacarb, isofenphos, lufenuron, malathion, metaflumizone, metaldehyde, methamidophos, methidathion, methomyl, methoprene, methoxychlor, metofluthrin, monocrotophos, methoxyfenozide, nitenpyram, nithiazine, novaluron, noviflumuron (XDE-007), oxamyl, parathion, parathion-methyl, permethrin, phorate, phosalone, phosmet, phosphamidon, pirimicarb, profenofos, profluthrin, pymetrozine, pyrafluprole, pyrethrin, pyridalyl, pyriprole, pyriproxyfen, rotenone, ryanodine, spinosad, spirotetramat, spiromesifen (BSN 2060), spirotetramat, sulprofos, tebufenozide, teflubenzuron, tefluthrin, terbufos, tetrachlorvinphos, thiacloprid, thiamethoxam, thiodicarb, thiosultap-sodium, tralomethrin, triazamate, trichlorfon, triflumuron, *Bacillus thuringiensis aizawai*, *Bacillus thuringiensis kurstaki*, *Bacillus thuringiensis* delta endotoxin, baculovirus, entomopathogenic bacteria, entomopathogenic virus and entomopathogenic fungi. The compound 3-bromo-1-(3-chloro-2-pyridinyl)-*N*-[4-cyano-2-methyl-6-[(methylamino)carbonyl]phenyl]-1*H*-pyrazole-5-carboxamide can be included in the group of additional biologically active compounds or agents listed above and is a compound of note as a mixture partner.

Also of note is a composition of the present invention wherein at least one additional biologically active compound or agent is selected from the group consisting of abamectin, acetamiprid, amitraz, avermectin, azadirachtin, bifenthrin, buprofezin, cartap, chlorantraniliprole, chlorfenapyr, chlorpyrifos, clothianidin, cyfluthrin, beta-cyfluthrin, cyhalothrin, lambda-cyhalothrin, cypermethrin, cyromazine, deltamethrin, dieldrin, dinotefuran, diofenolan, emamectin, endosulfan, esfenvalerate, ethiprole, fenothiocarb, fenoxycarb, fenvalerate, fipronil, flonicamid, flubendiamide, flufenoxuron, hexaflumuron, hydramethylnon, imidacloprid, indoxacarb, lufenuron, metaflumizone, methomyl, methoprene, methoxyfenozide, nitenpyram, nithiazine, novaluron, oxamyl, pymetrozine, pyrethrin, pyridaben, pyridalyl, pyriproxyfen, ryanodine, spinetoram, spinosad, spirotetramat, spiromesifen, tebufenozide, thiacloprid, thiamethoxam, thiodicarb, thiosultap-

sodium, tralomethrin, triazamate, triflumuron, *Bacillus thuringiensis* subsp. *aizawai*, *Bacillus thuringiensis* subsp. *kurstaki*, nucleopolyhedro viruses and encapsulated delta-endotoxins of *Bacillus thuringiensis*, entomopathogenic virus and entomopathogenic fungi. The compound 3-bromo-1-(3-chloro-2-pyridinyl)-*N*-[4-cyano-2-methyl-6-[(methylamino)-carbonyl]phenyl]-1*H*-pyrazole-5-carboxamide can be included in the group of additional biologically active compounds or agents listed above and is a compound of note as a mixture partner.

Also of note is a composition of the present invention wherein at least one additional biologically active compound or agent is selected from the group consisting of cypermethrin, cyhalothrin, cyfluthrin and beta-cyfluthrin, esfenvalerate, fenvalerate, tralomethrin, fenothicarb, methomyl, oxamyl, thiodicarb, acetamiprid, clothianidin, chlorantraniliprole, imidacloprid, thiamethoxam, thiacloprid, indoxacarb, spinosad, abamectin, avermectin, emamectin, endosulfan, ethiprole, fipronil, flufenoxuron, triflumuron, diofenolan, pyriproxyfen, pymetrozine, amitraz, *Bacillus thuringiensis* subsp. *aizawai*, *Bacillus thuringiensis* subsp. *kurstaki*, encapsulated delta-endotoxins of *Bacillus thuringiensis*, entomopathogenic virus and entomophagous fungi. The compound 3-bromo-1-(3-chloro-2-pyridinyl)-*N*-[4-cyano-2-methyl-6-[(methylamino)-carbonyl]phenyl]-1*H*-pyrazole-5-carboxamide can be included in the group of additional biologically active compounds or agents listed above and is a compound of note as a mixture partner.

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

In certain instances, combinations of a compound of this invention with other biologically active (particularly invertebrate pest control) compounds or agents (i.e. active ingredients) can result in a greater-than-additive (i.e. synergistic) effect. Reducing the quantity of active ingredients released in the environment while ensuring effective pest control is always desirable. When synergism of invertebrate pest control active ingredients 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.

Of note is a combination of a compound of Formula 1 with at least one other invertebrate pest control active ingredient. Of particular note is such a combination where

the other invertebrate pest control active ingredient has a different site of action from the compound 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 invention can further comprise a biologically effective amount of at least one additional invertebrate pest control active ingredient having a similar spectrum of control but a different site of action. Contacting a plant genetically modified to express an invertebrate pest compound (e.g., protein) or the locus of the plant with a biologically effective amount of a compound of this invention can also provide a broader spectrum of plant protection and be advantageous for resistance management.

Table A lists specific combinations of a compound of Formula 1 with other invertebrate pest control agents illustrative of the mixtures, compositions and methods of the present invention. The first column of Table A lists the specific invertebrate pest control agents (e.g., "Abamectin" in the first line). The second column of Table A lists the mode of action (if known) or chemical class of the invertebrate pest control agents. The third column of Table A lists embodiment(s) of ranges of weight ratios for rates at which the invertebrate pest control agent can be applied relative to a compound of Formula 1, an *N*-oxide, or a salt thereof, (e.g., "50:1 to 1:50" of abamectin relative to a compound of Formula 1 by weight). Thus, for example, the first line of Table A specifically discloses the combination of a compound of Formula 1 with abamectin can be applied in a weight ratio between 50:1 to 1:50. The remaining lines of Table A are to be construed similarly. Of further note Table A lists specific combinations of a compound of Formula 1 with other invertebrate pest control agents illustrative of the mixtures, compositions and methods of the present invention and includes additional embodiments of weight ratio ranges for application rates.

Table A

Invertebrate Pest Control Agent	Mode of Action or Chemical Class	Typical Weight Ratio
Abamectin	macrocyclic lactones	50:1 to 1:50
Acetamiprid	neonicotinoids	150:1 to 1:200
Amitraz	octopamine receptor ligands	200:1 to 1:100
Avermectin	macrocyclic lactones	50:1 to 1:50
Azadirachtin	ecdysone agonists	100:1 to 1:120
Beta-cyfluthrin	sodium channel modulators	150:1 to 1:200
Bifenthrin	sodium channel modulators	100:1 to 1:10
Buprofezin	chitin synthesis inhibitors	500:1 to 1:50
Cartap	nereistoxin analogs	100:1 to 1:200
Chlorantraniliprole	ryanodine receptor ligands	100:1 to 1:120
Chlorfenapyr	mitochondrial electron transport inhibitors	300:1 to 1:200

Invertebrate Pest Control Agent	Mode of Action or Chemical Class	Typical Weight Ratio
Chlorpyrifos	cholinesterase inhibitors	500:1 to 1:200
Clothianidin	neonicotinoids	100:1 to 1:400
Cyfluthrin	sodium channel modulators	150:1 to 1:200
Cyhalothrin	sodium channel modulators	150:1 to 1:200
Cypermethrin	sodium channel modulators	150:1 to 1:200
Cyromazine	chitin synthesis inhibitors	400:1 to 1:50
Deltamethrin	sodium channel modulators	50:1 to 1:400
Dieldrin	cyclodiene insecticides	200:1 to 1:100
Dinotefuran	neonicotinoids	150:1 to 1:200
Diofenolan	molting inhibitor	150:1 to 1:200
Emamectin	macrocyclic lactones	50:1 to 1:10
Endosulfan	cyclodiene insecticides	200:1 to 1:100
Esfenvalerate	sodium channel modulators	100:1 to 1:400
Ethiprole	GABA-regulated chloride channel blockers	200:1 to 1:100
Fenothiocarb		150:1 to 1:200
Fenoxycarb	juvenile hormone mimics	500:1 to 1:100
Fenvalerate	sodium channel modulators	150:1 to 1:200
Fipronil	GABA-regulated chloride channel blockers	150:1 to 1:100
Flonicamid		200:1 to 1:100
Flubendiamide	ryanodine receptor ligands	100:1 to 1:120
Flufenoxuron	chitin synthesis inhibitors	200:1 to 1:100
Hexaflumuron	chitin synthesis inhibitors	300:1 to 1:50
Hydramethylnon	mitochondrial electron transport inhibitors	150:1 to 1:250
Imidacloprid	neonicotinoids	1000:1 to 1:1000
Indoxacarb	sodium channel modulators	200:1 to 1:50
Lambda-cyhalothrin	sodium channel modulators	50:1 to 1:250
Lufenuron	chitin synthesis inhibitors	500:1 to 1:250
Metaflumizone		200:1 to 1:200
Methomyl	cholinesterase inhibitors	500:1 to 1:100
Methoprene	juvenile hormone mimics	500:1 to 1:100
Methoxyfenozide	ecdysone agonists	50:1 to 1:50
Nitenpyram	neonicotinoids	150:1 to 1:200
Nithiazine	neonicotinoids	150:1 to 1:200

Invertebrate Pest Control Agent	Mode of Action or Chemical Class	Typical Weight Ratio
Novaluron	chitin synthesis inhibitors	500:1 to 1:150
Oxamyl	cholinesterase inhibitors	200:1 to 1:200
Pymetrozine		200:1 to 1:100
Pyrethrin	sodium channel modulators	100:1 to 1:10
Pyridaben	mitochondrial electron transport inhibitors	200:1 to 1:100
Pyridalyl		200:1 to 1:100
Pyriproxyfen	juvenile hormone mimics	500:1 to 1:100
Ryanodine	ryanodine receptor ligands	100:1 to 1:120
Spinetoram	macrocyclic lactones	150:1 to 1:100
Spinosad	macrocyclic lactones	500:1 to 1:10
Spirodiclofen	lipid biosynthesis inhibitors	200:1 to 1:200
Spiromesifen	lipid biosynthesis inhibitors	200:1 to 1:200
Tebufenozide	ecdysone agonists	500:1 to 1:250
Thiacloprid	neonicotinoids	100:1 to 1:200
Thiamethoxam	neonicotinoids	1250:1 to 1:1000
Thiodicarb	cholinesterase inhibitors	500:1 to 1:400
Thiosultap-sodium		150:1 to 1:100
Tralomethrin	sodium channel modulators	150:1 to 1:200
Triazamate	cholinesterase inhibitors	250:1 to 1:100
Triflumuron	chitin synthesis inhibitors	200:1 to 1:100
<i>Bacillus thuringiensis</i>	biological agents	50:1 to 1:10
<i>Bacillus thuringiensis</i> delta-endotoxin	biological agents	50:1 to 1:10
NPV (e.g., Gemstar)	biological agents	50:1 to 1:10

The compound 3-bromo-1-(3-chloro-2-pyridinyl)-*N*-[4-cyano-2-methyl-6-[(methylamino)-carbonyl]phenyl]-1*H*-pyrazole-5-carboxamide can be included as an “Invertebrate Pest Control Agent” in Table A above. The “Mode of Action or Chemical Class” for this compound is “ryanodine receptor ligands” and the “Typical Weight Ratio” of this compound is 100:1 to 1:120.

One embodiment of invertebrate pest control agents (e.g., insecticides and acaricides) for mixing with compounds of this invention include sodium channel modulators such as bifenthrin, cypermethrin, cyhalothrin, lambda-cyhalothrin, cyfluthrin, beta-cyfluthrin, deltamethrin, dimefluthrin, esfenvalerate, fenvalerate, indoxacarb, metofluthrin, profluthrin, pyrethrin and tralomethrin; cholinesterase inhibitors such as chlorpyrifos, methomyl, oxamyl, thiodicarb and triazamate; neonicotinoids such as acetamiprid, clothianidin, dinotefuran, imidacloprid, nitenpyram, nithiazine, thiacloprid and thiamethoxam; insecticidal

macrocyclic lactones such as spinetoram, spinosad, abamectin, avermectin and emamectin; GABA (γ -aminobutyric acid)-regulated chloride channel blockers such as endosulfan, ethiprole and fipronil; chitin synthesis inhibitors such as buprofezin, cyromazine, flufenoxuron, hexaflumuron, lufenuron, novaluron, noviflumuron and triflumuron; juvenile hormone mimics such as diofenolan, fenoxycarb, methoprene and pyriproxyfen; octopamine receptor ligands such as amitraz; ecdysone agonists such as azadirachtin, methoxyfenozide and tebufenozide; ryanodine receptor ligands such as ryanodine, anthranilic diamides such as chlorantraniliprole (see U.S. Patent 6,747,047, PCT Publications WO 2003/015518 and WO 2004/067528) and flubendiamide (see U.S. Patent 6,603,044); nereistoxin analogs such as cartap; mitochondrial electron transport inhibitors such as chlorfenapyr, hydramethylnon and pyridaben; lipid biosynthesis inhibitors such as spirotetramat and spiromesifen; cyclodiene insecticides such as dieldrin; cyflumetofen; fenothiocarb; flonicamid; metaflumizone; pyrafluprole; pyridalyl; pyriprole; pymetrozine; spirotetramat; and thiosultap-sodium. One embodiment of biological agents for mixing with compounds of this invention include nucleopolyhedro virus such as HzNPV and AfNPV; *Bacillus thuringiensis* and encapsulated delta-endotoxins of *Bacillus thuringiensis* such as Cellcap, MPV and MPVII; as well as naturally occurring and genetically modified viral insecticides including members of the family Baculoviridae as well as entomophagous fungi. Of note is the composition of the present invention wherein the at least one additional biologically active compound or agent is selected from the Invertebrate Pest Control Agents listed in Table A above.

The weight ratios of a compound, including a compound of Formula 1, an *N*-oxide or a salt thereof, to the additional invertebrate pest control agent typically are between 1000:1 and 1:1000, with one embodiment being between 500:1 and 1:500, another embodiment being between 250:1 and 1:200 and another embodiment being between 100:1 and 1:50.

Listed below in Table B are embodiments of specific compositions comprising a compound of Formula 1 (compound numbers refer to compounds in Index Table A) and an additional invertebrate pest control agent.

Table B

Mixture No.	Cmpd. No.	and	Invertebrate Pest Control Agent	Mixture No.	Cmpd. No.	and	Invertebrate Pest Control Agent
A-1	1	and	Abamectin	B-1	4	and	Abamectin
A-2	1	and	Acetamiprid	B-2	4	and	Acetamiprid
A-3	1	and	Amitraz	B-3	4	and	Amitraz
A-4	1	and	Avermectin	B-4	4	and	Avermectin
A-5	1	and	Azadirachtin	B-5	4	and	Azadirachtin
A-6	1	and	Beta-cyfluthrin	B-6	4	and	Beta-cyfluthrin
A-7	1	and	Bifenthrin	B-7	4	and	Bifenthrin
A-8	1	and	Buprofezin	B-8	4	and	Buprofezin

Mixture No.	Cmpd. No.	and	Invertebrate Pest Control Agent	Mixture No.	Cmpd. No.	and	Invertebrate Pest Control Agent
A-9	1	and	Cartap	B-9	4	and	Cartap
A-10	1	and	Chlorantraniliprole	B-10	4	and	Chlorantraniliprole
A-11	1	and	Chlorfenapyr	B-11	4	and	Chlorfenapyr
A-12	1	and	Chlorpyrifos	B-12	4	and	Chlorpyrifos
A-13	1	and	Clothianidin	B-13	4	and	Clothianidin
A-14	1	and	Cyfluthrin	B-14	4	and	Cyfluthrin
A-15	1	and	Cyhalothrin	B-15	4	and	Cyhalothrin
A-16	1	and	Cypermethrin	B-16	4	and	Cypermethrin
A-17	1	and	Cyromazine	B-17	4	and	Cyromazine
A-18	1	and	Deltamethrin	B-18	4	and	Deltamethrin
A-19	1	and	Dieldrin	B-19	4	and	Dieldrin
A-20	1	and	Dinotefuran	B-20	4	and	Dinotefuran
A-21	1	and	Diofenolan	B-21	4	and	Diofenolan
A-22	1	and	Emamectin	B-22	4	and	Emamectin
A-23	1	and	Endosulfan	B-23	4	and	Endosulfan
A-24	1	and	Esfenvalerate	B-24	4	and	Esfenvalerate
A-25	1	and	Ethiprole	B-25	4	and	Ethiprole
A-26	1	and	Fenothiocarb	B-26	4	and	Fenothiocarb
A-27	1	and	Fenoxycarb	B-27	4	and	Fenoxycarb
A-28	1	and	Fenvalerate	B-28	4	and	Fenvalerate
A-29	1	and	Fipronil	B-29	4	and	Fipronil
A-30	1	and	Flonicamid	B-30	4	and	Flonicamid
A-31	1	and	Flubendiamide	B-31	4	and	Flubendiamide
A-32	1	and	Flufenoxuron	B-32	4	and	Flufenoxuron
A-33	1	and	Hexaflumuron	B-33	4	and	Hexaflumuron
A-34	1	and	Hydramethylnon	B-34	4	and	Hydramethylnon
A-35	1	and	Imidacloprid	B-35	4	and	Imidacloprid
A-36	1	and	Indoxacarb	B-36	4	and	Indoxacarb
A-37	1	and	Lambda-cyhalothrin	B-37	4	and	Lambda-cyhalothrin
A-38	1	and	Lufenuron	B-38	4	and	Lufenuron
A-39	1	and	Metaflumizone	B-39	4	and	Metaflumizone
A-40	1	and	Methomyl	B-40	4	and	Methomyl
A-41	1	and	Methoprene	B-41	4	and	Methoprene
A-42	1	and	Methoxyfenozide	B-42	4	and	Methoxyfenozide
A-43	1	and	Nitenpyram	B-43	4	and	Nitenpyram
A-44	1	and	Nithiazine	B-44	4	and	Nithiazine

Mixture No.	Cmpd. No.	and	Invertebrate Pest Control Agent	Mixture No.	Cmpd. No.	and	Invertebrate Pest Control Agent
A-45	1	and	Novaluron	B-45	4	and	Novaluron
A-46	1	and	Oxamyl	B-46	4	and	Oxamyl
A-47	1	and	Pymetrozine	B-47	4	and	Pymetrozine
A-48	1	and	Pyrethrin	B-48	4	and	Pyrethrin
A-49	1	and	Pyridaben	B-49	4	and	Pyridaben
A-50	1	and	Pyridalyl	B-50	4	and	Pyridalyl
A-51	1	and	Pyriproxyfen	B-51	4	and	Pyriproxyfen
A-52	1	and	Ryanodine	B-52	4	and	Ryanodine
A-53	1	and	Spinetoram	B-53	4	and	Spinetoram
A-54	1	and	Spinosad	B-54	4	and	Spinosad
A-55	1	and	Spirodiclofen	B-55	4	and	Spirodiclofen
A-56	1	and	Spiromesifen	B-56	4	and	Spiromesifen
A-57	1	and	Tebufenozide	B-57	4	and	Tebufenozide
A-58	1	and	Thiacloprid	B-58	4	and	Thiacloprid
A-59	1	and	Thiamethoxam	B-59	4	and	Thiamethoxam
A-60	1	and	Thiodicarb	B-60	4	and	Thiodicarb
A-61	1	and	Thiosultap-sodium	B-61	4	and	Thiosultap-sodium
A-62	1	and	Tralomethrin	B-62	4	and	Tralomethrin
A-63	1	and	Triazamate	B-63	4	and	Triazamate
A-64	1	and	Triflumuron	B-64	4	and	Triflumuron
A-65	1	and	<i>Bacillus thuringiensis</i>	B-65	4	and	<i>Bacillus thuringiensis</i>
A-66	1	and	<i>Bacillus thuringiensis</i> delta-endotoxin	B-66	4	and	<i>Bacillus thuringiensis</i> delta-endotoxin
A-67	1	and	NPV (e.g., Gemstar)	B-67	4	and	NPV (e.g., Gemstar)
C-1	7	and	Abamectin	D-1	8	and	Abamectin
C-2	7	and	Acetamiprid	D-2	8	and	Acetamiprid
C-3	7	and	Amitraz	D-3	8	and	Amitraz
C-4	7	and	Avermectin	D-4	8	and	Avermectin
C-5	7	and	Azadirachtin	D-5	8	and	Azadirachtin
C-6	7	and	Beta-cyfluthrin	D-6	8	and	Beta-cyfluthrin
C-7	7	and	Bifenthrin	D-7	8	and	Bifenthrin
C-8	7	and	Buprofezin	D-8	8	and	Buprofezin
C-9	7	and	Cartap	D-9	8	and	Cartap
C-10	7	and	Chlorantraniliprole	D-10	8	and	Chlorantraniliprole
C-11	7	and	Chlorfenapyr	D-11	8	and	Chlorfenapyr
C-12	7	and	Chlorpyrifos	D-12	8	and	Chlorpyrifos

Mixture No.	Cmpd. No.	and	Invertebrate Pest Control Agent	Mixture No.	Cmpd. No.	and	Invertebrate Pest Control Agent
C-13	7	and	Clothianidin	D-13	8	and	Clothianidin
C-14	7	and	Cyfluthrin	D-14	8	and	Cyfluthrin
C-15	7	and	Cyhalothrin	D-15	8	and	Cyhalothrin
C-16	7	and	Cypermethrin	D-16	8	and	Cypermethrin
C-17	7	and	Cyromazine	D-17	8	and	Cyromazine
C-18	7	and	Deltamethrin	D-18	8	and	Deltamethrin
C-19	7	and	Dieldrin	D-19	8	and	Dieldrin
C-20	7	and	Dinotefuran	D-20	8	and	Dinotefuran
C-21	7	and	Diofenolan	D-21	8	and	Diofenolan
C-22	7	and	Emamectin	D-22	8	and	Emamectin
C-23	7	and	Endosulfan	D-23	8	and	Endosulfan
C-24	7	and	Esfenvalerate	D-24	8	and	Esfenvalerate
C-25	7	and	Ethiprole	D-25	8	and	Ethiprole
C-26	7	and	Fenothiocarb	D-26	8	and	Fenothiocarb
C-27	7	and	Fenoxycarb	D-27	8	and	Fenoxycarb
C-28	7	and	Fenvalerate	D-28	8	and	Fenvalerate
C-29	7	and	Fipronil	D-29	8	and	Fipronil
C-30	7	and	Flonicamid	D-30	8	and	Flonicamid
C-31	7	and	Flubendiamide	D-31	8	and	Flubendiamide
C-32	7	and	Flufenoxuron	D-32	8	and	Flufenoxuron
C-33	7	and	Hexaflumuron	D-33	8	and	Hexaflumuron
C-34	7	and	Hydramethylnon	D-34	8	and	Hydramethylnon
C-35	7	and	Imidacloprid	D-35	8	and	Imidacloprid
C-36	7	and	Indoxacarb	D-36	8	and	Indoxacarb
C-37	7	and	Lambda-cyhalothrin	D-37	8	and	Lambda-cyhalothrin
C-38	7	and	Lufenuron	D-38	8	and	Lufenuron
C-39	7	and	Metaflumizone	D-39	8	and	Metaflumizone
C-40	7	and	Methomyl	D-40	8	and	Methomyl
C-41	7	and	Methoprene	D-41	8	and	Methoprene
C-42	7	and	Methoxyfenozide	D-42	8	and	Methoxyfenozide
C-43	7	and	Nitenpyram	D-43	8	and	Nitenpyram
C-44	7	and	Nithiazine	D-44	8	and	Nithiazine
C-45	7	and	Novaluron	D-45	8	and	Novaluron
C-46	7	and	Oxamyl	D-46	8	and	Oxamyl
C-47	7	and	Pymetrozine	D-47	8	and	Pymetrozine
C-48	7	and	Pyrethrin	D-48	8	and	Pyrethrin

Mixture No.	Cmpd. No.	and	Invertebrate Pest Control Agent	Mixture No.	Cmpd. No.	and	Invertebrate Pest Control Agent
C-49	7	and	Pyridaben	D-49	8	and	Pyridaben
C-50	7	and	Pyridalyl	D-50	8	and	Pyridalyl
C-51	7	and	Pyriproxyfen	D-51	8	and	Pyriproxyfen
C-52	7	and	Ryanodine	D-52	8	and	Ryanodine
C-53	7	and	Spinetoram	D-53	8	and	Spinetoram
C-54	7	and	Spinosad	D-54	8	and	Spinosad
C-55	7	and	Spirodiclofen	D-55	8	and	Spirodiclofen
C-56	7	and	Spiromesifen	D-56	8	and	Spiromesifen
C-57	7	and	Tebufenozide	D-57	8	and	Tebufenozide
C-58	7	and	Thiacloprid	D-58	8	and	Thiacloprid
C-59	7	and	Thiamethoxam	D-59	8	and	Thiamethoxam
C-60	7	and	Thiodicarb	D-60	8	and	Thiodicarb
C-61	7	and	Thiosultap-sodium	D-61	8	and	Thiosultap-sodium
C-62	7	and	Tralomethrin	D-62	8	and	Tralomethrin
C-63	7	and	Triazamate	D-63	8	and	Triazamate
C-64	7	and	Triflumuron	D-64	8	and	Triflumuron
C-65	7	and	<i>Bacillus thuringiensis</i>	D-65	8	and	<i>Bacillus thuringiensis</i>
C-66	7	and	<i>Bacillus thuringiensis</i> delta-endotoxin	D-66	8	and	<i>Bacillus thuringiensis</i> delta-endotoxin
C-67	7	and	NPV (e.g., Gemstar)	D-67	8	and	NPV (e.g., Gemstar)

The specific mixtures listed in Table B typically combine a compound of Formula 1 with the other invertebrate pest agent in the ratios specified in Table A.

The compound 3-bromo-1-(3-chloro-2-pyridinyl)-*N*-[4-cyano-2-methyl-6-[(methylamino)carbonyl]phenyl]-1*H*-pyrazole-5-carboxamide can be included as an “Invertebrate Pest Control Agent” in Table B above and mixed with Compounds 1, 4, 7 and 8, as “Mixture No.” A-68, B-68, C-68 and D-68 respectively. These specific mixtures typically combine the compound of Formula 1 with this compound in the ratio of 100:1 to 1:120.

Invertebrate pests are controlled in agronomic and nonagronomic applications by applying one or more compounds of this invention, 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 invention 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

invention, 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 invention 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 invention or on granules separate from those of the compound of the invention.

To achieve contact with a compound or composition of the invention 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 invention can be applied to the plant foliage or the soil. Compounds of this invention can also be effectively delivered through plant uptake by contacting the plant with a composition comprising a compound of this invention 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 invention 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 invention or with a composition comprising a biologically effective amount of a compound of the present invention. 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 invention 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 invention 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 invention. The compounds of this invention can also be impregnated into materials for fabricating invertebrate control devices (e.g., insect netting).

Compounds of this invention 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 invention, which is typically formulated as a composition of the invention. 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 invention or a second active ingredient within the developing plant. Seed

treatments can be applied to all types of seeds, including those from which plants genetically transformed to express specialized traits will germinate. Representative examples include those expressing proteins toxic to invertebrate pests, such as *Bacillus thuringiensis* toxin or those expressing herbicide resistance such as glyphosate acetyltransferase, which provides resistance to glyphosate.

One method of seed treatment is by spraying or dusting the seed with a compound of the invention (i.e. as a formulated composition) before sowing the seeds. Compositions formulated for seed treatment generally comprise a film former or adhesive agent. Therefore typically a seed coating composition of the present invention comprises a biologically effective amount of a compound of Formula 1, 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 Monograph No. 57, and references listed therein.

The treated seed typically comprises a compound of the present invention 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 invention 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 invention 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 invention. Combinations with spray oils, spray oil concentrations, spreader stickers, adjuvants, other solvents, and synergists such as 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 invention and a carrier. One embodiment of such a spray composition comprises a biologically effective amount of a compound or a composition of the present invention 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.

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 invention, typically in the form of a 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 invention. As referred to in the present disclosure and claims, the terms “parasitocidal” and “parasitocidally” refers to observable effects on an invertebrate parasite pest to provide protection of an animal from the pest. Parasitocidal 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. 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 invention 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 invention 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 invention.

Typically a parasitocidal composition according to the present invention 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 invention and at least one carrier.

For parenteral administration including intravenous, intramuscular and subcutaneous injection, a compound of the present invention 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), 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 invention can be 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., 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.

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, for example, vitamins, antibiotics, chemotherapeutics, bacteriostats, fungistats, coccidiostats and hormones.

Compounds of the present invention 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, parasitically effective concentrations of compounds of the invention 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 invention, one or more carriers selected from binders and fillers suitable for oral administration and feed concentrate carriers).

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. Parasiticide compositions suitable for topical administration typically comprise a compound of the present invention and one or more topically suitable carriers. In applications of a parasiticide 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 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 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 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.

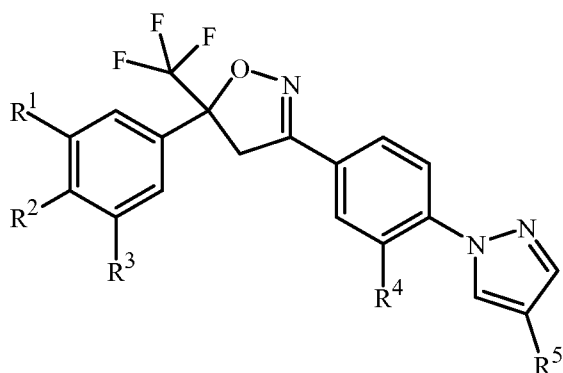
In general for veterinary use, a compound of Formula 1, an *N*-oxide or a salt thereof, is administered in a parasitically effective amount to an animal to be protected from invertebrate parasite pests. A parasitically effective amount is the amount of active ingredient needed to achieve an observable 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 invention, the desired parasitological 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 invention typically ranges from about 0.01 mg/kg to about 100 mg/kg, more typically 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 invention.

The following Tests demonstrate the control efficacy of compounds of this invention on specific pests. "Control efficacy" represents inhibition of invertebrate pest development (including mortality) that causes significantly reduced feeding. The pest control protection afforded by the compounds is not limited, however, to these species. See Index Tables A and B for compound descriptions. The abbreviation "Ex." stands for "Example" and is followed by a number indicating in which synthesis example the compound is prepared.

INDEX TABLE A



<u>Cmpd. No.</u>	<u>R¹</u>	<u>R²</u>	<u>R³</u>	<u>R⁴</u>	<u>R⁵</u>	<u>m.p. (°C)</u>
1	Cl	H	Cl	cyano	cyano	*
2	Cl	H	Cl	cyano	I	*
3 (Ex. 2)	Cl	H	Cl	cyano	C(O)NHCH ₂ CF ₃	**
4	CF ₃	H	H	cyano	cyano	*
5	Cl	H	Cl	cyano	Cl	182-183
6	Cl	H	Cl	cyano	Br	164-165
7	Cl	Cl	Cl	cyano	cyano	*
8 (Ex. 1)	Cl	F	Cl	cyano	cyano	**
9	CF ₃	H	CF ₃	cyano	cyano	*

<u>Cmpd. No.</u>	<u>R¹</u>	<u>R²</u>	<u>R³</u>	<u>R⁴</u>	<u>R⁵</u>	<u>m.p. (°C)</u>
10	OCF ₃	H	Cl	cyano	cyano	*
11	Cl	CHF ₂	Cl	cyano	cyano	191-192

* See Index Table B for ¹H NMR data.

** See synthesis example for ¹H NMR data.

INDEX TABLE B

Cmpd. No.	¹ H NMR Data (CDCl ₃ solution unless indicated otherwise) ^a
1	δ 8.62 (s, 1H), 8.1 (m, 3H), 7.9 (d, 1H), 7.51 (s, 2H), 7.45 (m, 1H), 4.1 (d, 1H), 3.75 (d, 1H).
2	δ 8.27 (s, 1H), 8.03 (m, 2H), 7.89 (d, 1H), 7.83 (s, 1H), 7.51 (s, 2H), 7.45 (m, 1H), 4.10 (d, 1H), 3.73 (d, 1H)
4	δ 8.61 (s, 1H), 8.1-8.15 (m, 3H), 7.92 (m, 1H), 7.87 (s, 1H), 7.82 (m, 1H), 7.73 (m, 1H), 7.63 (m, 1H), 4.17 (d, 1H), 3.80 (d, 1H)
7	δ 8.63 (s, 1H), 8.1 (m, 3H), 7.92 (d, 1H), 7.64 (s, 2H), 4.14 (d, 1H), 3.77 (d, 1H)
9	δ 8.63 (s, 1H), 8.08-8.16 (m, 5H), 8.0 (s, 1H), 7.92 (d, 1H), 4.25 (d, 1H), 3.83 (d, 1H)
10	δ 8.62 (s, 1H), 8.08-8.12 (m, 3H), 7.92 (d, 1H), 7.56 (s, 1H), 7.39 (s, 1H), 7.34 (s, 1H), 4.14 (d, 1H), 3.75 (d, 1H)

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

BIOLOGICAL EXAMPLES OF THE INVENTION

TEST A

For evaluating control of diamondback moth (*Plutella xylostella*), the test unit consisted of a small open container with a 12–14-day-old radish plant inside. This was pre-infested with about 50 neonate larvae that were dispensed into the test unit via corn-cob grits using a bazooka inoculator. The larvae moved onto the test plant after being dispensed into the test unit.

Test compounds were formulated using a solution containing 10% acetone, 90% water and 300 ppm X-77™ Spreader Lo-Foam Formula non-ionic surfactant containing alkylaryl polyoxyethylene, free fatty acids, glycols and isopropanol (Loveland Industries, Inc. Greeley, Colorado, USA). The formulated compounds were applied in 1 mL of liquid through a SUJ2 atomizer nozzle with 1/8 JJ custom body (Spraying Systems Co. Wheaton, Illinois, USA) positioned 1.27 cm (0.5 inches) above the top of each test unit. All experimental compounds in this test were sprayed at 50 ppm, and the test was replicated three times. After spraying of the formulated test compound, each test unit was allowed to dry for 1 h and then a black, screened cap was placed on top. The test units were held for 6 days in a growth chamber at 25 °C and 70% relative humidity. Plant feeding damage was then visually assessed based on foliage consumed and a pest mortality rating was also counted and calculated for each test unit.

Of the compounds of Formula 1 tested the following provided very good to excellent levels of control efficacy (20% or less feeding damage or 80% or more mortality): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11.

TEST B

5 For evaluating control of fall armyworm (*Spodoptera frugiperda*), the test unit consisted of a small open container with a 4–5-day-old corn (maize) plant inside. This was pre-infested (using a core sampler) with 10–15 1-day-old larvae on a piece of insect diet. Test compounds were formulated and sprayed at 50 ppm as described for Test A, and the test was replicated three times. After spraying, the test units were maintained in a growth
10 chamber and then the control efficacy was rated for each test unit as described for Test A.

Of the compounds of Formula 1 tested the following provided very good to excellent levels of control efficacy (20% or less feeding damage or 80% or more mortality): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11.

TEST C

15 For evaluating control of potato leafhopper (*Empoasca fabae*) through contact and/or systemic means, the test unit consisted of a small open container with a 5–6-day-old Soleil bean plant (primary leaves emerged) inside. White sand was added to the top of the soil and one of the primary leaves was excised prior to application. Test compounds were formulated and sprayed as described for Test A. All experimental compounds in these tests were
20 sprayed at 250 ppm, and the test was replicated three times. After spraying, the test units were allowed to dry for 1 hour before they were post-infested with 5 potato leafhoppers (18–21-day-old adults). A black, screened cap was placed on the top of the cylinder. The test units were held for 6 days in a growth chamber at 19–21 °C and 50–70% relative humidity. The control efficacy of each test unit was then visually assessed by the insect mortality.

25 Of the compounds of Formula 1 tested the following provided very good to excellent levels of control efficacy (80% or more mortality): 1, 4, 5, 6, 7, 8, 9, 10 and 11.

TEST D

For evaluating control of corn planthopper (*Peregrinus maidis*) through contact and/or systemic means, the test unit consisted of a small open container with a 3–4-day-old maize
30 plant (spike) inside. White sand was added to the top of the soil prior to application. Test compounds were formulated and sprayed at 250 ppm, and the test was replicated three times as described for Test A. After spraying, the test units were allowed to dry for 1 h before they were post-infested with 10–20 corn planthoppers (18–20-day-old nymphs) by sprinkling them onto the sand with a salt shaker. A black, screened cap was placed on the top of the
35 cylinder. 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 the following provided very good to excellent levels of control efficacy (80% or more mortality): 4.

TEST E

For evaluating control of the western flower thrip (*Frankliniella occidentalis*) through contact and/or systemic means, the test unit consisted of a small open container with a 5–7-day-old Soleil Bean plant inside. Test compounds were formulated and sprayed as described for Test A. All experimental compounds in these tests were sprayed at 250 ppm, and the test was replicated three times. After spraying, the test units were allowed to dry for 1 hour and then 22–27 adult thrips were added to each unit and then a black, screened cap was placed on top. The test units were held for 6 days at 25 °C and 45–55% relative humidity. A mortality rating was assessed along with a plant damage rating for each test unit.

Of the compounds of Formula 1 tested the following provided very good to excellent levels of control efficacy (20% or less feeding damage or 80% or more mortality): 1, 2, 3, 4, 5, 6, 7, 8, 10 and 11.

TEST F

For evaluating control of green peach aphid (*Myzus persicae*) through contact and/or systemic means, the test unit consisted of a small open container with a 12–15-day-old radish plant inside. This 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 larvae 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 as described for Test A. All experimental compounds in these tests were sprayed at 250 ppm, and the test was replicated three times. After spraying of the formulated test compound, each test unit was allowed to dry for 1 h 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 the following provided very good to excellent levels of control efficacy (80% or more mortality): 4, 7 and 11.

TEST G

For evaluating control of silverleaf whitefly (*Bemisia tabaci*), the test unit consisted of a 14–21-day-old cotton plant grown in Redi-earth® media (Scotts Co.) with at least two true leaves infested with 2nd and 3rd instar nymphs on the underside of the leaves.

Test compounds were formulated in no more than 2 mL of acetone and then diluted with water to 25–30 mL. The formulated compounds were applied using a flat fan air-assisted nozzle (Spraying Systems 122440) at 10 psi (69 kPa). Plants were sprayed to run-off on a turntable sprayer (patent publication EP-1110617-A1). All experimental

compounds in this screen were sprayed at 250 ppm, and the test was replicated three times. After spraying of the test compound, the test units were held for 6 days in a growth chamber at 50–60% relative humidity and 28 °C daytime and 24 °C nighttime temperature. Then the leaves were removed and then dead and live nymphs were counted to calculate percent mortality.

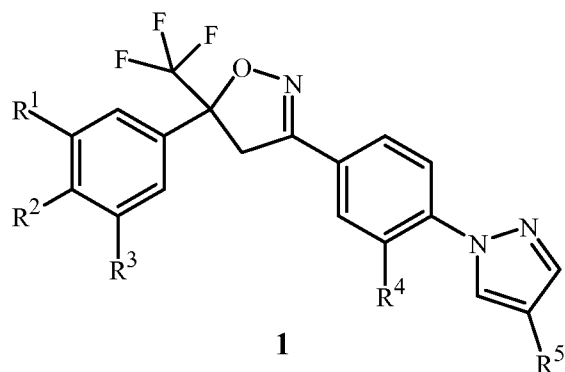
5

Of the compounds of Formula 1 tested the following provided very good to excellent levels of control efficacy (80% or more mortality): 7.

CLAIMS

What is claimed is:

1. A compound selected from Formula 1, an *N*-oxide or salt thereof,



wherein

R^1 is F, Cl, Br, CF_3 , $OCHF_2$, OCF_3 or OCH_2CF_3 ;

R^2 is H, F, Cl, Br, CH_3 , cyano, CF_3 , CHF_2 , $OCHF_2$, OCF_3 or OCH_2CF_3 ;

R^3 is H, F, Cl, Br or CF_3 ;

R^4 is cyano or $C(S)NH_2$;

R^5 is F, Cl, Br, I, cyano, $C(S)NH_2$ or $C(O)NHR^6$; and

R^6 is H; or R^6 is C_1 – C_3 alkyl, cyclopropyl or cyclopropylmethyl, each optionally substituted with halogen and further optionally substituted with 1 or 2 CH_3 ; or R^6 is 1-(trifluoromethyl)cyclopropyl.

2. A compound of Claim 1 wherein

R^1 is Cl, Br or CF_3 ;

R^2 is H, F or Cl; and

R^3 is H, Cl, Br or CF_3 .

3. A compound of Claim 2 wherein

R^4 is cyano.

4. A compound of Claim 3 wherein

R^5 is F, Cl or Br.

5. A compound of Claim 3 wherein

R^5 is cyano or $C(S)NH_2$.

6. A compound of Claim 3 wherein

R^5 is $C(O)NHR^6$.

7. A compound of Claim 2 wherein R^4 is $C(S)NH_2$.
8. A compound of Claim 7 wherein R^5 is F, Cl or Br.
- 5 9. A compound of Claim 7 wherein R^5 is cyano or $C(S)NH_2$.
10. A compound of Claim 7 wherein R^5 is $C(O)NHR^6$.
11. A compound of Claim 1 that is selected from the group consisting of:
1-[2-cyano-4-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carbonitrile,
1-[2-cyano-4-[4,5-dihydro-5-(3,4,5-trichlorophenyl)-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carbonitrile,
1-[2-cyano-4-[5-(3,5-dichloro-4-fluorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carbonitrile,
1-[2-cyano-4-[4,5-dihydro-5-(trifluoromethyl)-5-[3-(trifluoromethyl)phenyl]-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carbonitrile,
1-[4-[5-[3,5-bis(trifluoromethyl)phenyl]-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]-2-cyanophenyl]-1*H*-pyrazole-4-carbonitrile,
1-[2-cyano-4-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-*N*-(2,2,2-trifluoroethyl)-1*H*-pyrazole-4-carboxamide,
2-(4-chloro-1*H*-pyrazol-1-yl)-5-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]benzonitrile,
2-(4-bromo-1*H*-pyrazol-1-yl)-5-[5-(3,5-dichlorophenyl)-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]benzonitrile,
1-[4-[5-[3-chloro-5-(trifluoromethoxy)phenyl]-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]-2-cyanophenyl]-1*H*-pyrazole-4-carbonitrile, and
1-[2-cyano-4-[5-[3,5-dichloro-4-(difluoromethyl)phenyl]-4,5-dihydro-5-(trifluoromethyl)-3-isoxazolyl]phenyl]-1*H*-pyrazole-4-carbonitrile.
- 10 12. A composition comprising a compound of Claim 1 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.

13. A composition for controlling an invertebrate pest comprising a biologically effective amount of a compound of Claim 1 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 additional
5 biologically active compound or agent.

14. The composition of Claim 13 wherein at least one additional biologically active compound or agent is selected from insecticides of the group consisting of pyrethroids, carbamates, neonicotinoids, neuronal sodium channel blockers, insecticidal macrocyclic lactones, γ -aminobutyric acid (GABA) antagonists, insecticidal ureas and juvenile hormone
10 mimics, a member of *Bacillus thuringiensis*, a *Bacillus thuringiensis* delta-endotoxin, and a naturally occurring or a genetically modified viral insecticide.

15. The composition of Claim 13 wherein the at least one additional biologically active compound or agent is selected from the group consisting of abamectin, acephate, acetamiprid, amidoflumet (S-1955), avermectin, azadirachtin, azinphos-methyl, bifenthrin, bifenazate, 3-bromo-1-(3-chloro-2-pyridinyl)-*N*-[4-cyano-2-methyl-6-[(methylamino)-
15 carbonyl]phenyl]-1*H*-pyrazole-5-carboxamide, buprofezin, carbofuran, cartap, chlorantraniliprole, chlorfenapyr, chlorfluazuron, chlorpyrifos, chlorpyrifos-methyl, chromafenozide, clothianidin, cyflumetofen, cyfluthrin, beta-cyfluthrin, cyhalothrin, lambda-cyhalothrin, cypermethrin, cyromazine, deltamethrin, diafenthiuron, diazinon, dieldrin, diflubenzuron, dimefluthrin, dimethoate, dinotefuran, diofenolan, emamectin, endosulfan, esfenvalerate, ethiprole, fenothiocarb, fenoxycarb, fenpropathrin, fenvalerate, fipronil, flonicamid, flubendiamide, flucythrinate, tau-fluvalinate, flufenerim (UR-50701), flufenoxuron, fonophos, halofenozide, hexaflumuron, hydramethylnon, imidacloprid, indoxacarb, isofenphos, lufenuron, malathion, metaflumizone, metaldehyde,
25 methamidophos, methidathion, methomyl, methoprene, methoxychlor, metofluthrin, monocrotophos, methoxyfenozide, nitenpyram, nithiazine, novaluron, noviflumuron (XDE-007), oxamyl, parathion, parathion-methyl, permethrin, phorate, phosalone, phosmet, phosphamidon, pirimicarb, profenofos, profluthrin, pymetrozine, pyrafluprole, pyrethrin, pyridalyl, pyriprole, pyriproxyfen, rotenone, ryanodine, spinosad, spirotetramat, spiromesifen (BSN 2060), spirotetramat, sulprofos, tebufenozide, teflubenzuron, tefluthrin, terbufos, tetrachlorvinphos, thiacloprid, thiamethoxam, thiodicarb, thiosultap-sodium, tralomethrin, triazamate, trichlorfon, triflumuron, *Bacillus thuringiensis aizawai*, *Bacillus thuringiensis kurstaki*, *Bacillus thuringiensis* delta endotoxin, baculovirus, entomopathogenic bacteria, entomopathogenic virus and entomopathogenic fungi.
30

16. The composition of Claim 15 wherein the at least one additional biologically active compound or agent is selected from the group consisting of cypermethrin, cyhalothrin, cyfluthrin and beta-cyfluthrin, esfenvalerate, fenvalerate, tralomethrin, fenothicarb, methomyl, oxamyl, thiodicarb, acetamiprid, chlorantraniliprole, clothianidin, imidacloprid, thiamethoxam, thiacloprid, indoxacarb, spinosad, abamectin, avermectin, emamectin, endosulfan, ethiprole, fipronil, flufenoxuron, triflumuron, diofenolan, pyriproxyfen, pymetrozine, amitraz, *Bacillus thuringiensis* subsp. *Aizawai*, *Bacillus thuringiensis* subsp. *Kurstaki*, encapsulated delta-endotoxins of *Bacillus thuringiensis*, entomopathogenic virus and entomophagous fungi.

17. A method for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of a compound of Claim 1.

18. A method for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a composition of Claim 13.

19. A method for protecting a seed from an invertebrate pest comprising contacting the seed with a biologically effective amount of a compound of Claim 1.

20. 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.

21. A composition for protecting an animal from an invertebrate parasitic pest comprising a parasitically effective amount of a compound of Claim 1 and at least one carrier.

22. A method for protecting an animal from an invertebrate parasitic pest comprising administering to the animal a parasitically effective amount of a compound of Claim 1.