

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
10 February 2011 (10.02.2011)

PCT

(10) International Publication Number
WO 2011/017504 A1

(51) International Patent Classification:
A01N 43/64 (2006.01)

(21) International Application Number:
PCT/US2010/044525

(22) International Filing Date:
5 August 2010 (05.08.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/232,152 7 August 2009 (07.08.2009) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

Published:

— with international search report (Art. 21(3))

(54) Title: PESTICIDAL COMPOSITIONS

(57) Abstract: The present invention concerns novel heteroaryl-N-aryl thiosemicarbazones and their use in pest control, as insecticides and acaricides. This invention also includes preparation of the pesticide compositions containing the compounds, and methods of controlling insects using the compounds.



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PESTICIDAL COMPOSITIONS

FIELD OF THE INVENTION

This application claims the benefit of United States Provisional Application Serial Number 61/232,152 filed on 7 August 2009, the entire contents of which are hereby
5 incorporated by reference. The invention disclosed in this document is related to the field of pesticides and their use in controlling pests.

BACKGROUND OF THE INVENTION

Pests cause millions of human deaths around the world each year. Furthermore, there are more than ten thousand species of pests that cause losses in agriculture. These agricultural
10 losses amount to billions of U.S. dollars each year. Termites cause damage to various structures such as homes. These termite damage losses amount to billions of U.S. dollars each year. As a final note, many stored food pests eat and adulterate stored food. These stored food losses amount to billions of U.S. dollars each year, but more importantly, deprive people of needed food.

15 There is an acute need for new pesticides. Insects are developing resistance to pesticides in current use. Hundreds of insect species are resistant to one or more pesticides. The development of resistance to some of the older pesticides, such as DDT, the carbamates, and the organophosphates, is well known. But resistance has even developed to some of the newer pesticides. Therefore, a need exists for new pesticides and particularly for pesticides
20 that have new modes of action.

SUBSTITUENTS (NON-EXHAUSTIVE LIST)

The examples given for the substituents are (except for halo) non-exhaustive and must not be construed as limiting the invention disclosed in this document.

25 “**alkenyl**” means an acyclic, unsaturated (at least one carbon-carbon double bond), branched or unbranched, substituent consisting of carbon and hydrogen, for example, vinyl, allyl, butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, and decenyl.

“**alkenyloxy**” means an alkenyl further consisting of a carbon-oxygen single bond, for example, allyloxy, butenyloxy, pentenyloxy, hexenyloxy, heptenyloxy, octenyloxy, nonenyloxy, and decenyloxy.

“**alkoxy**” means an alkyl further consisting of a carbon-oxygen single bond, for example, methoxy, ethoxy, propoxy, isopropoxy, 1-butoxy, 2-butoxy, isobutoxy, *tert*-butoxy, pentoxy, 2-methylbutoxy, 1,1-dimethylpropoxy, hexoxy, heptoxy, octoxy, nonoxy, and decoxy.

5 “**alkyl**” means an acyclic, saturated, branched or unbranched, substituent consisting of carbon and hydrogen, for example, methyl, ethyl, propyl, isopropyl, 1-butyl, 2-butyl, isobutyl, *tert*-butyl, pentyl, 2-methylbutyl, 1,1-dimethylpropyl, hexyl, heptyl, octyl, nonyl, and decyl.

10 “**alkynyl**” means an acyclic, unsaturated (at least one carbon-carbon triple bond, and any double bonds), branched or unbranched, substituent consisting of carbon and hydrogen, for example, ethynyl, propargyl, butynyl, pentynyl, hexynyl, heptynyl, octynyl, nonynyl, and decynyl.

15 “**alkynyloxy**” means an alkynyl further consisting of a carbon-oxygen single bond, for example, pentynyloxy, hexynyloxy, heptynyloxy, octynyloxy, nonynyloxy, and decynyloxy.

“**aryl**” means a cyclic, aromatic substituent consisting of hydrogen and carbon, for example, phenyl, naphthyl, and biphenyl.

20 “**cycloalkenyl**” means a monocyclic or polycyclic, unsaturated (at least one carbon-carbon double bond) substituent consisting of carbon and hydrogen, for example, cyclobutenyl, cyclopentenyl, cyclohexenyl, cycloheptenyl, cyclooctenyl, cyclodecenyl, norbornenyl, bicyclo[2.2.2]octenyl, tetrahydronaphthyl, hexahydronaphthyl, and octahydronaphthyl.

25 “**cycloalkenyloxy**” means a cycloalkenyl further consisting of a carbon-oxygen single bond, for example, cyclobutenyloxy, cyclopentenylloxy, cyclohexenyloxy, cycloheptenyloxy, cyclooctenyloxy, cyclodecenyloxy, norbornenyloxy, and bicyclo[2.2.2]octenyloxy.

“**cycloalkyl**” means a monocyclic or polycyclic, saturated substituent consisting of carbon and hydrogen, for example, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclodecyl, norbornyl, bicyclo[2.2.2]octyl, and decahydronaphthyl.

30 “**cycloalkoxy**” means a cycloalkyl further consisting of a carbon-oxygen single bond, for example, cyclopropyloxy, cyclobutyloxy, cyclopentyloxy, cyclohexyloxy, cycloheptyloxy, cyclooctyloxy, cyclodecyloxy, norbornyloxy, and bicyclo[2.2.2]octyloxy.

“**haloalkyl**” means an alkyl further consisting of, from one to the maximum possible number of, identical or different, halos, for example, fluoromethyl, difluoromethyl, trifluoromethyl, 1-fluoromethyl, 2-fluoroethyl, 2,2,2-trifluoroethyl, chloromethyl, dichloromethyl, and 1,1,2,2-tetrafluoroethyl.

15 **DETAILED DESCRIPTION OF THE INVENTION**

$$\text{Ar}_1\text{-Het-Ar}_2\text{-C(R}_1\text{)=N-N(R}_2\text{)-C(=X)-N(R}_3\text{)-R}_4$$

(a) Ar_1 is

- 3-

halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl),
 5 C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, phenoxy, substituted phenyl, and substituted phenoxy,

wherein such substituted phenyl and substituted phenoxy have one or more substituents independently selected from H, F, Cl, Br, I, CN, NO₂, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl),
 10 C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl) phenyl, and phenoxy;

(b) Het is a 5 or 6 membered, saturated or unsaturated, heterocyclic ring, containing one or more heteroatoms independently selected from nitrogen, sulfur, or oxygen, and where Ar₁ and Ar₂ are not ortho to each other (but may be meta or para, such as, for a
 20 five membered ring they are 1,3 and for a 6 membered ring they are either 1,3 or 1,4), and where said heterocyclic ring may also be substituted with one or more substituents independently selected from H, OH, F, Cl, Br, I, CN, NO₂, oxo, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, phenoxy, substituted phenyl and
 25 substituted phenoxy
 30 substituted phenoxy

wherein such substituted phenyl and substituted phenoxy have one or more substituents independently selected from H, F, Cl, Br, I, CN, NO₂, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)H, C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, and phenoxy;

10 (c) Ar₂ is

(1) furanyl, phenyl, pyridazinyl, pyridyl, pyrimidinyl, thienyl, or

(2) substituted furanyl, substituted phenyl, substituted pyridazinyl, substituted pyridyl, substituted pyrimidinyl, or substituted thienyl,

wherein said substituted furanyl, substituted phenyl, substituted pyridazinyl, substituted pyridyl, substituted pyrimidinyl, and substituted thienyl, have one or more substituents independently selected from H, F, Cl, Br, I, CN, NO₂, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, phenoxy, substituted phenyl and substituted phenoxy

25 wherein such substituted phenyl and substituted phenoxy have one or more substituents independently selected from H, F, Cl, Br, I, CN, NO₂, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ hydroxycycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)H, C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl),

C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, and phenoxy);

(d) X is O or S;

5 (e) R₁ is selected from H, CN, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, phenoxy;

(f) R₂, R₃ and R₄ are independently selected from H, C₁-C₆ alkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), C(=O)phenyl, phenyl, C₁-C₆ alkylphenyl, C₁-C₆ alkylphenoxy, indanyl, C(=O)Het-1, Het-1, (C₁-C₆ alkyl)Het-1, or C₁-C₆ alkyl-O-Het-1,

wherein each alkyl, cycloalkyl, cycloalkoxy, halocycloalkoxy, alkoxy, haloalkoxy, alkenyl, alkynyl, C₁-C₆ alkylphenyl, phenyl, phenoxy, and Het-1, are optionally substituted with one or more substituents independently selected from F, Cl, Br, I, CN, NO₂, NR_xR_y, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₃-C₆ cycloalkenyl, C₂-C₆ alkynyl, C₃-C₆ cycloalkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), S(=O)₂N(C₁-C₆ alkyl)₂, OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)H, C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, phenoxy, O-Het-1, and Het-1,

wherein Het-1 is a 5- or 6-membered, saturated or unsaturated, heterocyclic ring, containing one or more heteroatoms independently selected from nitrogen, sulfur or oxygen,

wherein R3 and R4 together can optionally form a 3- to 8-membered saturated or unsaturated cyclic group which may contain one or more heteroatoms selected from nitrogen, sulfur, and oxygen;

(g) $n = 0, 1, \text{ or } 2$;

(h) R_x and R_y are independently selected from H, C_1 - C_6 alkyl, C_1 - C_6 haloalkyl, C_3 - C_6 cycloalkyl, C_3 - C_6 halocycloalkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, $S(=O)_n(C_1$ - C_6 alkyl), $S(=O)_n(C_1$ - C_6 haloalkyl), $OSO_2(C_1$ - C_6 alkyl), $OSO_2(C_1$ - C_6 haloalkyl), $C(=O)H$, $C(=O)(C_1$ - C_6 alkyl), $C(=O)O(C_1$ - C_6 alkyl), $C(=O)(C_1$ - C_6 haloalkyl), $C(=O)O(C_1$ - C_6 haloalkyl), $C(=O)(C_3$ - C_6 cycloalkyl), $C(=O)O(C_3$ - C_6 cycloalkyl), $C(=O)(C_2$ - C_6 alkenyl), $C(=O)O(C_2$ - C_6 alkenyl), $(C_1$ - C_6 alkyl) $O(C_1$ - C_6 alkyl), $(C_1$ - C_6 alkyl) $S(C_1$ - C_6 alkyl), $C(=O)(C_1$ - C_6 alkyl) $C(=O)O(C_1$ - C_6 alkyl), and phenyl.

In another embodiment Ar_1 is a substituted phenyl wherein said substituted phenyl, has one or more substituents independently selected from C_1 - C_6 alkyl, C_1 - C_6 haloalkyl, and C_1 - C_6 haloalkoxy. In a more preferred embodiment Ar_1 is a substituted phenyl wherein said substituted phenyl, has one or more substituents independently selected from OCF_3 , OCF_2CF_3 , CF_3 ,

In another embodiment Het is a triazolyl, imidazolyl, pyrrolyl, or pyrazolyl.

In another embodiment Het is a substituted pyrazolyl wherein said substituted pyrazolyl has one or more substituents independently selected from H, $C(=O)O(C_1$ - C_6 alkyl), or $C(=O)NR_xR_y$.

In another embodiment Ar_2 is a phenyl.

In another embodiment R1 is an H or a C_1 - C_6 alkyl.

In another embodiment R2 is H or a C_1 - C_6 alkyl.

In another embodiment R3 is H.

In another embodiment X is S.

In another embodiment R4 is a C₁-C₆ alkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkenyl, C(=O)phenyl, C₁-C₆ alkylphenyl, Het-1, or (C₁-C₆ alkyl)Het-1.

In another embodiment R4 is a C₁-C₆ alkyl, C₁-C₆ alkylphenyl, phenyl, or Het-1,
5 wherein each is substituted with one or more substituents independently selected from F, Cl, Br, I, CN, NO₂, NR_xR_y, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkenyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), S(=O)₂N(C₁-C₆ alkyl)₂, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), phenyl, O-Het-1, and Het-1.

10 While these embodiments have been expressed, other embodiments and combinations of these expressed embodiments and other embodiments are possible.

PREPARATION OF TRIARYL-INTERMEDIATES

Compounds of this invention can be prepared by making a triaryl intermediate, Ar₁-Het-Ar₂, and then linking it to the desired intermediate to form the desired compound. A wide
15 variety of triaryl intermediates can be used to prepare compounds of this invention, provided that such triaryl intermediates contain a suitable functional group on Ar₂ to which the rest of the desired intermediate can be attached. Suitable functional groups include an oxoalkyl, or formyl group. These triaryl intermediates can be prepared by methods previously described in the chemical literature. Several of these methods are described below.

20 Intermediates wherein 'Het' is a disubstituted pyridine, pyrimidine, pyrazine or pyridazine can be made by coupling of a halo- or alkylthio-substituted pyridine, pyrimidine or pyrazine with an aryl boronic acid or borate ester, under Suzuki arylation conditions. See, for example, the following.

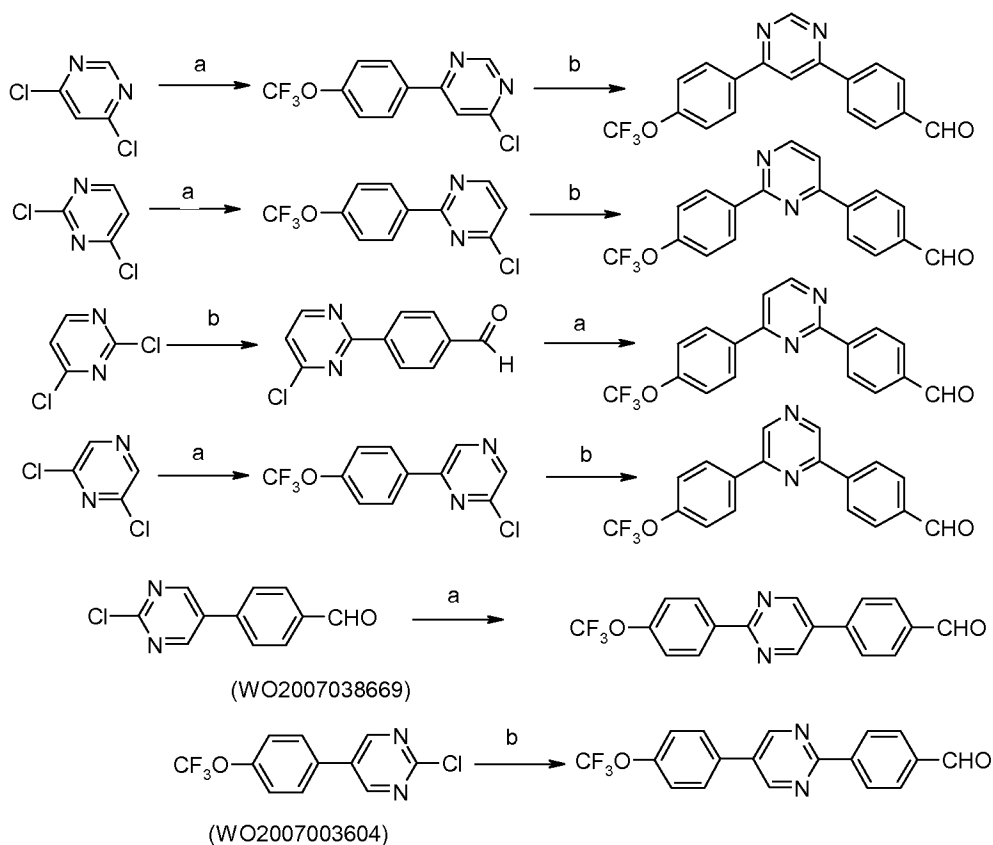
For pyridines: Couve-Bonnaire et al. *Tetrahedron* **2003**, 59, 2793 and Puglisi et al.
25 *Eur. J. Org. Chem.* **2003**, 1552.

For pyrazines: Schultheiss and Bosch *Heterocycles* **2003**, 60, 1891.

For pyrimidines: Qing et al. *J. Fluorine Chem.* **2003**, 120, 21 and Ceide and Montalban *Tetrahedron Lett.* **2006**, 47, 4415.

For 2,4-diaryl pyrimidines: Schomaker and Delia, *J. Org.Chem.* **2001**, 66, 7125.

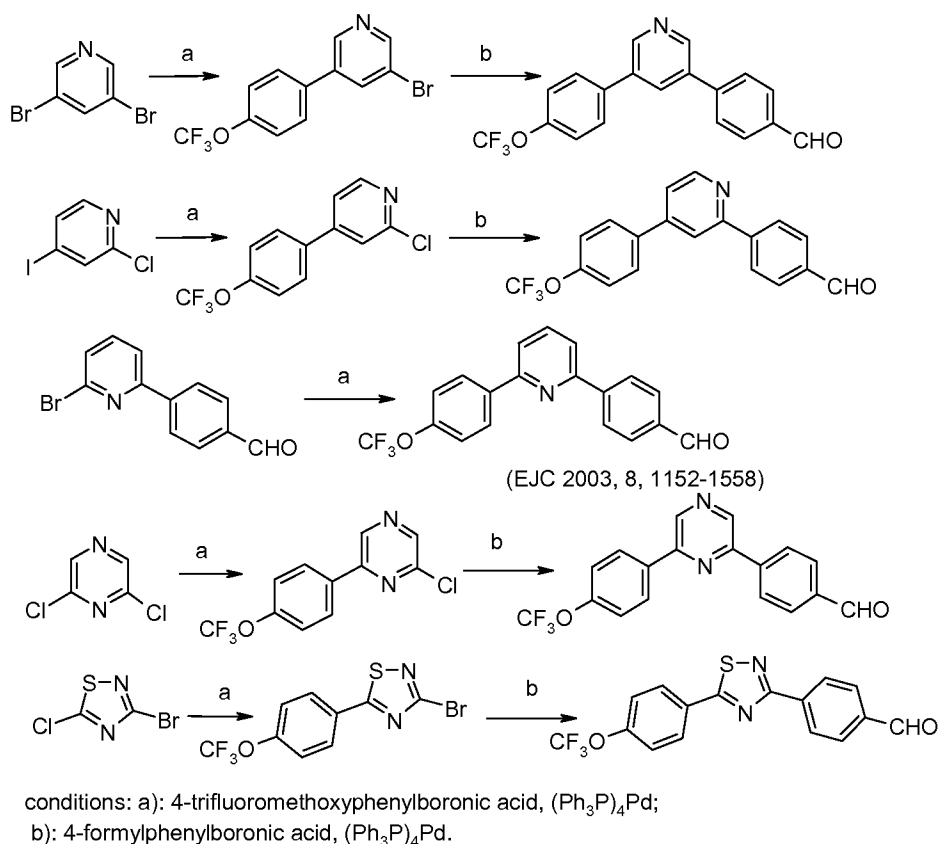
Thus, successive palladium-catalyzed arylations, using 4-formylphenyl boronic acid and 4-trifluoromethoxyphenyl boronic acid, can generate virtually any particular substitution pattern, as shown in the scheme below:



conditions: a): 4-trifluoromethoxyphenylboronic acid, $(\text{Ph}_3\text{P})_4\text{Pd}$;
b): 4-formylphenylboronic acid, $(\text{Ph}_3\text{P})_4\text{Pd}$

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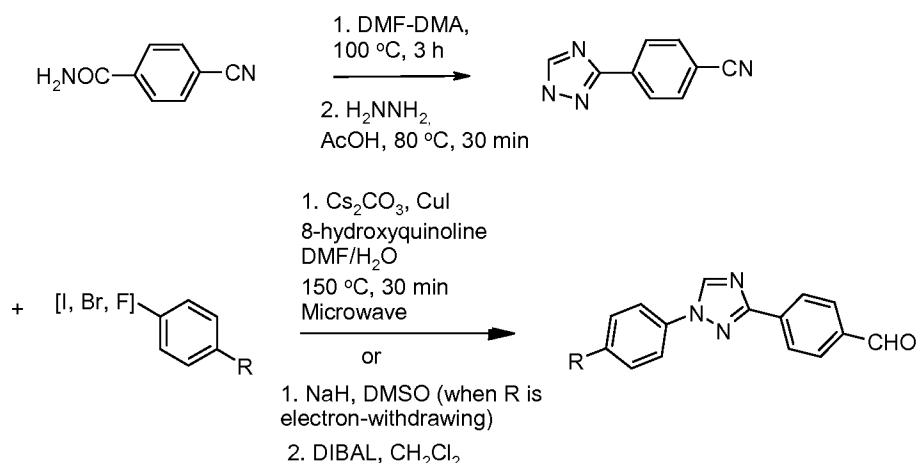
Similarly, diaryl pyridines and pyrazines and other dihalogenated heterocyclic aromatic compounds can be prepared from dihalogenated pyridines and pyrazines and other dihalogenated heterocyclic aromatic compounds using the same protocol:



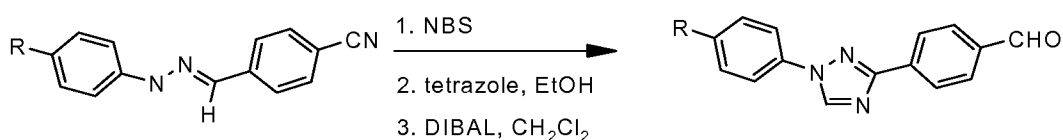
The halo- or alkylthio-pyrimidine and pyridine precursors are either commercially available, or may be synthesized by routes described in the literature (Rorig and Wagner U.S. Patent 3,149,109, 1964; Kreutzberger and Tesch *Arzneim.-Forsch.* **1978**, 28, 235).

- 5 Intermediate compounds wherein 'Het' is a 1,3-disubstituted 1,2,4-triazole can be prepared according to one of the following schemes.

Route A: 1,3-Diaryl 1,2,4-triazoles were prepared from the corresponding -NH 3-aryl 1,2,4-triazoles by following a published route for N-arylation of imidazoles (Lin et al. *J. Org. Chem.* **1979**, 44, 4160). Coupling of 1,2,4-triazoles to aryl halides was done under thermal or, preferably, microwave conditions (Antilla et al. *J. Org. Chem.* **2004**, 69, 5578). (DIBAL is diisobutylaluminum hydride.)



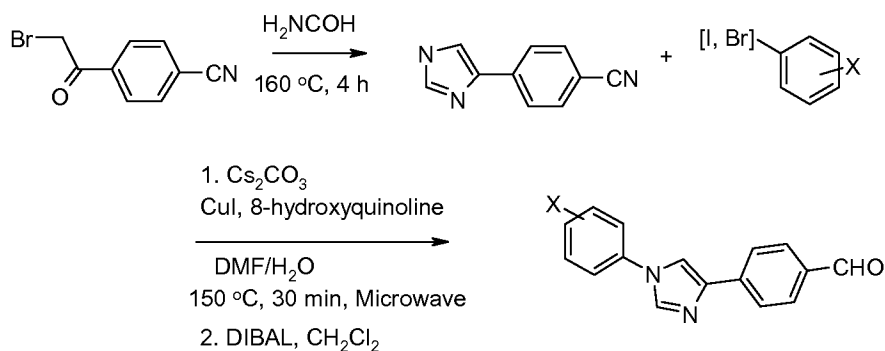
Route B: Bromination of hydrazones followed by treatment of the bromohydrazone with tetrazole results in formation of the 1,3-diaryl 1,2,4-triazole (Butler and Fitzgerald *J. Chem. Soc., Perkin Trans. 1* **1988**, 1587).



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Compounds where 'Het' is an imidazole can be prepared according to one of the following schemes:

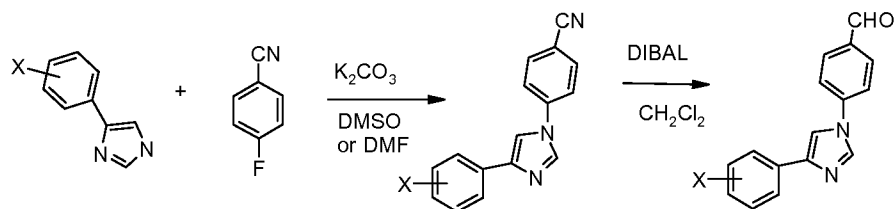
Route A (Step 1: Lynch et al. *J. Am. Chem. Soc.* **1994**, 116, 11030. Step 2: Liu et al. *J. Org. Chem.* **2005**, 70, 10135):



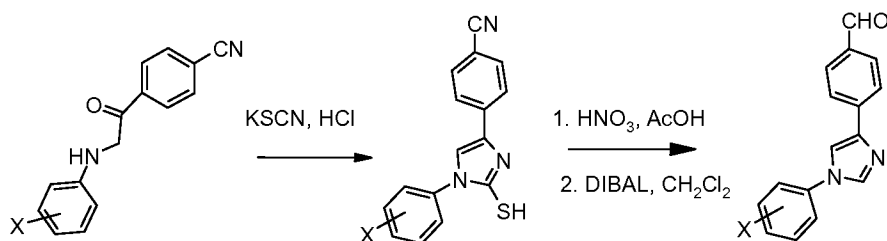
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Route B. For halo-aryl groups that also contain an activating group such as nitro or cyano, displacement of an aryl halide with an imidazole, using a base such as potassium carbonate in a polar aprotic solvent, such as *N,N*-dimethylformamide (DMF) or dimethyl

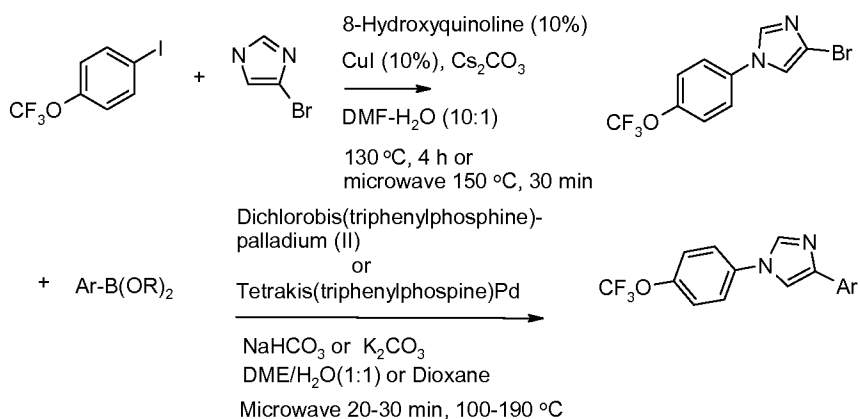
sulfoxide (DMSO), can be accomplished in the following manner (Bouchet et al. *Tetrahedron* **1979**, 35, 1331):



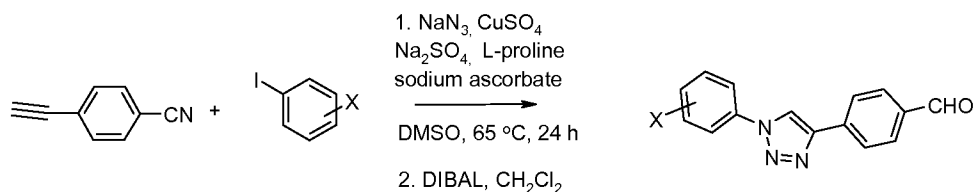
Route C: Following a procedure first described by Porretta et al. (*Farmaco, Edizione Scientifica* **1985**, 40, 404), an *N*-phenacyl aniline is treated with potassium thiocyanate in acidic medium (HCl), and the resulting 2-mercapto imidazole is then converted into the desulfurized diaryl imidazole by treatment with nitric acid in acetic acid.



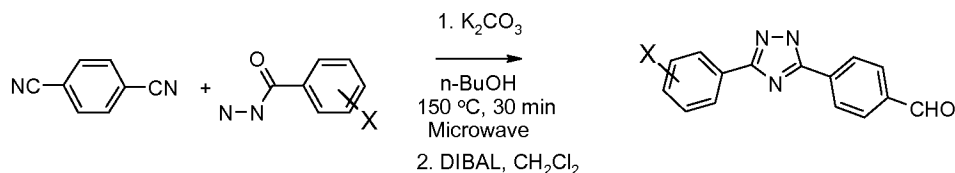
Route D. N-Arylation of 4-bromoimidazole under microwave irradiation conditions (Route A, Step 2) furnished the intermediate 1-aryl-4-bromoimidazole, which was converted into triaryl-intermediates by treatment with aryl boronic acids under palladium-catalyzed conditions.



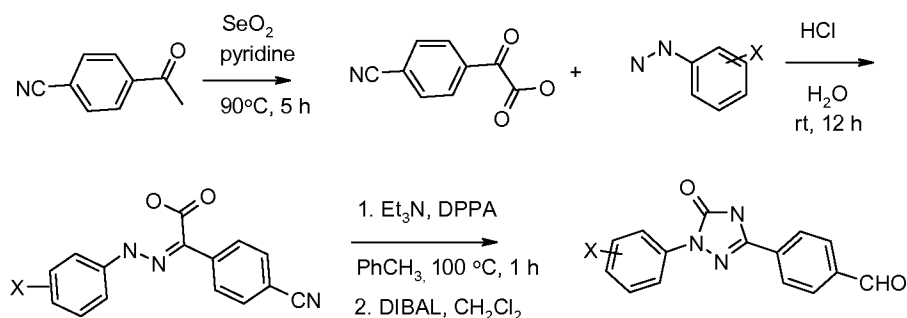
Compounds where 'Het' is a 1,4-disubstituted 1,2,3-triazole can be prepared according to the following scheme (Feldman et al. *Org Lett.* **2004**, 6, 3897):



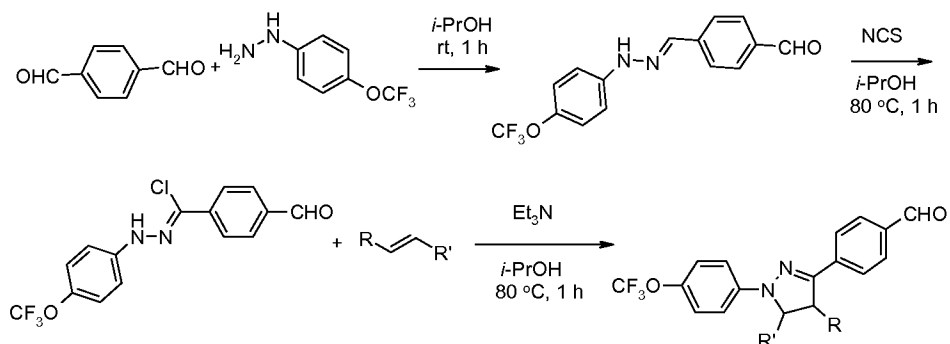
Compounds where 'Het' is a 3,5-disubstituted 1,2,4-triazole can be prepared according to the following scheme (Yeung et al. *Tetrahedron Lett.* **2005**, 46, 3429):



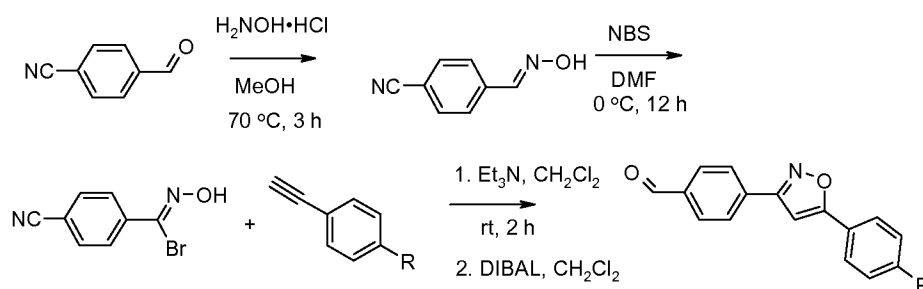
5 Compounds where 'Het' is a 1,3-disubstituted 1,2,4-triazolin-5-one can be prepared according to the following scheme (Pirrung and Tepper *J. Org. Chem.* **1995**, 60, 2461 and Lyga *Synth. Commun.* **1986**, 16, 163). (DPPA is diphenyl phosphoryl azide.):



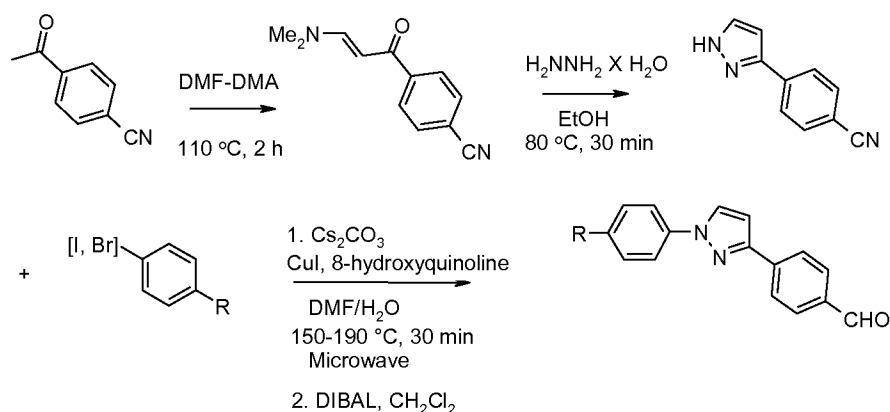
10 Compounds where 'Het' is a 1,3-diaryl pyrazoline can be prepared according to the following scheme. The monohydrazone of terephthalaldehyde is treated with *N*-chlorosuccinimide (NCS) in isopropyl alcohol (*i*-PrOH), and the resulting chlorohydrazone intermediate is treated directly with base and a substituted olefin to generate the pyrazoline:



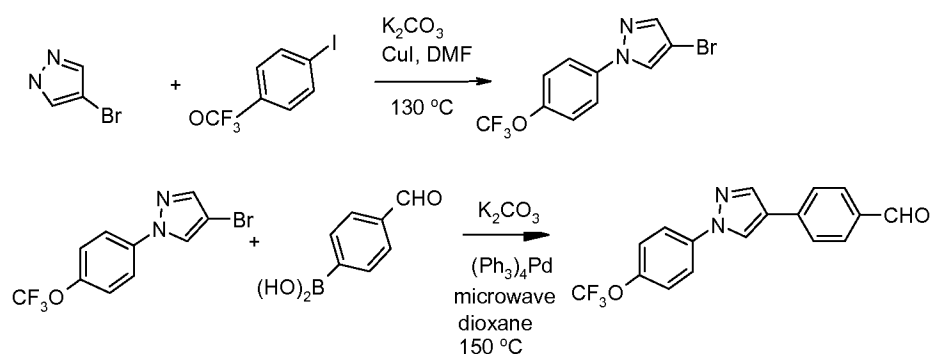
Compounds where 'Het' is a 3,5-disubstituted isoxazole can be prepared according to the following scheme:



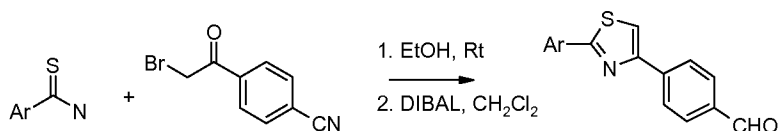
Compounds where 'Het' is a 1,3-disubstituted pyrazole can be prepared according to the following scheme. Coupling of the pyrazole to halogenated aromatics was accomplished using microwave conditions described by Liu et al., Route A, Step 2 above. (DMA is dimethyl acetal.)



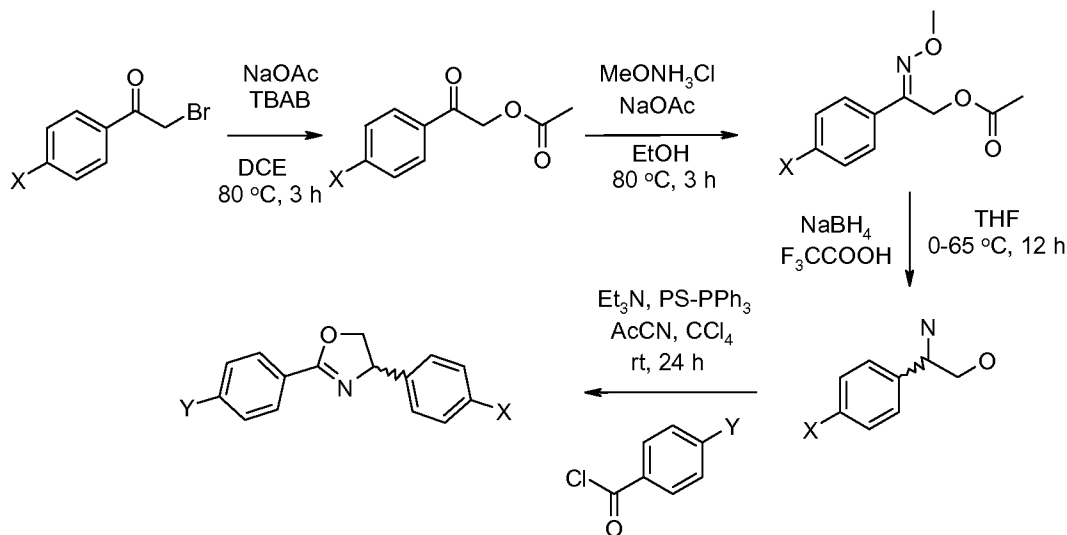
Compounds where 'Het' is a 1,4-disubstituted pyrazole can be prepared according to the following scheme. 4-Bromopyrazole is first coupled with an iodophenyl analog, and the resulting 1-aryl-4-bromopyrazole is then coupled with a phenylboronic acid using conditions described earlier for arylation of imidazoles.



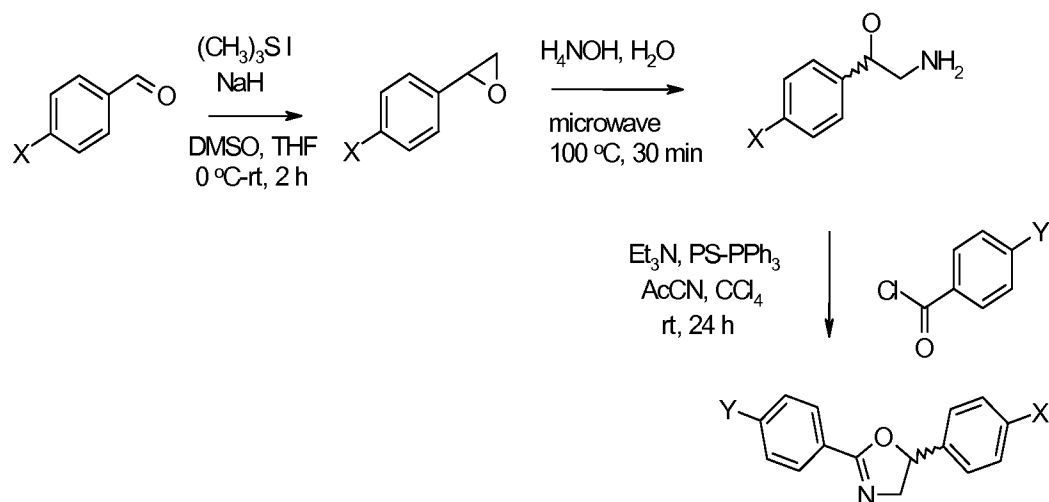
Compounds where 'Het' is a 2,4-disubstituted thiazole are prepared by condensation of a thioamide to an α -halo acetophenone in a protic solvent such as ethanol (for example, Potts and Marshall *J. Org. Chem.* **1976**, 41, 129).



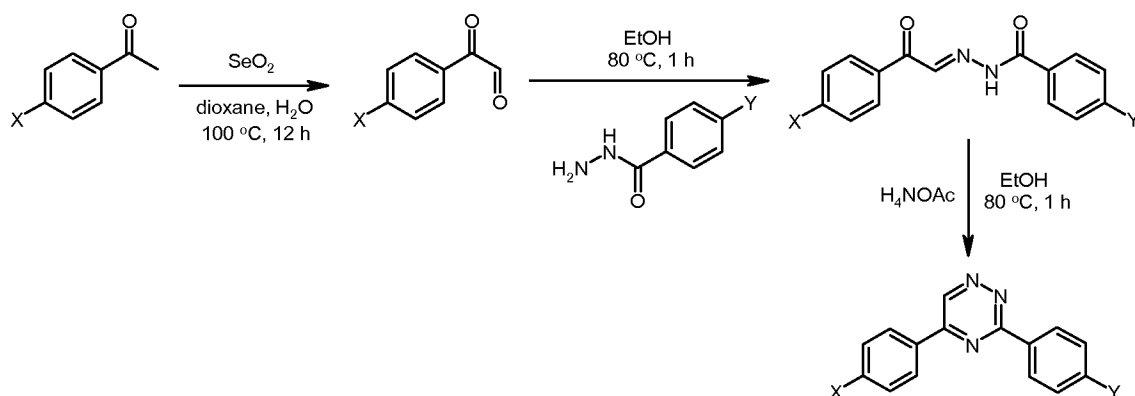
- 5 Compounds where 'Het' is a 2,4-disubstituted oxazoline are prepared starting from the α -bromoacetophenone according to the following scheme (Periasamy et al. *Synthesis* **2003**, 1965 and Liu et al. *J. Am. Chem. Soc.* **2007**, 129, 5834).



- 10 Compounds where 'Het' is a 2,5-disubstituted oxazoline are prepared according to the following scheme (Favretto et al. *Tetrahedron Lett.* **2002**, 43, 2581 and Liu et al. *J. Am. Chem. Soc.* **2007**, 129, 5834):



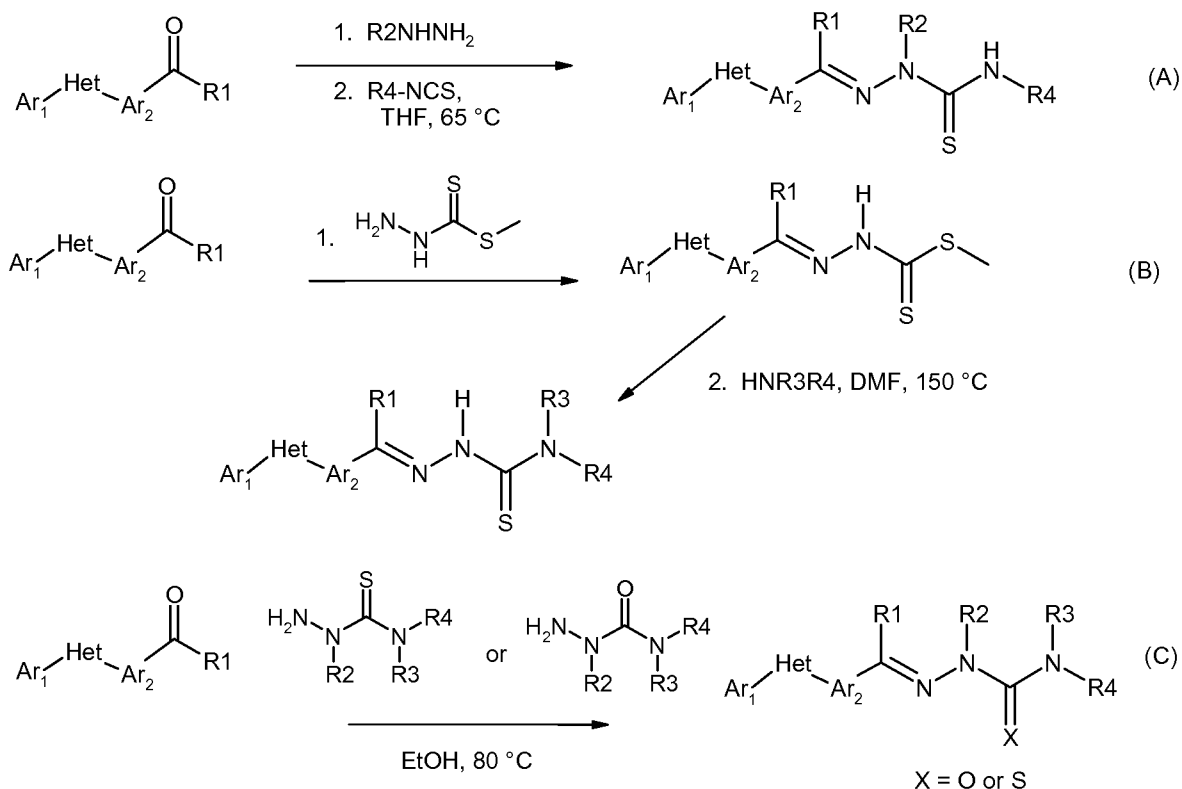
Compounds where 'Het' is a 3,5-disubstituted 1,2,4-triazine are prepared according to the following scheme (Reid et al. *Bioorg. Med. Chem. Lett.* **2008**, 18, 2455 and Saraswathi and Srinivasan *Tetrahedron Lett.* **1971**, 2315):



5

PREPARATION OF HYDRAZONE-LINKED COMPOUNDS

Hydrazone-linked compounds can be prepared from the corresponding aryl aldehydes or ketones by one of three methods: (A) by reaction with hydrazine, followed by reaction with an aryl isothiocyanate in tetrahydrofuran (THF), at temperatures between 0 and 100 °C; (B) by reaction with methyl hydrazinecarbodithioate, followed by reaction with an amine in a polar aprotic solvent such as DMF, at temperatures between 25 and 150 °C; or (C) by reaction with an alkyl or aryl semicarbazide or thiosemicarbazide, that is either commercially available or can be prepared by one who is skilled in the art, in a polar protic solvent such as ethyl alcohol (EtOH), at temperatures between 0 and 100 °C.

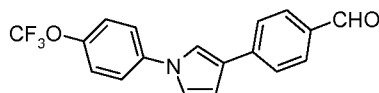


EXAMPLES

The examples are for illustration purposes and are not to be construed as limiting the invention disclosed in this document to only the embodiments disclosed in these examples.

Starting materials, reagents and solvents which were obtained from commercial sources were used without further purification. Anhydrous solvents were purchased as Sure/Seal™ from Aldrich and were used as received. Melting points were obtained on a Thomas Hoover Unimelt capillary melting point apparatus or an OptiMelt Automated Melting Point System from Sanford Research Systems and are uncorrected.

Example 1: Preparation of 4-[1-(4-trifluoromethoxyphenyl)-1H-pyrrol-3-yl]-benzaldehyde.



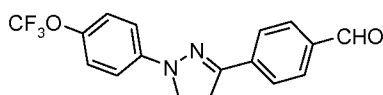
Step 1. 1-(4-Trifluoromethoxyphenyl)-1H-pyrrole. The compound was prepared according to Colotta et al. *J. Med. Chem.* **2006**, 49, 6015. A solution of 4-trifluoromethoxyphenyl amine (500 milligrams (mg), 2.82 millimoles (mmol), 1.00

equivalent (eq)) and 2,5-diethoxy tetrahydrofuran (452 mg, 2.82 mmol, 1.00 eq) in glacial acetic acid (20 milliliters (mL)) was heated at 90 °C for 1 hour (h) before being dried onto silica gel. The residue was then slurried in refluxing hexane, filtered hot, and concentrated to dryness affording the desired intermediate (519 mg, 81%).

5 **Step 2. 3-Bromo-1-(4-trifluoromethoxyphenyl)-1H-pyrrole.** The compound was prepared according to Bray et al. *J. Org. Chem.* **1990**, 55, 6317. To a solution of 1-(4-trifluoromethoxyphenyl)-1H-pyrrole (519 mg, 2.29 mmol, 1.00 eq) in THF (250 mL) at -78 °C was added a 0.05 M solution of *N*-bromosuccinimide (NBS; 408 mg, 2.29 mmol, 1.00 eq) in THF over 45 minutes (min). The vessel was slowly warmed to room temperature before
10 concentration to afford the crude bromopyrrole, which was shown to consist of 55% desired intermediate by GC-MS. The material was used in the subsequent reaction without further purification.

Step 3. 4-[1-(4-Trifluoromethoxyphenyl)-1H-pyrrol-3-yl]-benzaldehyde. A suspension of crude 3-bromo-1-(4-trifluoromethoxyphenyl)-1H-pyrrole (356 mg, 1.26 mmol, 1.00 eq), 4-formylphenylboronic acid (283 mg, 1.89 mmol, 1.50 eq),
15 bis(triphenylphosphine)palladium(II) dichloride (27 mg, 0.04 mmol, 0.03 eq), 2 M Na₂CO₃ (aq) (1.26 mL, 2.52 mmol, 2.0 eq), and 1,4-dioxane (5 mL) were heated at 150 °C in a microwave reaction vessel for 45 min. The cooled solution was then diluted with EtOAc (20 mL), filtered over Celite®, concentrated to dryness, and purified via chromatography (2:2:1,
20 hexane:EtOAc:acetone) to afford the desired intermediate (79 mg, 21%).

Example 2: Preparation of 4-[1-(4-trifluoromethoxyphenyl)-4,5-dihydro-1H-pyrazol-3-yl]-benzaldehyde.



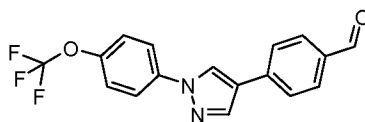
Step 1. 1-(4-Trifluoromethoxyphenyl)-pyrazolidin-3-one: The compound was prepared according to Rees and Tsoi *Chem. Commun.* **2000**, 415. A suspension of (4-trifluoromethoxyphenyl)-hydrazine hydrochloride (300 mg, 1.32 mmol, 1.00 eq), 3-chloropropionyl chloride (167 mg, 1.32 mmol, 1.00 eq), and PS-DIEA (1.30 grams (g), 5.28 mmol, 4.00 eq) in THF (20 mL) was stirred at ambient temperature for 12 h. The solution
25

was then filtered, concentrated to dryness, and purified via chromatography (2:2:1, hexane:EtOAc:acetone) to afford the desired intermediate (120 mg, 37%).

Step 2. 3-Chloro-1-(4-trifluoromethoxyphenyl)-4,5-dihydro-1H-pyrazole: The general procedure was taken from Wang et al. *Tetrahedron Lett.* **2005**, 46, 2631. To a solution of 1-(4-trifluoromethoxyphenyl)-pyrazolidin-3-one (120 mg, 0.49 mmol, 1.00 eq) in toluene (20 mL) was slowly added phosphoryl chloride (22.5 mg, 1.47 mmol, 3.00 eq). The mixture was then heated at 80 °C for 1 h before cooling to room temperature and quenching with H₂O (10 mL). The vessel was stirred under an atmosphere of nitrogen (N₂) for 8 h before the product was extracted into EtOAc (200 mL), dried (MgSO₄), and concentrated under reduced pressure. GC-MS proved 88% formation of the desired intermediate, which was used in subsequent reactions without further purification.

Step 3. 4-[1-(4-Trifluoromethoxyphenyl)-4,5-dihydro-1H-pyrazol-3-yl]-benzaldehyde: A suspension of 3-chloro-1-(4-trifluoromethoxyphenyl)-4,5-dihydro-1H-pyrazole (114 mg, 0.43 mmol, 1.00 eq), 4-formylphenylboronic acid (97 mg, 0.65 mmol, 1.50 eq), bis(triphenylphosphine)palladium(II) dichloride (10 mg, 0.01 mmol, 0.03 eq), 2 M Na₂CO₃ (aq) (0.43 mL, 0.86 mmol, 2.0 eq), and 1,4-dioxane (5 mL) were heated at 150 °C in a microwave reaction vessel for 45 min. The cooled solution was then diluted with EtOAc (20 mL), filtered over Celite®, concentrated to dryness, and purified via chromatography (2:2:1, hexane:EtOAc:acetone) to afford the desired intermediate (50 mg, 0.15 mmol, 31%).

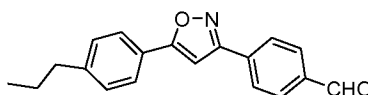
Example 3: Preparation of 4-[1-(4-trifluoromethoxyphenyl)-1H-pyrazol-4-yl]-benzaldehyde



Step 1. 4-Bromo-1-(4-trifluoromethoxyphenyl)-1H-pyrazole. 4-Bromopyrazole (1.5 g, 10 mmol) and 4-iodotrifluoromethoxybenzene (3.0 g, 10.3 mmol) were stirred in DMF (8 mL) and treated with potassium phosphate (6.3 g, 30 mmol) and CuI (0.5 g, 2.6 mmol). The solution was stirred and heated to 130 °C for 30 min, then it was cooled to ambient temperature and poured into 1 N NH₄OH (50 mL). The solid precipitate was isolated by filtration, re-dissolved in ether, filtered and concentrated to a tan solid. Recrystallization from EtOH gave an off-white solid (2.1 g): mp 63-65 °C; LCMS 308.6 (M+1).

Step 2. 4-[1-(4-Trifluoromethoxyphenyl)-1*H*-pyrazol-4-yl]-benzaldehyde. A suspension of the bromopyrazole (0.31 g, 1 mmol) and 4-formylboronic acid (0.15 g, 1 mmol), 2 M aqueous potassium carbonate solution (1 mL), and tetrakis(triphenylphosphine)-palladium(0) (35 mg, cat) in dioxane (6 mL) was heated to 150 °C in a microwave reactor. The residue was then concentrated *in vacuo* and purified by chromatography (0-100% EtOAc-hexanes) to give the title compound (175 mg) as a tan solid: mp 107-109 °C; LCMS 332.8 (M+1).

Example 4: Preparation of 4-[5-(4-propylphenyl)-isoxazol-3-yl]-benzaldehyde.

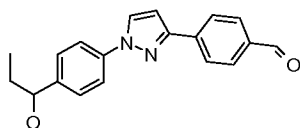


Step 1. 4-(Hydroxyiminomethyl)-benzonitrile. The compound was prepared according to Biasotti et al. *Bioorg. Med. Chem.* **2003**, *11*, 2247. A suspension of 4-formylbenzonitrile (500 mg, 3.81 mmol, 1.00 eq), hydroxylamine hydrochloride (290 mg, 4.19 mmol, 1.10 eq), and sodium acetate (1.56 g, 19.05 mmol, 5.00 eq) in MeOH (50 mL) was heated at 70 °C for 4 h before concentration to dryness. The residue was then slurried in Et₂O, filtered, and concentrated to afford the desired intermediate (496 mg, 3.39 mmol, 89%).

Step 2. 4-(Hydroxyimino-bromomethyl)-benzonitrile. The compound was prepared according to Tanaka et al. *Bull. Chem. Soc. Jpn.* **1984**, *57*, 2184. A 0.05 M solution of *N*-bromosuccinimide (724 mg, 4.07 mmol, 1.20 eq) in CH₂Cl₂ was added dropwise to a 0 °C solution of 4-(hydroxyiminomethyl)-benzonitrile (496 mg, 3.39 mmol, 1.00 eq) in CH₂Cl₂ (50 mL). The solution was warmed to room temperature before being volumetrically partitioned between two different reaction vials. Each vial was then concentrated and the crude residues were used without further purification.

Step 3. 4-[5-(4-Propylphenyl)-isoxazol-3-yl]-benzonitrile. A solution of 4-(hydroxyimino-bromomethyl)-benzonitrile (381 mg, 1.70 mmol), triethylamine (0.71 mL, 5.10 mmol, 3.0 eq), and 1-ethynyl-4-propylbenzene (1.23 g, 8.50 mmol, 5.0 eq) in toluene (20 mL) was heated at 100 °C for 1 h before concentration to dryness. Purification via normal phase chromatography afforded the desired intermediate (108 mg, 22%). Reduction of the nitrile to the corresponding aldehyde was accomplished following the DIBAL procedure described earlier.

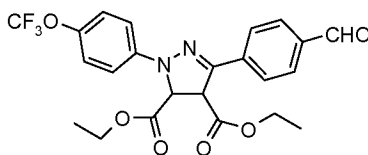
Example 5: Preparation of 4-{1-[4-(1-hydroxypropyl)-phenyl]-1*H*-pyrazol-3-yl}-benzaldehyde.



Step 1. 3-(4-Cyanophenyl)pyrazole. To a round bottom flask equipped with
5 mechanical stir bar and reflux condenser were added *p*-cyanoacetophenone (5 g, 34.44 mmol) and dimethylformamide dimethylacetal (DMF-DMA; 40 mL). The mixture was stirred at reflux for 5 h before concentration under reduced pressure afforded the crude dimethylamino-acryloylbenzonitrile intermediate. The residue was then suspended in a minimal volume of EtOH (~20 mL), charged with hydrazine monohydrate (1.67 mL, 34.4 mmol), and heated at
10 80 °C for 30 min before concentration. The crude 3-(4-cyanophenyl)pyrazole material (5.59 g, 33 mmol, 96%) which was isolated was of sufficient purity for use in the subsequent reaction.

Step 2. 4-[1-(4-Propionyl-phenyl)-1*H*-pyrazol-3-yl]-benzonitrile. 4-(1*H*-Pyrazol-3-yl)-benzonitrile (100 mg, 0.591 mmol), 1-(4-bromophenyl)-propan-1-one (126 mg, 0.591
15 mmol), Cs₂CO₃ (770 mg, 2.364 mmol), CuI (4 mg, 0.018 mmol), 8-hydroxyquinoline (3 mg, 0.018 mmol), and DMF/H₂O (2 mL; 10:1 solution) were combined in a 10 mL CEM Microwave reaction vessel fitted with magnetic stir bar and subjected to microwave irradiation at 150 °C for 30 min. The contents were then filtered and concentrated to dryness affording the nitrile (158 mg, 0.508 mmol, 86%). Reduction of the nitrile to the
20 corresponding aldehyde was accomplished following the DIBAL procedure described earlier.

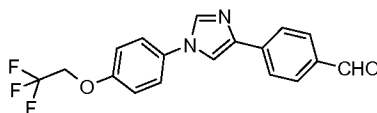
Example 6: Preparation of 5-(4-formylphenyl)-2-(4-trifluoromethoxyphenyl)-3,4-dihydro-2H-pyrazole-3,4-dicarboxylic acid diethyl ester.



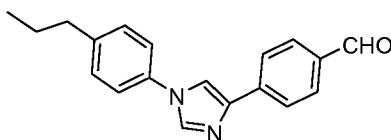
Step 1. Preparation of 4-[(4-trifluoromethoxyphenyl)-hydrazonomethyl]-benzaldehyde. The compound was prepared according to Paulvannan et al. *Tetrahedron* **2000**, 56, 8071. To a stirred solution of benzene-1,4-dicarbaldehyde (1.50 g, 11.2 mmol, 1.0 eq) in *i*-PrOH (250 mL) was added 4-trifluoromethoxyphenylhydrazine hydrochloride (2.55 g, 11.2 mmol, 1.0 eq) portionwise over 5 min. The solution was stirred at ambient temperature for 1 h before concentration to dryness and purification via chromatography (2:2:1 hexane:EtOAc:acetone) to afford the intermediate (2.48 g, 72%).

Step 2. Chlorohydrazone synthesis. The intermediate was prepared according to Lokanatha Rai and Hassner *Synth. Commun.* **1989**, 19, 2799. A solution of 4-[(4-trifluoromethoxyphenyl)-hydrazonomethyl]-benzaldehyde (2.48 g, 8.05 mmol, 1.00 eq) and *N*-chlorosuccinimide (1.61 g, 12.08 mmol, 1.5 eq) in *i*-PrOH (100 mL) was heated at 80 °C for 1 h. The solution was then cooled and volumetrically partitioned evenly between six different reaction vessels to each contain 1.34 mmol of the intermediate.

Step 3. Pyrazoline synthesis. The compounds were prepared according to Paulvannan et al. *Tetrahedron* **2000**, 56, 8071. To each reaction vessel were added triethylamine (0.56 mL, 4.02 mmol, 3.00 eq) and the respective acrylates (6.70 mmol, 5.00 eq). The reaction mixtures were then heated at 70 °C for 90 min before concentration to dryness and purification via chromatography (2:2:1, hexane:EtOAc:acetone). Reduction of the nitriles to the corresponding aldehydes was accomplished following the DIBAL procedure described earlier.

Example 7: Preparation of 4-{1-[4-(2,2,2-trifluoroethoxy)-phenyl]-1*H*-imidazol-4-yl}-benzaldehyde.

4-(2-Bromoacetyl)-benzonitrile (58 mg, 0.21 mmol) and 4-(2,2,2-trifluoroethoxy)-phenylamine (50 mg, 0.21 mmol) were combined in a 100 mL Erlenmeyer flask fitted with a magnetic stir bar. The contents were dissolved in EtOH (1 mL) and stirred at ambient temperature for 2 h. The crude intermediate was then transferred to a 100 mL round bottom flask containing KSCN (21 mg, 0.21 mmol) and conc. HCl (18 μ L, 0.21 mmol). The vessel was heated at 80 °C for 1 h before its contents were poured into 1:1 H₂O/NH₄OH solution (5 mL). The solution was allowed to stand for 24 h, and then the solid was filtered and washed with ether to afford the intermediate imidazoethiol (32 mg, 0.086 mmol, 33%). An aqueous solution of HNO₃ (1.35 mL, 0.387 mmol) and KNO₃ (1 mg, 0.003 mmol) was then added dropwise over 10 min to a suspension of the imidazoethiol in acetic acid (2 mL). After stirring for 2 h at ambient temperature the solution was poured into crushed ice and neutralized (pH = 7) with 0.1 N sodium hydroxide (NaOH, aq). The intermediate nitrile was isolated by vacuum filtration and dried in a 45 °C vacuum oven for 12 h (23 mg, 78%), mp 179 °C. Reduction to the corresponding aldehyde was accomplished using DIBAL under conditions described previously.

Example 8: Preparation of 4-[1-(4-propylphenyl)-1*H*-imidazol-4-yl]-benzaldehyde.

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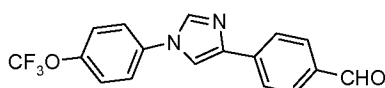
4-Propylaniline (2.70 g, 20 mmol) was added dropwise to a solution of 4-cyanophenacyl bromide (2.20 g, 10 mmol) in DMF (5 mL). This solution was then added to hot (180 °C) formamide (20 mL) over 5 min, and the combined solution was allowed to stir at 180 °C for 2 h. The cooled solution was then poured onto ice (100 mL), and extracted with ether (2 x 75 mL). After drying and concentrating, the resulting dark oil was purified by chromatography (3:1:2 hexanes:EtOAc:CH₂Cl₂). The first product (510 mg) was identified as 4-(5-propyl-1*H*-indol-3-yl)-benzonitrile, mp 140 °C. The second fraction (275 mg) was

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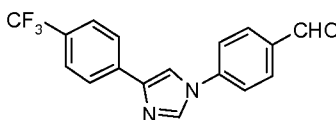
identified as the desired imidazole: mp 133 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.95 (d, *J* = 6 Hz, 2H), 7.90 (s, 1H), 7.70 (d, *J* = 6 Hz, 2H), 7.68 (s, 1H), 7.38 (d, *J* = 4 Hz, 2H), 7.31 (d, *J* = 4 Hz, 2H), 2.69 (t, *J* = 8.9 Hz, 2H), 1.68 (m, 2H), 0.98 (t, *J* = 7.5 Hz, 3H); ESIMS *m/z* 288.1 (M+H).

- 5 Reduction to the corresponding aldehyde was accomplished using DIBAL under conditions described previously: mp 97 °C; ¹H NMR (300 MHz, CDCl₃) δ 10.02 (s, 1H), 8.03 (d, *J* = 6 Hz, 2H), 7.92 (d, *J* = 6 Hz, 2H), 7.90 (s, 1H), 7.72 (s, 1H), 7.38 (d, *J* = 4 Hz, 2H), 7.31 (d, *J* = 4 Hz, 2H), 2.69 (t, *J* = 8.9 Hz, 2H), 1.68 (m, 2H), 0.98 (t, *J* = 7.5 Hz, 3H); ESIMS *m/z* 291.1 (M+H).

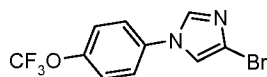
10 **Example 9: Preparation of 4-[1-(4-trifluoromethoxyphenyl)-1*H*-imidazol-4-yl]-benzaldehyde.**



- 15 4-Trifluoromethoxyaniline (2.20 g, 12.4 mmol) was added dropwise to a solution of 4-cyanophenacyl bromide (1.50 g, 6.7 mmol) in DMF (5 mL). This solution was then added to hot (180 °C) formamide (20 mL) over 5 min, and the combined solution was allowed to stir at 180 °C for 2 h. The cooled solution was then poured onto ice (100 mL), and extracted with ether (2 x 75 mL). After drying and concentrating, the resulting semi-solid was crystallized from MeOH/H₂O. A second recrystallization from MeOH/H₂O removed traces of the formanilide impurity and furnished pure product (200 mg): mp 155 °C. Anal. Calcd. for C₁₇H₁₀F₃N₃O: C, 62.01; H, 3.06; N, 12.76. Found: C, 61.53; H, 3.13; N, 12.55. Reduction to the corresponding aldehyde was accomplished using DIBAL under conditions described previously: mp 112 °C; ¹H NMR (300 MHz, CDCl₃) δ 10.0 (s, 1H), 8.05-7.90 (m, 5H), 7.70 (s, 1H), 7.50 (d, *J* = 6 Hz, 2H), 7.42 (d, *J* = 6 Hz, 2H); ESIMS *m/z* 333.0 (M+H).
- 20

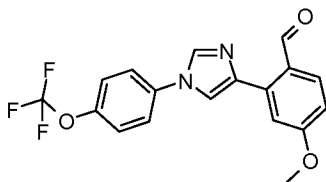
Example 10: Preparation of 4-[4-(4-trifluoromethylphenyl)-1H-imidazol-1-yl]-benzaldehyde.

4-Trifluoromethylphenyl imidazole (4.0 g, 19 mmol), 4-fluorobenzonitrile (1.2 g, 8.5 mmol) and potassium carbonate (1.5 g, 10.9 mmol) were combined in DMSO (15 mL) and heated at 100 °C for 6 h. The cooled solution was then poured onto water (H₂O; 100 mL), and the resulting solid was filtered and air-dried to give the imidazole nitrile (4.65 g) as a white solid: mp 252 °C; ¹H NMR (300 MHz, CDCl₃) δ 8.05 (s, 1H), 7.95 (d, *J* = 8 Hz, 2H), 7.85 (d, *J* = 8 Hz, 2H), 7.72 (s, 1H), 7.72 (d, *J* = 8 Hz, 2H), 7.62 (d, *J* = 8 Hz, 2H); ESIMS *m/z* 314.1 (M+H). Anal. Calcd. for C₁₆H₁₀F₃N₃O₂: C, 65.18; H, 3.22; N, 13.41. Found: C, 64.49; H, 3.23; N, 13.08. A portion of the nitrile (3.8 g) was reduced in the presence of DIBAL under conditions described previously to give the corresponding aldehyde (2.41 g): mp 141 °C; ¹H NMR (300 MHz, CDCl₃) δ 10.1 (s, 1H), 8.10 (d, *J* = 8 Hz, 2H), 8.05 (s, 1H), 7.95 (d, *J* = 8 Hz, 2H), 7.75 (s, 1H), 7.7 (m, 4H); ESIMS *m/z* 317.1 (M+H).

Example 11: Preparation of 4-bromo-1-(4-trifluoromethoxyphenyl)-1H-imidazole.

A round bottom flask was charged with 4-bromoimidazole (1.15 g, 7.81 mmol), CuI (0.07 g, 0.36 mmol), 8-hydroxyquinoline (0.05 g, 0.36 mmol), cesium carbonate (3.39 g, 10.4 mmol) and 4-trifluoromethoxyiodobenzene (1.50 g, 5.21 mmol). A 10:1 mixture of DMF (15 mL) and H₂O (1.5 mL) was added to the reaction mixture, and the solution was heated to 130 °C for 4 h. The reaction mixture was then diluted with EtOAc and washed sequentially with H₂O, ammonium chloride (NH₄Cl, saturated), H₂O and sodium bicarbonate (NaHCO₃). The organics were dried over MgSO₄, filtered and purified by reverse phase column chromatography to give the imidazole (820 mg) as a white solid: mp 139–141 °C; ESIMS *m/z* 308.0 (M+H).

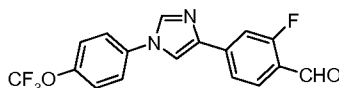
Example 12: Preparation of 4-methoxy-2-[1-(4-trifluoromethoxyphenyl)-1H-imidazol-4-yl]-benzaldehyde.



4-Bromo-1-(4-trifluoromethoxyphenyl)-1*H*-imidazole (100 mg, 0.326 mmol), 2-formyl-5-methoxyphenylboronic acid (73 mg, 0.41 mmol), bis(triphenylphosphine)palladium dichloride (2 mg, 0.003 mmol), NaHCO₃ (49 mg, 0.59 mmol) and 1:1 DME/H₂O (8:8 mL) were combined and added to a microwave vessel. The reaction mixture was heated in the microwave with stirring at 100 °C for 12 min. The microwave took 5 min to reach 100 °C, then maintained at 100 °C for 12 min, and then cooled. TLC (1:1 EtOAc:cyclohexane) showed the presence of starting materials, thus the sample was heated to 100 °C for another 8 min. Upon cooling a precipitate formed; this was filtered and washed with H₂O to give a grey solid (86 mg): ESIMS *m/z* 363.0 (M+H).

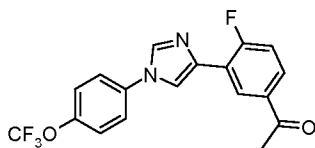
The following intermediate was also prepared using this procedure:

Example 13: Preparation of 2-fluoro-4-[1-(4-trifluoromethoxyphenyl)-1*H*-imidazol-4-yl]-benzaldehyde.



ESIMS *m/z* 351.0 (M+H).

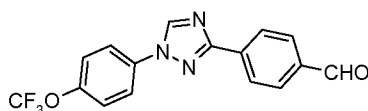
Example 14: Preparation of 1-{4-fluoro-3-[1-(4-trifluoromethoxyphenyl)-1*H*-imidazol-4-yl]-phenyl}-ethanone.



4-Bromo-1-(4-trifluoromethoxyphenyl)-1*H*-imidazole (200 mg, 0.651 mmol), 5-acetyl-2-fluorophenylboronic acid (178 mg, 0.977 mmol), tetrakis(triphenylphosphine)palladium(0) (7 mg, 0.007 mmol), a 2 N aqueous solution of potassium carbonate (0.651 mL) and dioxane (8 mL) were combined and added to a microwave vessel. The reaction mixture was heated in the microwave with stirring to 150 °C for 20 min. LC-MS indicated 88%

anticipated product; TLC (1:1 hexanes:EtOAc) indicated the presence of starting material plus 3 other materials. EtOAc and H₂O were added to the reaction mixture. The aqueous layer was extracted with EtOAc, and the organic extracts were washed with brine, dried over MgSO₄, and concentrated *in vacuo*. The crude product was purified by chromatography with
5 gradient elution (100% hexanes to 100% EtOAc) resulting in an off-white solid (90 mg): mp 129 °C; ESIMS *m/z* 265.0 (M+H).

Example 15: Preparation of 4-[1-(4-trifluoromethoxyphenyl)-1*H*-[1,2,4]triazol-3-yl]-benzaldehyde.

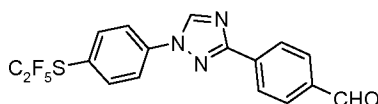


Step 1. 4-(1*H*-[1,2,4]Triazol-3-yl)-benzonitrile. The general procedure outlined by Lin et al. (*J. Org. Chem.* **1979**, *44*, 4163) for preparation of 3-(4-nitrophenyl)-1*H*-[1,2,4]triazole was used. 4-Cyanobenzamide (21.63 g, 0.148 mol) was dissolved in DMF-DMA (100 mL) and was stirred at reflux under N₂ for 8 h. The mixture was concentrated to dryness and suspended in AcOH (50 mL). The vessel was then charged with hydrazine
15 monohydrate (7.18 mL, 0.148 mmol) and stirred at reflux for 1 h before concentration. The desired 4-(1*H*-[1,2,4]triazol-3-yl)-benzonitrile was obtained in 98% purity by trituration with Et₂O followed by filtration (12.17 g, 0.072 mol, 48%).

Step 2. 4-[1-(4-Trifluoromethoxyphenyl)-1*H*-[1,2,4]triazol-3-yl]-benzonitrile.. The triazole (70 mg, 0.41 mmol), 1-iodo-4-trifluoromethoxybenzene (142 mg, 0.493 mmol),
20 Cs₂CO₃ (535 mg, 1.644 mmol), CuI (3 mg, 0.012 mmol), 8-hydroxyquinoline (2 mg, 0.012 mmol), and DMF/H₂O (2 mL; 10:1 solution) were combined in a 10 mL CEM Microwave reaction vessel fitted with magnetic stir bar and subjected to microwave irradiation at 150 °C for 30 min. The contents were then filtered and concentrated to dryness affording the 1,3-diphenyl triazole intermediate (18 mg, 13%).

Step 3. 4-[1-(4-Trifluoromethoxyphenyl)-1*H*-[1,2,4]triazol-3-yl]-benzaldehyde. The nitrile was reduced with DIBAL under conditions previously described: mp 137–140 °C; ¹H NMR (300 MHz, CDCl₃) δ 10.1 (s, 1H), 8.61 (s, 1H), 8.37 (d, *J* = 9 Hz, 2H), 8.0 (d, *J* = 8.4 Hz, 2H), 7.8 (d, *J* = 9 Hz, 2H), 7.4 (d, *J* = 8.4 Hz, 2H); ESIMS *m/z* 334.2 (M+H).

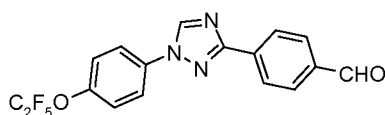
Example 16: Preparation of 4-[1-(4-pentafluoroethylsulfanylphenyl)-1H-[1,2,4]triazol-3-yl]-benzaldehyde.



Step 1. 1-Bromo-4-pentafluoroethylsulfanylbenzene. The title compound was prepared using perfluoroalkylation conditions originally described by Popov et. al. *J. Fluorine Chem.* **1982**, 21, 365. To a solution of 4-bromobenzenethiol (500 mg, 2.64 mmol, 1.00 eq) and triethylbenzyl ammonium chloride (60 mg, 0.26 mmol, 0.10 eq) in 10 mL of 1:1 Et₂O/NaOH (25% aq) at 0 °C was bubbled 1,1,1,2,2-pentafluoro-2-iodoethane gas for 30 min (> 5eq). During this time a UV lamp was directed at the reaction vessel while the temperature was maintained below 10 °C by intermittent use of an ice bath. The contents were then warmed to room temperature, extracted into Et₂O (300 mL), dried (MgSO₄), and concentrated under reduced pressure. A portion of this crude material was used in subsequent reactions without further purification (200 mg residue: 120 mg product, 0.39 mmol, 1.2 eq).

Step 2. 4-[1-(4-Pentafluoroethylsulfanylphenyl)-1H-[1,2,4]triazol-3-yl]-benzonitrile. Coupling with 4-(1H-[1,2,4]triazol-3-yl)-benzonitrile as described above gave 4-[1-(4-pentafluoroethylsulfanylphenyl)-1H-[1,2,4]triazol-3-yl]-benzonitrile (70 mg, 46%). Reduction with DIBAL, as described previously, gave the corresponding aldehyde.

Example 17: Preparation of 4-[1-(4-pentafluoroethoxy-phenyl)-1H-[1,2,4]triazol-3-yl]-benzaldehyde.

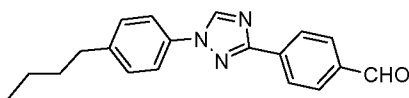


Step 1. A solution of 3-*p*-tolyl-1H-[1,2,4]triazole (4.85 g, 30.5 mmol), 4-bromophenyl pentafluoroethyl ether (10.0 g, 34.4 mmol), Cs₂CO₃ (25 g, 77 mmol), CuI (1.25 g, 6.5 mmol) and 8-hydroxyquinoline (0.35 g, 2.4 mmol) in 9:1 DMF/H₂O (50 mL) was stirred vigorously and heated to 130 °C (internal temperature) for 20 h. The solution was then cooled, poured into H₂O, and acidified with 2 N HCl to pH 2. Ether (250 mL) was then added and the solution was shaken and filtered before separating layers. The organic layer was dried and concentrated, and the resulting gummy solid was heated with hexanes (100 mL). The hot

hexane layer was decanted from insoluble residue, the resulting solution cooled to 0 °C and the precipitated solid was filtered and air-dried to furnish 1-(4-pentafluoroethoxy-phenyl)-3-*p*-tolyl-1*H*-[1,2,4]triazole (7.0 g, 61% based on starting triazole) as an off-white solid: mp 130–132 °C; ESIMS *m/z* 370.8 (M+H).

5 **Step 2.** The product from Step 1 (7.0 g, 18.7 mmol) was dissolved in acetonitrile (200 mL) and stirred at ambient temperature while ceric ammonium nitrate (32 g, 58 mmol) in H₂O (60 mL) was added in portions over 10 min. The solution was then heated to reflux for 4 h, cooled, and diluted with H₂O (200 mL). The solution was extracted with ether (2 x 200 mL), and the combined organic layer was dried and concentrated to give an orange oil. This
10 material was dissolved in dioxane (40 mL) and treated with a solution of potassium hydroxide (KOH; 5 g, 90 mmol) in H₂O (20 mL). The solution was heated to reflux for 2 h, then cooled and diluted with H₂O (100 mL). The aldehyde precipitated and was collected by filtration. Recrystallization from MeOH/H₂O gave the pure aldehyde as a white solid (2.2 g, 30%): mp 137–144 °C; ¹H NMR (300 MHz, CDCl₃) δ 10.1 (s, 1H), 8.65 (s, 1H), 8.40 (d, *J* =
15 8.4 Hz, 2H), 8.0 (d, *J* = 8.4 Hz, 2H), 7.85 (d, *J* = 9 Hz, 2H), 7.45 (d, *J* = 9 Hz, 2H); ESIMS *m/z* 384.2 (M+H).

Example 18: Preparation of 4-[1-(4-butylphenyl)-1*H*-[1,2,4]triazol-3-yl]-benzaldehyde.



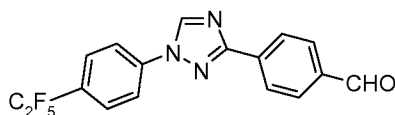
20 **Step 1. 4-[1-(4-Butylphenyl)-1*H*-[1,2,4]triazol-3-yl]-benzonitrile.** A solution of 4-*n*-butyl phenyl hydrazine (1.0 g, 5 mmol) and 4-cyanobenzaldehyde (0.8 g, 6.0 mmol) in *i*-PrOH (15 mL) was heated on a steam bath for 2 h and then was cooled and diluted with H₂O (5 mL). The resulting orange solid was filtered and air-dried to give the hydrazone (1.30 g) as a yellow solid, mp 107 °C. A solution of this hydrazone (1.1 g, 4.0 mmol) and NCS (0.67 g, 5 mmol) in *i*-PrOH (20 mL) was stirred under nitrogen at ambient temperature for 2 h, during
25 which time the original solid dissolved and a new solid formed. The resulting orange solution was then treated with tetrazole (0.45 g, 6.4 mmol) and triethylamine (960 μL, 7.0 mmol). The orange-brown solution was heated at reflux for 2 h. The solution was then cooled, diluted with H₂O (25 mL), extracted with EtOAc, dried, concentrated, and purified by chromatography (Biotage, 4:1 hexane:EtOAc) to give the triazole (0.42 g, 35%) of as an off-

white solid: mp 124 °C; ¹H NMR (300 MHz, CDCl₃) δ 8.58 (s, 1H), 8.33 (d, *J* = 8 Hz, 2H), 7.78 (d, *J* = 8 Hz, 2H), 7.64 (d, *J* = 8.2 Hz, 2H), 7.33 (d, *J* = 8.2 Hz, 2H), 2.70 (t, *J* = 7.8 Hz, 2H), 1.63 (m, 2H), 1.38 (m, 2H), 0.95 (t, *J* = 7.5 Hz, 3H); ESIMS *m/z* 303.1.

Step 2. 4-[1-(4-Butylphenyl)-1*H*-[1,2,4]triazol-3-yl]-benzaldehyde. Reduction with

5 DIBAL, as described previously, gave the corresponding aldehyde: mp 124 °C; ¹H NMR (300 MHz, CDCl₃) δ 10.08 (s, 1H), 8.58 (s, 1 H), 8.37 (d, *J* = 8 Hz, 2H), 7.98 (d, *J* = 8 Hz, 2H), 7.62 (d, *J* = 8.2 Hz, 2H), 7.33 (d, *J* = 8.2 Hz, 2H), 2.70 (t, *J* = 7.8 Hz, 2H), 1.63 (m, 2H), 1.38 (m, 2H), 0.95 (t, *J* = 7.5 Hz, 3H); ESIMS *m/z* 306.1.

Example 19: Preparation of 4-[1-(4-pentafluoroethylphenyl)-1*H*-[1,2,4]triazol-3-yl]-
10 **benzaldehyde.**



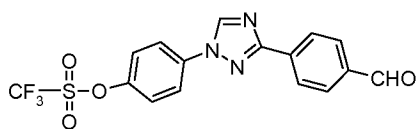
Step 1. 1-(4-Pentafluoroethylphenyl)-3-*p*-tolyl-1*H*-[1,2,4]triazole. Pentafluoroethyl

iodide (521 mg, 2.12 mmol) was condensed into a vial containing 1-bromo-4-iodobenzene (300 mg, 1.06 mmol), copper(0) powder (135 mg, 2.12 mmol), and DMSO (5 mL). The vial
15 was then sealed and subjected to microwave irradiation at 150 °C for 60 min. GC–MS proved consumption of the starting material yielding both 1-bromo-4-pentafluoroethylbenzene and 1-iodo-4-pentafluoroethylbenzene intermediates. The mixture (1.06 mmol) was transferred to a 250 mL round bottom flask and 3-*p*-tolyl-1*H*-[1,2,4]triazole (169 mg, 1.06 mmol), Cs₂CO₃ (1.38 g, 4.24 mmol), CuI (202 mg, 1.06 mmol), 8-hydroxyquinoline (2 mg, 0.011 mmol), and
20 DMF/H₂O (12 mL; 10:1 solution) were added. The solution was stirred at reflux at 160 °C for 6 h. Upon completion, the cooled contents were poured into H₂O and precipitation was allowed for 1 h. The precipitate was collected by vacuum filtration and dried overnight in a 45 °C vacuum oven. The crude 1-(4-pentafluoroethylphenyl)-3-*p*-tolyl-1*H*-[1,2,4]triazole intermediate was used in step 2 without further purification.

25 **Step 2. Oxidation to the aldehyde.** Ammonium cerium(IV) nitrate (3.32 g, 4.24 mmol) and the intermediate from Step 1 were combined in a round bottom flask with acetonitrile and H₂O (20 mL; 1:1). The solution was stirred at reflux at 110 °C for 4 h, affording a mixture of the 3-(4-nitrooxymethyl-phenyl)-1-(4-pentafluoroethyl-phenyl)-1*H*-[1,2,4]triazole and 4-[1-(4-pentafluoroethyl-phenyl)-1*H*-[1,2,4]triazol-3-yl]-benzaldehyde

intermediates. The acetonitrile was removed under vacuum and the crude intermediate precipitates were collected by filtration. The material was then combined with powdered KOH (178 mg, 3.18 mmol) in dioxane and H₂O (10 mL; 1:1) and was stirred at reflux at 105 °C for 90 min before the dioxane was removed under vacuum allowing precipitation of the intermediate from H₂O. The 4-[1-(4-pentafluoroethylphenyl)-1*H*-[1,2,4]triazol-3-yl]-benzaldehyde intermediate was collected by filtration (35 mg, 0.095 mmol, 9% overall from 4-tolyl triazole).

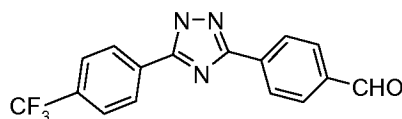
Example 20: Preparation of trifluoromethanesulfonic acid 4-[3-(4-formylphenyl)-[1,2,4]triazol-1-yl]-phenyl ester.



Step 1. 1-(4-Methoxyphenyl)-3-*p*-tolyl-1*H*-[1,2,4]triazole was prepared by coupling 3-*p*-tolyl-1*H*-[1,2,4]triazole with 4-iodoanisole under conditions described in Step 1 of the previous example. This material was then demethylated using conditions described in Hitchcock et al. *Synlett* **2006**, 2625. Boron tribromide (1 M solution in hexanes; 1.67 mL, 1.67 mmol) was added dropwise to a solution of 1-(4-methoxyphenyl)-3-*p*-tolyl-1*H*-[1,2,4]triazole (300 mg, 1.28 mmol) in CH₂Cl₂ (10 mL) at 0 °C under N₂. After addition was complete, the vessel was warmed to ambient temperature before refluxing at 40 °C for 6 h. The cooled contents were then quenched with H₂O before removal of the CH₂Cl₂ and partitioning between EtOAc and H₂O. The organic layer was collected, washed with brine, dried (MgSO₄), concentrated, and purified via chromatography (3:1:1, hexanes:EtOAc:acetone) to afford the 4-(3-*p*-tolyl-[1,2,4]triazol-1-yl)-phenol intermediate (219 mg, 0.872 mmol, 68%). Trifluoromethanesulfonic anhydride (0.16 mL, 0.96 mmol) was added dropwise to a solution of the phenol and 4-*tert*-butyl-2,6-dimethylpyridine (142 mg, 0.872 mmol) in CH₂Cl₂ (10 mL) at 0 °C under N₂. The vessel was warmed to ambient temperature before the solvent was removed under reduced pressure and the residue purified via chromatography (2:2:1, hexanes:EtOAc:acetone) affording the trifluoromethanesulfonic acid 4-(3-*p*-tolyl-[1,2,4]triazol-1-yl)-phenyl ester intermediate (304 mg, 0.794 mmol, 91%).

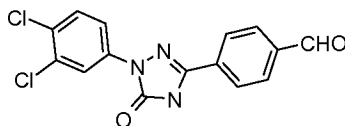
Step 2. Oxidation of the 4-methyl intermediate above to the corresponding aldehyde was carried out using ammonium cerium(IV) nitrate under conditions described in Step 2 of the previous example.

Example 21: Preparation of 4-[5-(4-trifluoromethylphenyl)-1H-[1,2,4]triazol-3-yl]-benzaldehyde.



Terephthalonitrile (115 mg, 0.90 mmol), 4-trifluoromethylbenzoic acid hydrazide (92 mg, 0.450 mmol), K_2CO_3 (31 mg, 0.225 mmol), and *n*-butyl alcohol (~2 mL) were combined in a 10 mL CEM Microwave reaction vial fitted with magnetic stir bar and subjected to microwave irradiation at 150 °C for 30 min. The contents were then filtered and concentrated to dryness. Chromatography (3:1 hexanes/EtOAc) afforded the 1,2,4-triazole nitrile (72 mg, 0.230 mmol, 51%). Reduction with DIBAL then generated the corresponding aldehyde.

Example 22: Preparation of 4-[1-(3,4-dichlorophenyl)-5-oxo-4,5-dihydro-1H-[1,2,4]triazol-3-yl]-benzaldehyde.

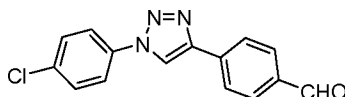


Step 1. 4-Cyanophenyl-oxo-acetic acid. A round bottom flask equipped with mechanical stirrer and reflux condenser was charged with *p*-cyanoacetophenone (5 g, 34.44 mmol), selenium dioxide (SeO_2 ; 9.55 g, 86.1 mmol), and pyridine (~100 mL). The mixture was stirred at reflux for 6 h before precipitates were removed by filtration and the filtrate was charged with 10% HCl (aq) (20 mL). The filtrate was extracted into EtOAc (3 x 50 mL) and the combined organic layers were further extracted into nearly saturated $NaHCO_3$. The aqueous layer was then carefully made acidic (pH = 1) with conc. HCl affording a small crop of the desired product. The remainder of the oxo acetic acid was obtained by extracting into EtOAc, drying ($MgSO_4$), and concentration (1.69 g, 28%).

Step 2. 4-[1-(3,4-Dichlorophenyl)-5-oxo-4,5-dihydro-1H-[1,2,4]triazol-3-yl]-benzonitrile. A suspension of 4-cyanophenyl-oxo-acetic acid (100 mg, 0.571 mmol), (3,4-

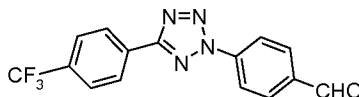
dichlorophenyl)hydrazine hydrochloride (122 mg, 0.571 mmol), 12.1 N HCl (5 μ L, 0.057 mmol), and H₂O (~10 mL) in a 25 mL reaction vial was stirred vigorously at ambient temperature for 24 h. The hydrazone was obtained by vacuum filtration and placed into a 100 mL round bottom flask with a magnetic stir bar. The flask was then supplemented with triethylamine (0.08 mL, 0.571 mmol), diphenylphosphoryl azide (157 mg, 0.571 mmol), and toluene (20 mL) before heating at 110 °C for 1 h. Upon cooling the contents were quenched with 10% NaOH (aq) and made acidic (pH 1) with conc. HCl. Precipitation was allowed for 15 min before the intermediate was obtained by vacuum filtration and dried overnight in a 45 °C vacuum oven (16 mg, 8%). The nitrile was reduced to the aldehyde using DIBAL under conditions previously described.

Example 23: Preparation of 4-[1-(4-Chlorophenyl)-1H-[1,2,3]triazol-4-yl]-benzaldehyde.



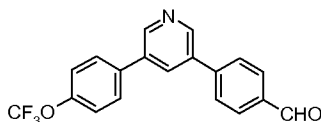
Following the procedure published by Feldman et al. (*Org Lett.* **2004**, 6, 3897), a suspension of 4-ethynylbenzonitrile (50 mg, 0.393 mmol), 1-chloro-4-iodobenzene (94 mg, 0.393 mmol), L-proline (9 mg, 0.079 mmol), ascorbic acid (7 mg, 0.039 mmol), NaN₃ (31 mg, 0.472 mmol), CuSO₄ (3 mg, 0.020 mmol), and Na₂SO₄ (11 mg, 0.079 mmol) in DMSO (1.5 mL) was heated at 65 °C for 24 h. Upon cooling the mixture was diluted with H₂O and stirred for 30 min at ambient temperature. The intermediate 4-[1-(4-chlorophenyl)-1H[1,2,3]triazol-4-yl]-benzonitrile (54 mg, 48%) was then obtained by vacuum filtration after washing with copious volumes of H₂O and 20% NH₄OH (~20 mL). Reduction to the aldehyde was then conducted under conditions previously described.

Example 24: Preparation of 4-[5-(4-trifluoromethyl-phenyl)-tetrazol-2-yl]-benzaldehyde.



This aldehyde was prepared from 4-trifluoromethylbenzaldehyde by following the route described in Roppe et al. *J. Med Chem.* **2004**, 47, 4645.

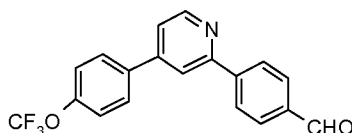
Example 25: Preparation of 4-[5-(4-trifluoromethoxyphenyl)-pyridin-3-yl]-benzaldehyde.



Step 1. 3,5-Dibromopyridine (4.4 mmol), 4-trifluoromethoxyphenyl boronic acid (5.1 mmol), tetrakis(triphenylphosphine)palladium(0) (0.04 mmol), 2 M potassium carbonate (8.44 mmol) and dioxane (21 mL) were combined in a vial and heated by microwave for 10 min at 150 °C. The reaction mixture was taken up in ether and washed with brine. The ether layer was dried over magnesium sulfate, was filtered and the solvent removed *in vacuo*. The crude mixture was purified by silica gel chromatography to yield 3-bromo-5-(4-trifluoromethoxyphenyl)-pyridine (130 mg) as a yellow solid: ^1H NMR (400 MHz, CDCl_3) δ 8.71 (m, 2H), 8.00 (t, $J = 2.1$ Hz, 1H), 7.58 (d, $J = 8.8$ Hz, 2H), 7.34 (d, $J = 8.0$ Hz, 2H); EIMS m/z 317 (M^+).

Step 2. The compound was prepared by palladium-catalyzed arylation of the product of step 1 with 4-formylphenyl boronic acid.

Example 26: Preparation of 4-[4-(4-trifluoromethoxyphenyl)-pyridin-2-yl]-benzaldehyde.

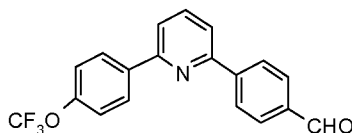


Step 1. The compound was prepared by palladium-catalyzed arylation of 2-chloro-4-iodopyridine with 4-trifluoromethoxyphenyl boronic acid.

Step 2. 2-Chloro-4-(4-trifluoromethoxyphenyl)-pyridine (0.55 mmol) starting from 2-chloro-4-iodopyridine, 4-formylphenyl boronic acid (0.82 mmol), tetrakis(triphenylphosphine)palladium(0) (0.005 mmol), 2 M potassium carbonate (0.55 mL) and dioxane (3 mL) were combined in a vial and irradiated by microwave for 15 min at 150 °C. The reaction mixture was taken up in EtOAc and washed with brine. The organic layer was dried over magnesium sulfate, was filtered and the solvent removed *in vacuo*.

Purification by silica gel chromatography (EtOAc/hexanes) yielded the product (120 mg) as an off-white solid: ^1H NMR (400 MHz, CDCl_3) δ 10.11 (s, 1H), 8.81 (d, $J = 4.8$ Hz, 1H), 8.24 (d, $J = 8.7$ Hz, 2H), 8.03 (d, $J = 8.4$ Hz, 2H), 7.96 (m, 1H), 7.73 (d, $J = 9.0$ Hz, 2H), 7.49 (dd, $J = 5.3, 1.8$ Hz, 1H), 7.37 (d, $J = 8.1$ Hz, 2H); EIMS m/z 343 (M^+).

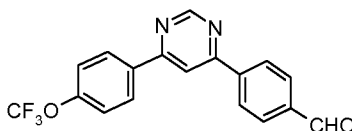
5 Example 27: Preparation of 4-[6-(4-trifluoromethoxyphenyl)-pyridin-2-yl]-benzaldehyde.



Step 1. 4-(6-Bromopyridin-2-yl)-benzaldehyde (0.31 mmol) was prepared as in Puglisi et al. *Eur. J. Org. Chem* **2003**, 8, 1552-1558.

10 Step 2. 4-[6-(4-Trifluoromethoxyphenyl)-pyridin-2-yl]-benzaldehyde. 4-(6-Bromo-pyridin-2-yl)-benzaldehyde (0.31 mmol), 4-trifluoromethoxyphenyl boronic acid (0.46 mmol), tetrakis(triphenylphosphine)palladium(0) (0.003 mmol), 2 M potassium carbonate (0.31 mL) and dioxane (2 mL) were combined in a vial and irradiated by microwave for 10 min at 150 °C. The reaction mixture was taken up in ether and washed with
15 brine. The organic layer was dried over magnesium sulfate, was filtered and the solvent removed *in vacuo*. Purification by silica gel chromatography (EtOAc/hexanes) yielded the product (80 mg) as an off-white solid: mp 109–112 °C; ^1H NMR (400 MHz, CDCl_3) δ 10.11 (s, 1H), 8.32 (d, $J = 8.5$ Hz, 2H), 8.19 (d, $J = 8.1$ Hz, 2H), 8.03 (d, $J = 8.4$ Hz, 2H), 7.89 (t, $J = 7.9$ Hz, 1H), 7.79 (d, $J = 7.7$ Hz, 1H), 7.74 (d, $J = 8.0$ Hz, 1H), 7.35 (d, $J = 8.3$ Hz, 2H);
20 EIMS m/z 343 (M^+).

Example 28: Preparation of 4-[6-(4-trifluoromethoxyphenyl)-pyrimidin-4-yl]-benzaldehyde.

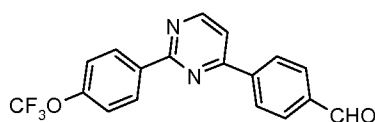


25 Step 1. 4-Chloro-6-(4-trifluoromethoxyphenyl)-pyrimidine was prepared by palladium-catalyzed arylation of 4,6-dichloropyrimidine and 4-trifluoromethoxyphenyl

boronic acid: ^1H NMR (400 MHz, CDCl_3) δ 9.05 (s, 1H), 8.14 (d, $J = 9.8$ Hz, 2H), 7.74 (m, 1H), 7.36 (d, $J = 8.4$ Hz, 2H); EIMS m/z 274 (M^+).

Step 2. The compound was prepared by palladium-catalyzed arylation of the product of step 1 with 4-formylphenyl boronic acid: ^1H NMR (400 MHz, CDCl_3) δ 10.15 (s, 1H), 9.38 (d, $J = 0.9$ Hz, 1H), 8.33 (d, $J = 8.4$ Hz, 2H), 8.23 (d, $J = 8.5$ Hz, 2H), 8.16 (d, $J = 0.8$ Hz, 1H), 8.08 (d, $J = 8.8$ Hz, 2H), 7.40 (d, $J = 8.1$ Hz, 2H); EIMS m/z 344 (M^+).

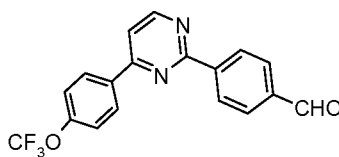
Example 29: Preparation of 4-[2-(4-trifluoromethoxyphenyl)-pyrimidin-4-yl]-benzaldehyde.



Step 1. 4-Chloro-2-(4-trifluoromethoxyphenyl)-pyrimidine. The title compound was prepared by palladium-catalyzed arylation of 2,4-dichloropyrimidine and 4-trifluoromethoxyphenyl boronic acid: mp 70–73 °C; ^1H NMR (400 MHz, CDCl_3) δ 8.68 (d, $J = 5.6$ Hz, 1H), 8.16 (d, $J = 9.1$ Hz, 2H), 7.65 (d, $J = 5.3$ Hz, 1H), 7.36 (dd, $J = 9.2, 0.9$ Hz, 2H); EIMS m/z 274 (M^+).

Step 2. The compound was prepared by palladium-catalyzed arylation of the product of step 1 with 4-formylphenyl boronic acid: ^1H NMR (400 MHz, CDCl_3) δ 10.13 (s, 1H), 8.91 (d, $J = 4.8$ Hz, 1H), 8.74 (d, $J = 8.5$ Hz, 2H), 8.28 (d, $J = 8.4$ Hz, 2H), 8.03 (d, $J = 8.4$ Hz, 2H), 7.65 (d, $J = 5.3$ Hz, 1H), 7.39 (d, $J = 8.6$ Hz, 2H); EIMS m/z 344 (M^+).

Example 30: Preparation of 4-[4-(4-trifluoromethoxyphenyl)-pyrimidin-2-yl]-benzaldehyde.

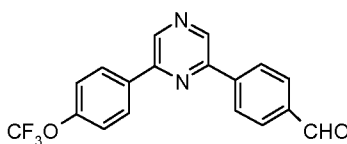


Step 1. 4-(4-Chloropyrimidin-2-yl)-benzaldehyde. The compound was prepared by palladium-catalyzed arylation of 2,4-dichloropyrimidine and 4-formylphenyl boronic acid: ^1H

NMR (400 MHz, CDCl_3) δ 10.13 (s, 1H), 8.74 (d, $J = 5.0$ Hz, 1H), 8.27 (d, $J = 7.8$ Hz, 2H), 8.04 (d, $J = 7.9$ Hz, 2H), 7.74 (m, 1H); EIMS m/z 218 (M^+).

Step 2. The compound was prepared by palladium-catalyzed arylation of the product of Step 1 with 4-trifluoromethoxyphenyl boronic acid: ^1H NMR (400 MHz, CDCl_3) δ 10.14 (s, 1H), 8.91 (d, $J = 4.2$ Hz, 1H), 8.63 (d, $J = 8.5$ Hz, 2H), 8.37 (d, $J = 8.4$ Hz, 2H), 8.06 (d, $J = 8.8$ Hz, 2H), 7.67 (d, $J = 5.4$ Hz, 1H), 7.35 (d, $J = 8.7$ Hz, 2H); EIMS m/z 344 (M^+).

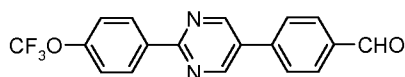
Example 31; Preparation of 4-[6-(4-trifluoromethoxyphenyl)-pyrazin-2-yl]-benzaldehyde.



Step 1. 2-Chloro-6-(4-trifluoromethoxyphenyl)-pyrazine. The compound was prepared by palladium-catalyzed arylation of 2,6-dichloropyrazine and 4-trifluoromethoxyphenyl boronic acid: mp 58–60 °C; ^1H NMR (400 MHz, CDCl_3) δ 8.94 (s, 1H), 8.57 (s, 1H), 8.10 (d, $J = 9.0$ Hz, 2H), 7.37 (d, $J = 8.4$ Hz, 2H); EIMS m/z 274 (M^+).

Step 2. The compound was prepared by palladium-catalyzed arylation of the product of step 1 with 4-formylphenyl boronic acid: ^1H NMR (400 MHz, CDCl_3) δ 10.13 (s, 1H), 9.07 (s, 1H), 9.03 (s, 1H), 8.33 (d, $J = 8.1$ Hz, 2H), 8.21 (d, $J = 8.7$ Hz, 2H), 8.07 (d, $J = 7.6$ Hz, 2H), 7.40 (d, $J = 8.3$ Hz, 2H); EIMS m/z 344 (M^+).

Example 32: Preparation of 4-[2-(4-trifluoromethoxyphenyl)-pyrimidin-5-yl]-benzaldehyde.

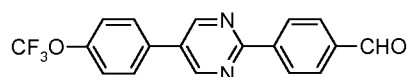


Step 1. 4-(2-Chloropyrimidin-5-yl)-benzaldehyde. The compound was prepared by palladium-catalyzed arylation of 2,5-dichloropyrimidine and 4-formylphenyl boronic acid.

Step 2. 4-(2-Chloropyrimidin-5-yl)-benzaldehyde (0.92 mmol), 4-trifluoromethoxyphenyl boronic acid (1.10 mmol), dichlorobis(triphenylphosphine)-palladium(II) (0.01 mmol), 2 M potassium carbonate (0.92 mL) and dioxane (5 mL) were

combined in a vial and irradiated by microwave for 10 min at 150 °C. The organic layer from the reaction mixture was loaded directly onto silica and dried *in vacuo*. Purification by silica gel chromatography (EtOAc/hexanes) yielded the product (140 mg) as a white solid: ¹H NMR (400 MHz, CDCl₃) δ 10.11 (s, 1H), 9.07 (s, 2H), 8.57 (d, *J* = 9.0 Hz, 2H), 8.07 (d, *J* = 8.5 Hz, 2H), 7.82 (d, *J* = 8.3 Hz, 2H), 7.35 (d, *J* = 8.3 Hz, 2H); EIMS *m/z* 344 (M⁺).

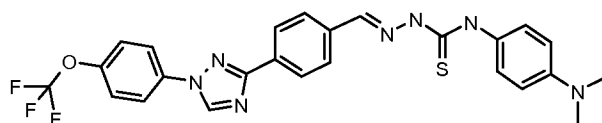
Example 33: Preparation of 4-[5-(4-trifluoromethoxyphenyl)-pyrimidin-2-yl]-benzaldehyde.



Step 1. 2-Chloro-5-(4-trifluoromethoxyphenyl)-pyrimidine. The compound was prepared by palladium-catalyzed arylation of 2,5-dichloropyrimidine with 4-trifluoromethoxyphenyl boronic acid.

Step 2. 2-Chloro-5-(4-trifluoromethoxyphenyl)-pyrimidine (4.22 mmol), 4-formylphenyl boronic acid (5.1 mmol), dichlorobis(triphenylphosphine)palladium(II) (0.05 mmol), 2 M potassium carbonate (4.2 mL) and dioxane (21 mL) were combined in a vial and irradiated by microwave for 20 min at 150 °C. The organic layer from the reaction mixture was loaded directly onto silica and dried *in vacuo*. Purification by silica gel chromatography (EtOAc/hexanes) yielded the product (75 mg) as a white solid: ¹H NMR (400 MHz, CDCl₃) δ 10.13 (s, 1H), 9.06 (s, 2H), 8.68 (d, *J* = 8.8 Hz, 2H), 8.03 (d, *J* = 8.3 Hz, 2H), 7.68 (d, *J* = 8.8 Hz, 2H), 7.40 (d, *J* = 8.7 Hz, 2H); EIMS *m/z* 344 (M⁺).

Example 34: Preparation of (E)-N-(4-dimethylamino)phenyl)-2-(4-(1-(4-(trifluoromethoxy)phenyl)-1H-1,2,4-triazol-3-yl)benzylidene)hydrazine-carbothioamide (Compound 1) [Synthesis Method A].

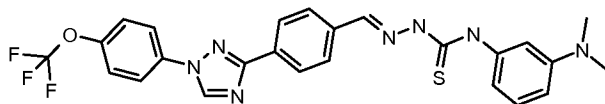


Step 1. (E)-3-(4-(Hydrazonomethyl)phenyl)-1-(4-(trifluoromethoxy)phenyl)-1H-1,2,4-triazole. To a 250 mL round-bottomed flask containing hydrazine hydrate (64% aq solution; 7.27 mL, 15.0 mmol) in EtOH (100 mL) at 80 °C was added 4-[1-(4-trifluoromethoxyphenyl)-1H-[1,2,4]triazol-3-yl]-benzaldehyde (5.00 g, 1.50 mmol)

portionwise over 5 min. The solution was stirred at reflux for an additional 3 h before being diluted with H₂O (300 mL) and cooled to 0 °C. The precipitated product was collected by vacuum filtration as a white solid (4.89 g, 93%) mp 222-226 °C; ¹H NMR (400 MHz, DMSO-*d*₆) δ 8.59 (s, 1H), 8.22 (d, *J* = 8.2 Hz, 2H), 7.84-7.79 (m, 2H), 7.66 (d, *J* = 8.3 Hz, 2H), 7.41 (d, *J* = 8.2 Hz, 2H), 7.29 (s, 1H), 5.63 (br s, 2H); ESIMS *m/z* 348 (M+H).

Step 2. To a 25 mL round-bottomed flask containing (*E*)-3-(4-(hydrazonomethyl)phenyl)-1-(4-(trifluoromethoxy)phenyl)-1*H*-1,2,4-triazole (250 mg, 0.720 mmol) in THF (10 mL) was added 4-isothiocyanato-*N,N*-dimethylaniline (385 mg, 2.16 mmol). The contents were heated at 65 °C with stirring for 2 h before the solvent was removed under reduced pressure. The residue was slurried in CH₂Cl₂ (10 mL) resulting in precipitation of product material. The desired product was obtained as a yellow solid via vacuum filtration (350 mg, 93%): mp 205-208 °C; ¹H NMR (400 MHz, DMSO-*d*₆) δ 11.78 (s, 1H), 10.02 (s, 1H), 9.42 (s, 1H), 8.19-7.99 (m, 6H), 7.64 (d, *J* = 8.3 Hz, 2H), 7.28 (d, *J* = 8.3 Hz, 2H), 7.73 (d, *J* = 8.3 Hz, 2H), 2.92 (s, 6H); ESIMS *m/z* 526 (M+H).

Example 35: Preparation of *N*-(3-(dimethylamino)phenyl)-2-(4-(1-(4-(trifluoromethoxy)phenyl)-1*H*-1,2,4-triazol-3-yl)benzylidene)hydrazinecarbothioamide (Compound 2) [Synthesis Method B].

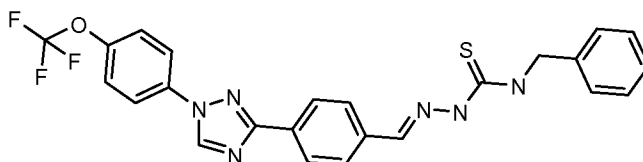


Step 1. (*E*)-Methyl 2-(4-(1-(4-(trifluoromethoxy)phenyl)-1*H*-1,2,4-triazol-3-yl)benzylidene)hydrazinecarbodithioate. To a 250 mL round-bottom flask containing hydrazinecarbodithioic acid methyl ester (2.38 g, 1.95 mmol) in EtOH (100 mL) was added 4-[1-(4-trifluoromethoxyphenyl)-1*H*-[1,2,4]triazol-3-yl]-benzaldehyde (5.00 g, 1.50 mmol). The vessel was heated at 80 °C for 3 h before being diluted with H₂O (300 mL) and cooled to 0 °C. The precipitated product was collected by vacuum filtration as an off-white solid (6.13 g, 93%) mp 204-206 °C; ¹H NMR (400 MHz, DMSO-*d*₆) δ 13.39 (s, 1H), 9.43 (s, 1H), 8.38 (s, 1H), 8.21 (d, *J* = 8.3 Hz, 2H), 8.09 (d, *J* = 8.4 Hz, 2H), 7.88 (d, *J* = 8.4 Hz, 2H), 7.62 (d, *J* = 8.3 Hz, 2H), 2.57 (s, 3H); ESIMS *m/z* 438 (M+H).

Step 2. To a 50 mL round-bottomed flask containing (*E*)-methyl 2-(4-(1-(4-(trifluoromethoxy)phenyl)-1*H*-1,2,4-triazol-3-yl)benzylidene)hydrazinecarbodithioate (250 mg, 0.571 mmol) in DMF (3 mL) was added *N*1,*N*1-dimethylbenzene-1,3-diamine (195 mg,

1.43 mmol). The contents were heated at 150 °C with stirring for 5 h before the solution was allowed to cool overnight. The mixture was filtered, and the filtrate purified via RP-HPLC to afford the desired material (235 mg, 78%) as an off-white solid: mp 192-194 °C; ¹H NMR (400 MHz, DMSO-*d*₆) δ 11.82 (s, 1H), 10.04 (s, 1H), 9.41 (s, 1H), 8.19 (s, 1H), 8.16-7.99 (m, 6H), 7.61 (d, *J* = 8.3 Hz, 2H), 7.16 (t, *J* = 7.2 Hz, 1H), 7.01 (m, 1H), 6.87 (m, 1H), 6.58 (m, 1H), 2.88 (s, 6H); ESIMS *m/z* 526 ([M+H]⁺).

Example 36: Preparation of *N*-benzyl-2-(4-(1-(4-(trifluoromethoxy)phenyl)-1*H*-1,2,4-triazol-3-yl)benzylidene)hydrazinecarbothioamide (Compound 3) [Synthesis Method C].



10 To a 50 mL round-bottomed flask containing 4-[1-[4-(trifluoromethoxy)phenyl]-1,2,4-triazol-3-yl]benzaldehyde (500 mg, 1.5 mmol) in EtOH (3 mL) was added 4-benzylthiosemicarbazide (650 mg, 3.6 mmol). The reaction mixture was heated at 80 °C overnight. H₂O was added upon completion of the reaction and the crude product material was isolated by vacuum filtration. The title compound was isolated via RP-HPLC as a white
15 solid (390 mg, 52% yield): mp 220-224 °C; ¹H NMR (400 MHz, CDCl₃) δ 9.29 (s, 1H), 8.59 (s, 1H), 8.21 (d, *J* = 8.4 Hz, 2H), 7.85-7.79 (m, 3H), 7.71 (d, *J* = 8.4 Hz, 2H), 7.46-7.30 (m, 8H), 5.01 (d, *J* = 5.8 Hz, 2H); ESIMS 497.2 (M+H).

Compounds **4-159** in Table 1 were synthesized in accordance with the examples
20 above.

The compounds were tested against beet armyworm and corn earworm using procedures described in the following examples and reported in Table 2.

In each case of Table 2, the rating scale is as follows:

% Control (or Mortality)	Rating
50-100	A
Less than 50	B
Not tested	C

Example 37: Insecticidal test for beet armyworm (*Spodoptera exigua*)

Bioassays on beet armyworm (BAW; *Spodoptera exigua*: Lepidoptera) were conducted using a 128-well diet tray assay. Three to five second instar BAW larvae were placed in each well (3 mL) of the diet tray that had been previously filled with 1 mL of artificial diet to which 50 $\mu\text{g}/\text{cm}^2$ of the test compound (dissolved in 50 μL of 90:10 acetone-water mixture) had been applied (to each of eight wells) and then allowed to dry. Trays were covered with a clear self-adhesive cover, and held at 25 °C, 14:10 light-dark for six days. Percent mortality was recorded for the larvae in each well; activity in the eight wells was then averaged. The results for both bioassays are indicated in Table 2.

Example 38: Insecticidal test for corn earworm (*Helicoverpa zea*)

Bioassays on corn earworm (CEW; *Helicoverpa zea*: Lepidoptera) were conducted using a 128-well diet tray assay. Three to five second instar CEW larvae were placed in each well (3 mL) of the diet tray that had been previously filled with 1 mL of artificial diet to which 50 $\mu\text{g}/\text{cm}^2$ of the test compound (dissolved in 50 μL of 90:10 acetone–water mixture) had been applied (to each of eight wells) and then allowed to dry. Trays were covered with a clear self-adhesive cover, and held at 25 °C, 14:10 light-dark for six days. Percent mortality was recorded for the larvae in each well; activity in the eight wells was then averaged. The results for both bioassays are indicated in Table 2.

The compounds were also tested against green peach aphid using a procedure described in the following example and reported in Table 2.

In each case of Table 2, the rating scale is as follows:

% Control (or Mortality)	Rating
80-100	A
Less than 80	B
Not tested	C

Example 39: Insecticidal test for green peach aphid (*Myzus persicae*) in foliar spray assay

Cabbage seedlings grown in 3-inch pots, with 2-3 small (3-5 cm) true leaves, were used as test substrate. The seedlings were infested with 20-50 green peach aphids (wingless adult and nymph) one day prior to chemical application. Four pots with individual seedlings were used for each treatment. Compounds (2 mg) were dissolved in 2 mL of acetone/methanol (1:1) solvent, forming stock solutions of 1000 ppm. The stock solutions were diluted 5X with 0.025% Tween 20 in H₂O to obtain the test solution at 200 ppm. A hand-held Devilbiss sprayer was used for spraying a solution to both sides of cabbage leaves until runoff. Reference plants (solvent check) were sprayed with the diluent only. Treated plants were held in a holding room for three days at approximately 25 °C and 40% relative humidity (RH) prior to grading. Evaluation was conducted by counting the number of live aphids per plant under a microscope. Insecticidal activity data, measured by using Abbott's correction formula, are presented in Table 2:

$$\text{Corrected \% Control} = 100 * (X - Y) / X$$

where X = No. of live aphids on solvent check plants

Y = No. of live aphids on treated plants

ACID AND SALT DERIVATIVES AND SOLVATES

The compounds disclosed in this invention can be in the form of pesticidally acceptable acid addition salts.

By way of non-limiting example, an amine function can form salts with hydrochloric, hydrobromic, sulfuric, phosphoric, acetic, benzoic, citric, malonic, salicylic, malic, fumaric,

oxalic, succinic, tartaric, lactic, gluconic, ascorbic, maleic, aspartic, benzenesulfonic, methanesulfonic, ethanesulfonic, hydroxymethanesulfonic, and hydroxyethanesulfonic acids.

Additionally, by way of non-limiting example, an acid function can form salts including those derived from alkali or alkaline earth metals and those derived from ammonia and amines. Examples of preferred cations include sodium, potassium, magnesium, and aminium cations.

The salts are prepared by contacting the free base form with a sufficient amount of the desired acid to produce a salt. The free base forms may be regenerated by treating the salt with a suitable dilute aqueous base solution such as dilute aqueous NaOH, potassium carbonate, ammonia, and sodium bicarbonate. As an example, in many cases, a pesticide is modified to a more water soluble form e.g. 2,4-dichlorophenoxy acetic acid dimethyl amine salt is a more water soluble form of 2,4-dichlorophenoxy acetic acid a well known herbicide.

The compounds disclosed in this invention can also form stable complexes with solvent molecules that remain intact after the non-complexed solvent molecules are removed from the compounds. These complexes are often referred to as "solvates."

STEREISOIMERS

Certain compounds disclosed in this document can exist as one or more stereoisomers. The various stereoisomers include geometric isomers, diastereomers, and enantiomers. Thus, the compounds disclosed in this invention include racemic mixtures, individual stereoisomers, and optically active mixtures. It will be appreciated by those skilled in the art that one stereoisomer may be more active than the others. Individual stereoisomers and optically active mixtures may be obtained by selective synthetic procedures, by conventional synthetic procedures using resolved starting materials, or by conventional resolution procedures.

PESTS

In another embodiment, the invention disclosed in this document can be used to control pests.

In another embodiment, the invention disclosed in this document can be used to control pests of the **Phylum Nematoda**.

In another embodiment, the invention disclosed in this document can be used to control pests of the **Phylum Arthropoda**.

In another embodiment, the invention disclosed in this document can be used to control pests of the **Subphylum Chelicerata**.

5 In another embodiment, the invention disclosed in this document can be used to control pests of the **Class Arachnida**.

In another embodiment, the invention disclosed in this document can be used to control pests of the **Subphylum Myriapoda**.

10 In another embodiment, the invention disclosed in this document can be used to control pests of the **Class Symphyla**.

In another embodiment, the invention disclosed in this document can be used to control pests of the **Subphylum Hexapoda**.

In another embodiment, the invention disclosed in this document can be used to control pests of the **Class Insecta**.

15 In another embodiment, the invention disclosed in this document can be used to control **Coleoptera (beetles)**. A non-exhaustive list of these pests includes, but is not limited to, *Acanthoscelides* spp. (weevils), *Acanthoscelides obtectus* (common bean weevil), *Agrilus planipennis* (emerald ash borer), *Agriotes* spp. (wireworms), *Anoplophora glabripennis* (Asian longhorned beetle), *Anthonomus* spp. (weevils), *Anthonomus grandis* (boll weevil),
 20 *Aphidius* spp., *Apion* spp. (weevils), *Apogonia* spp. (grubs), *Ataenius spretulus* (Black Turgrass Ataenius), *Atomaria linearis* (pygmy mangold beetle), *Aulacophore* spp., *Bothynoderes punctiventris* (beet root weevil), *Bruchus* spp. (weevils), *Bruchus pisorum* (pea weevil), *Cacoesia* spp., *Callosobruchus maculatus* (southern cow pea weevil), *Carpophilus hemipteras* (dried fruit beetle), *Cassida vittata*, *Cerosterna* spp., *Cerotoma* spp.
 25 (chrysomelids), *Cerotoma trifurcata* (bean leaf beetle), *Ceutorhynchus* spp. (weevils), *Ceutorhynchus assimilis* (cabbage seedpod weevil), *Ceutorhynchus napi* (cabbage curculio), *Chaetocnema* spp. (chrysomelids), *Colaspis* spp. (soil beetles), *Conoderus scalaris*, *Conoderus stigmatus*, *Conotrachelus nenuphar* (plum curculio), *Cotinus nitidis* (Green June beetle), *Crioceris asparagi* (asparagus beetle), *Cryptolestes ferrugineus* (rusty grain beetle),
 30 *Cryptolestes pusillus* (flat grain beetle), *Cryptolestes turcicus* (Turkish grain beetle), *Ctenicera* spp. (wireworms), *Curculio* spp. (weevils), *Cyclocephala* spp. (grubs),

Cylindropterus adspersus (sunflower stem weevil), *Deporaus marginatus* (mango leaf-cutting weevil), *Dermestes lardarius* (larder beetle), *Dermestes maculatus* (hide beetle), *Diabrotica* spp. (chrysomelids), *Epilachna varivestis* (Mexican bean beetle), *Faustinus cubae*, *Hylobius pales* (pales weevil), *Hypera* spp. (weevils), *Hypera postica* (alfalfa weevil),
 5 *Hyperdoes* spp. (Hyperodes weevil), *Hypothenemus hampei* (coffee berry beetle), *Ips* spp. (engravers), *Lasioderma serricorne* (cigarette beetle), *Leptinotarsa decemlineata* (Colorado potato beetle), *Liogenys fuscus*, *Liogenys suturalis*, *Lissorhoptrus oryzophilus* (rice water weevil), *Lyctus* spp. (wood beetles/powder post beetles), *Maecolaspis joliveti*, *Megascelis* spp., *Melanotus communis*, *Meligethes* spp., *Meligethes aeneus* (blossom beetle), *Melolontha*
 10 *melolontha* (common European cockchafer), *Oberea brevis*, *Oberea linearis*, *Oryctes rhinoceros* (date palm beetle), *Oryzaephilus mercator* (merchant grain beetle), *Oryzaephilus surinamensis* (sawtoothed grain beetle), *Otiorhynchus* spp. (weevils), *Oulema melanopus* (cereal leaf beetle), *Oulema oryzae*, *Pantomorus* spp. (weevils), *Phyllophaga* spp. (May/June beetle), *Phyllophaga cuyabana*, *Phyllotreta* spp. (chrysomelids), *Phynchites* spp., *Popillia*
 15 *japonica* (Japanese beetle), *Prostephanus truncatus* (larger grain borer), *Rhizopertha dominica* (lesser grain borer), *Rhizotrogus* spp. (European chafer), *Rhynchophorus* spp. (weevils), *Scolytus* spp. (wood beetles), *Shenophorus* spp. (Billbug), *Sitona lineatus* (pea leaf weevil), *Sitophilus* spp. (grain weevils), *Sitophilus granaries* (granary weevil), *Sitophilus oryzae* (rice weevil), *Stegobium paniceum* (drugstore beetle), *Tribolium* spp. (flour beetles),
 20 *Tribolium castaneum* (red flour beetle), *Tribolium confusum* (confused flour beetle), *Trogoderma variabile* (warehouse beetle), and *Zabrus tenebrioides*.

In another embodiment, the invention disclosed in this document can be used to control **Dermaptera (earwigs)**.

In another embodiment, the invention disclosed in this document can be used to
 25 control **Dictyoptera (cockroaches)**. A non-exhaustive list of these pests includes, but is not limited to, *Blattella germanica* (German cockroach), *Blatta orientalis* (oriental cockroach), *Parcoblatta pennsylvanica*, *Periplaneta americana* (American cockroach), *Periplaneta australoasiae* (Australian cockroach), *Periplaneta brunnea* (brown cockroach), *Periplaneta fuliginosa* (smokybrown cockroach), *Pycnoselus suninamensis* (Surinam cockroach), and
 30 *Supella longipalpa* (brownbanded cockroach).

In another embodiment, the invention disclosed in this document can be used to control **Diptera (true flies)**. A non-exhaustive list of these pests includes, but is not limited

to, *Aedes* spp. (mosquitoes), *Agromyza frontella* (alfalfa blotch leafminer), *Agromyza* spp. (leaf miner flies), *Anastrepha* spp. (fruit flies), *Anastrepha suspensa* (Caribbean fruit fly), *Anopheles* spp. (mosquitoes), *Bactrocera* spp. (fruit flies), *Bactrocera cucurbitae* (melon fly), *Bactrocera dorsalis* (oriental fruit fly), *Ceratitis* spp. (fruit flies), *Ceratitis capitata* (Mediterranean fruit fly), *Chrysops* spp. (deer flies), *Cochliomyia* spp. (screwworms),
 5 *Contarinia* spp. (gall midges), *Culex* spp. (mosquitoes), *Dasineura* spp. (gall midges), *Dasineura brassicae* (cabbage gall midge), *Delia* spp., *Delia platura* (seedcorn maggot), *Drosophila* spp. (vinegar flies), *Fannia* spp. (filth flies), *Fannia canicularis* (little house fly), *Fannia scalaris* (latrine fly), *Gasterophilus intestinalis* (horse bot fly), *Gracillia perseae*,
 10 *Haematobia irritans* (horn fly), *Hylemyia* spp. (root maggots), *Hypoderma lineatum* (common cattle grub), *Liriomyza* spp. (leafminer flies), *Liriomyza brassica* (serpentine leafminer), *Melophagus ovinus* (sheep ked), *Musca* spp. (muscid flies), *Musca autumnalis* (face fly), *Musca domestica* (house fly), *Oestrus ovis* (sheep bot fly), *Oscinella frit* (frit fly), *Pegomyia betae* (beet leafminer), *Phorbia* spp., *Psila rosae* (carrot rust fly), *Rhagoletis*
 15 *cerasi* (cherry fruit fly), *Rhagoletis pomonella* (apple maggot), *Sitodiplosis mosellana* (orange wheat blossom midge), *Stomoxys calcitrans* (stable fly), *Tabanus* spp. (horse flies), and *Tipula* spp. (crane flies).

In another embodiment, the invention disclosed in this document can be used to control **Hemiptera (true bugs)**. A non-exhaustive list of these pests includes, but is not
 20 limited to, *Acrosternum hilare* (green stink bug), *Blissus leucopterus* (chinch bug), *Calocoris norvegicus* (potato mirid), *Cimex hemipterus* (tropical bed bug), *Cimex lectularius* (bed bug), *Dagbertus fasciatus*, *Dichelops furcatus*, *Dysdercus suturellus* (cotton stainer), *Edessa mediatubunda*, *Eurygaster maura* (cereal bug), *Euschistus heros*, *Euschistus servus* (brown stink bug), *Helopeltis antonii*, *Helopeltis theivora* (tea blight plantbug), *Lagynotomus* spp.
 25 (stink bugs), *Leptocorisa oratorius*, *Leptocorisa varicornis*, *Lygus* spp. (plant bugs), *Lygus hesperus* (western tarnished plant bug), *Maconellicoccus hirsutus*, *Neurocolpus longirostris*, *Nezara viridula* (southern green stink bug), *Phytocoris* spp. (plant bugs), *Phytocoris californicus*, *Phytocoris relativus*, *Piezodorus guildingi*, *Poecilocapsus lineatus* (fourlined plant bug), *Psallus vaccinicola*, *Pseudacysta perseae*, *Scaptocoris castanea*, and *Triatoma*
 30 spp. (bloodsucking conenose bugs/kissing bugs).

In another embodiment, the invention disclosed in this document can be used to control **Homoptera (aphids, scales, whiteflies, leafhoppers)**. A non-exhaustive list of these

pests includes, but is not limited to, *Acrythosiphon pisum* (pea aphid), *Adelges* spp. (adelgids), *Aleurodes proletella* (cabbage whitefly), *Aleurodicus disperses*, *Aleurothrix floccosus* (woolly whitefly), *Aluacaspis* spp., *Amrasca bigutella bigutella*, *Aphrophora* spp. (leafhoppers), *Aonidiella aurantii* (California red scale), *Aphis* spp. (aphids), *Aphis gossypii* (cotton aphid), *Aphis pomi* (apple aphid), *Aulacorthum solani* (foxglove aphid), *Bemisia* spp. (whiteflies), *Bemisia argentifolii*, *Bemisia tabaci* (sweetpotato whitefly), *Brachycolus noxius* (Russian aphid), *Brachycorynella asparagi* (asparagus aphid), *Brevennia rehi*, *Brevicoryne brassicae* (cabbage aphid), *Ceroplastes* spp. (scales), *Ceroplastes rubens* (red wax scale), *Chionaspis* spp. (scales), *Chrysomphalus* spp. (scales), *Coccus* spp. (scales), *Dysaphis plantaginea* (rosy apple aphid), *Empoasca* spp. (leafhoppers), *Eriosoma lanigerum* (woolly apple aphid), *Icerya purchasi* (cottony cushion scale), *Idioscopus nitidulus* (mango leafhopper), *Laodelphax striatellus* (smaller brown planthopper), *Lepidosaphes* spp., *Macrosiphum* spp., *Macrosiphum euphorbiae* (potato aphid), *Macrosiphum granarium* (English grain aphid), *Macrosiphum rosae* (rose aphid), *Macrosteles quadrilineatus* (aster leafhopper), *Mahanarva frimbiolata*, *Metopolophium dirhodum* (rose grain aphid), *Mictis longicornis*, *Myzus persicae* (green peach aphid), *Nephotettix* spp. (leafhoppers), *Nephotettix cinctipes* (green leafhopper), *Nilaparvata lugens* (brown planthopper), *Parlatoria pergandii* (chaff scale), *Parlatoria ziziphi* (ebony scale), *Peregrinus maidis* (corn delphacid), *Philaenus* spp. (spittlebugs), *Phylloxera vitifoliae* (grape phylloxera), *Physokermes piceae* (spruce bud scale), *Planococcus* spp. (mealybugs), *Pseudococcus* spp. (mealybugs), *Pseudococcus brevipes* (pine apple mealybug), *Quadraspidotus perniciosus* (San Jose scale), *Rhapalosiphum* spp. (aphids), *Rhapalosiphum maida* (corn leaf aphid), *Rhapalosiphum padi* (oat bird-cherry aphid), *Saissetia* spp. (scales), *Saissetia oleae* (black scale), *Schizaphis graminum* (greenbug), *Sitobion avenae* (English grain aphid), *Sogatella furcifera* (white-backed planthopper), *Therioaphis* spp. (aphids), *Toumeyella* spp. (scales), *Toxoptera* spp. (aphids), *Trialeurodes* spp. (whiteflies), *Trialeurodes vaporariorum* (greenhouse whitefly), *Trialeurodes abutiloneus* (bandedwing whitefly), *Unaspis* spp. (scales), *Unaspis yanonensis* (arrowhead scale), and *Zulia entreriana*.

In another embodiment, the invention disclosed in this document can be used to control **Hymenoptera (ants, wasps, and bees)**. A non-exhaustive list of these pests includes, but is not limited to, *Acromyrmex* spp., *Athalia rosae*, *Atta* spp. (leafcutting ants), *Camponotus* spp. (carpenter ants), *Diprion* spp. (sawflies), *Formica* spp. (ants), *Iridomyrmex humilis* (Argentine ant), *Monomorium* spp., *Monomorium minimum* (little black ant),

Monomorium pharaonis (Pharaoh ant), *Neodiprion* spp. (sawflies), *Pogonomyrmex* spp. (harvester ants), *Polistes* spp. (paper wasps), *Solenopsis* spp. (fire ants), *Tapinoma sessile* (odorous house ant), *Tetranomorium* spp. (pavement ants), *Vespula* spp. (yellow jackets), and *Xylocopa* spp. (carpenter bees).

5 In another embodiment, the invention disclosed in this document can be used to control **Isoptera (termites)**. A non-exhaustive list of these pests includes, but is not limited to, *Coptotermes* spp., *Coptotermes curvignathus*, *Coptotermes frenchii*, *Coptotermes formosanus* (Formosan subterranean termite), *Cornitermes* spp. (nasute termites), *Cryptotermes* spp. (drywood termites), *Heterotermes* spp. (desert subterranean termites),
 10 *Heterotermes aureus*, *Kalotermes* spp. (drywood termites), *Incistitermes* spp. (drywood termites), *Macrotermes* spp. (fungus growing termites), *Marginitermes* spp. (drywood termites), *Microcerotermes* spp. (harvester termites), *Microtermes obesi*, *Procornitermes* spp., *Reticulitermes* spp. (subterranean termites), *Reticulitermes banyulensis*, *Reticulitermes grassei*, *Reticulitermes flavipes* (eastern subterranean termite), *Reticulitermes hageni*,
 15 *Reticulitermes hesperus* (western subterranean termite), *Reticulitermes santonensis*, *Reticulitermes speratus*, *Reticulitermes tibialis*, *Reticulitermes virginicus*, *Schedorhinotermes* spp., and *Zootermopsis* spp. (rotten-wood termites).

In another embodiment, the invention disclosed in this document can be used to control **Lepidoptera (moths and butterflies)**. A non-exhaustive list of these pests includes,
 20 but is not limited to, *Achoea janata*, *Adoxophyes* spp., *Adoxophyes orana*, *Agrotis* spp. (cutworms), *Agrotis ipsilon* (black cutworm), *Alabama argillacea* (cotton leafworm), *Amorbia cuneana*, *Amyelosis transitella* (navel orangeworm), *Anacamptodes defectaria*, *Anarsia lineatella* (peach twig borer), *Anomis sabulifera* (jute looper), *Anticarsia gemmatalis* (velvetbean caterpillar), *Archips argyrospila* (fruit tree leafroller), *Archips rosana* (rose leaf
 25 roller), *Argyrotaenia* spp. (tortricid moths), *Argyrotaenia citrana* (orange tortrix), *Autographa gamma*, *Bonagota cranaodes*, *Borbo cinnara* (rice leaf folder), *Bucculatrix thurberiella* (cotton leaf perforator), *Caloptilia* spp. (leaf miners), *Capua reticulana*, *Carposina niponensis* (peach fruit moth), *Chilo* spp., *Chlumetia transversa* (mango shoot borer), *Choristoneura rosaceana* (oblique banded leaf roller), *Chrysodeixis* spp.,
 30 *Cnaphalocerus medinalis* (grass leafroller), *Colias* spp., *Conpomorpha cramerella*, *Cossus cossus* (carpenter moth), *Crambus* spp. (Sod webworms), *Cydia funebrana* (plum fruit moth), *Cydia molesta* (oriental fruit moth), *Cydia nignicana* (pea moth), *Cydia pomonella* (codling

moth), *Darna diducta*, *Diaphania* spp. (stem borers), *Diatraea* spp. (stalk borers), *Diatraea saccharalis* (sugarcane borer), *Diatraea graniosella* (southwestern corn borer), *Earias* spp. (bollworms), *Earias insulata* (Egyptian bollworm), *Earias vitella* (rough northern bollworm), *Ecdyttopopha aurantianum*, *Elasmopalpus lignosellus* (lesser cornstalk borer), *Epiphysias*
5 *postruttana* (light brown apple moth), *Ephestia* spp. (flour moths), *Ephestia cautella* (almond moth), *Ephestia elutella* (tobacco moth), *Ephestia kuehniella* (Mediterranean flour moth), *Epimeces* spp., *Epinotia aporema*, *Erionota thrax* (banana skipper), *Eupoecilia ambiguella* (grape berry moth), *Euxoa auxiliaris* (army cutworm), *Feltia* spp. (cutworms), *Gortyna* spp. (stemborers), *Grapholita molesta* (oriental fruit moth), *Hedylepta indicata* (bean leaf
10 webber), *Helicoverpa* spp. (noctuid moths), *Helicoverpa armigera* (cotton bollworm), *Helicoverpa zea* (bollworm/corn earworm), *Heliothis* spp. (noctuid moths), *Heliothis virescens* (tobacco budworm), *Hellula undalis* (cabbage webworm), *Indarbela* spp. (root borers), *Keiferia lycopersicella* (tomato pinworm), *Leucinodes orbonalis* (eggplant fruit borer), *Leucoptera malifoliella*, *Lithocolletis* spp., *Lobesia botrana* (grape fruit moth),
15 *Loxagrotis* spp. (noctuid moths), *Loxagrotis albicosta* (western bean cutworm), *Lymantria dispar* (gypsy moth), *Lyonetia clerkella* (apple leaf miner), *Mahasena corbetti* (oil palm bagworm), *Malacosoma* spp. (tent caterpillars), *Mamestra brassicae* (cabbage armyworm), *Maruca testulalis* (bean pod borer), *Metisa plana* (bagworm), *Mythimna unipuncta* (true armyworm), *Neoleucinodes elegantalis* (small tomato borer), *Nymphula depunctalis* (rice
20 caseworm), *Operophtera brumata* (winter moth), *Ostrinia nubilalis* (European corn borer), *Oxydia vesulia*, *Pandemis cerasana* (common currant tortrix), *Pandemis heparana* (brown apple tortrix), *Papilio demodocus*, *Pectinophora gossypiella* (pink bollworm), *Peridroma* spp. (cutworms), *Peridroma saucia* (variegated cutworm), *Perileucoptera coffeella* (white coffee leafminer), *Phthorimaea operculella* (potato tuber moth), *Phyllocnistis citrella*,
25 *Phyllonorycter* spp. (leafminers), *Pieris rapae* (imported cabbageworm), *Plathypena scabra*, *Plodia interpunctella* (Indian meal moth), *Plutella xylostella* (diamondback moth), *Polychrosis viteana* (grape berry moth), *Prays endocarpa*, *Prays oleae* (olive moth), *Pseudaletia* spp. (noctuid moths), *Pseudaletia unipunctata* (armyworm), *Pseudoplusia includens* (soybean looper), *Rachiplusia nu*, *Scirpophaga incertulas*, *Sesamia* spp.
30 (stemborers), *Sesamia inferens* (pink rice stem borer), *Sesamia nonagrioides*, *Setora nitens*, *Sitotroga cerealella* (Angoumois grain moth), *Sparganothis pillariana*, *Spodoptera* spp. (armyworms), *Spodoptera exigua* (beet armyworm), *Spodoptera frugiperda* (fall armyworm), *Spodoptera oridania* (southern armyworm), *Synanthedon* spp. (root borers), *Thecla basilides*,

Thermisia gemmatalis, *Tineola bisselliella* (webbing clothes moth), *Trichoplusia ni* (cabbage looper), *Tuta absoluta*, *Yponomeuta spp.*, *Zeuzera coffeae* (red branch borer), and *Zeuzera pyrina* (leopard moth).

In another embodiment, the invention disclosed in this document can be used to control **Mallophaga (chewing lice)**. A non-exhaustive list of these pests includes, but is not limited to, *Bovicola ovis* (sheep biting louse), *Menacanthus stramineus* (chicken body louse), and *Menopon gallinea* (common hen louse).

In another embodiment, the invention disclosed in this document can be used to control **Orthoptera (grasshoppers, locusts, and crickets)**. A non-exhaustive list of these pests includes, but is not limited to, *Anabrus simplex* (Mormon cricket), *Gryllotalpidae* (mole crickets), *Locusta migratoria*, *Melanoplus spp.* (grasshoppers), *Microcentrum retinerve* (angular winged katydid), *Pterophylla spp.* (katydids), *chistocerca gregaria*, *Scudderia furcata* (fork tailed bush katydid), and *Valanga nigricorni*.

In another embodiment, the invention disclosed in this document can be used to control **Phthiraptera (sucking lice)**. A non-exhaustive list of these pests includes, but is not limited to, *Haematopinus spp.* (cattle and hog lice), *Linognathus ovillus* (sheep louse), *Pediculus humanus capitis* (human body louse), *Pediculus humanus humanus* (human body lice), and *Pthirus pubis* (crab louse),

In another embodiment, the invention disclosed in this document can be used to control **Siphonaptera (fleas)**. A non-exhaustive list of these pests includes, but is not limited to, *Ctenocephalides canis* (dog flea), *Ctenocephalides felis* (cat flea), and *Pulex irritans* (human flea).

In another embodiment, the invention disclosed in this document can be used to control **Thysanoptera (thrips)**. A non-exhaustive list of these pests includes, but is not limited to, *Frankliniella fusca* (tobacco thrips), *Frankliniella occidentalis* (western flower thrips), *Frankliniella shultzei* *Frankliniella williamsi* (corn thrips), *Heliothrips haemorrhaidalis* (greenhouse thrips), *Rhipiphorothrips cruentatus*, *Scirtothrips spp.*, *Scirtothrips citri* (citrus thrips), *Scirtothrips dorsalis* (yellow tea thrips), *Taeniothrips rhopalantennalis*, and *Thrips spp.*

In another embodiment, the invention disclosed in this document can be used to control **Thysanura (bristletails)**. A non-exhaustive list of these pests includes, but is not limited to, *Lepisma spp.* (silverfish) and *Thermobia spp.* (firebrats).

In another embodiment, the invention disclosed in this document can be used to control **Acarina (mites and ticks)**. A non-exhaustive list of these pests includes, but is not limited to, *Acarapsis woodi* (tracheal mite of honeybees), *Acarus spp.* (food mites), *Acarus siro* (grain mite), *Aceria mangiferae* (mango bud mite), *Aculops spp.*, *Aculops lycopersici* (tomato russet mite), *Aculops pelekasi*, *Aculus pelekassi*, *Aculus schlechtendali* (apple rust mite), *Amblyomma americanum* (lone star tick), *Boophilus spp.* (ticks), *Brevipalpus obovatus* (privet mite), *Brevipalpus phoenicis* (red and black flat mite), *Demodex spp.* (mange mites), *Dermacentor spp.* (hard ticks), *Dermacentor variabilis* (American dog tick), *Dermatophagoides pteronyssinus* (house dust mite), *Eotetranychus spp.*, *Eotetranychus carpini* (yellow spider mite), *Epitimerus spp.*, *Eriophyes spp.*, *Ixodes spp.* (ticks), *Metatetranychus spp.*, *Notoedres cati*, *Oligonychus spp.*, *Oligonychus coffee*, *Oligonychus ilicis* (southern red mite), *Panonychus spp.*, *Panonychus citri* (citrus red mite), *Panonychus ulmi* (European red mite), *Phyllocoptruta oleivora* (citrus rust mite), *Polyphagotarsonemus latus* (broad mite), *Rhipicephalus sanguineus* (brown dog tick), *Rhizoglyphus spp.* (bulb mites), *Sarcoptes scabiei* (itch mite), *Tegolophus perseafloreae*, *Tetranychus spp.*, *Tetranychus urticae* (two-spotted spider mite), and *Varroa destructor* (honey bee mite).

In another embodiment, the invention disclosed in this document can be used to control **Nematoda (nematodes)**. A non-exhaustive list of these pests includes, but is not limited to, *Aphelenchoides spp.* (bud and leaf & pine wood nematodes), *Belonolaimus spp.* (sting nematodes), *Criconebella spp.* (ring nematodes), *Dirofilaria immitis* (dog heartworm), *Ditylenchus spp.* (stem and bulb nematodes), *Heterodera spp.* (cyst nematodes), *Heterodera zae* (corn cyst nematode), *Hirschmanniella spp.* (root nematodes), *Hoplolaimus spp.* (lance nematodes), *Meloidogyne spp.* (root knot nematodes), *Meloidogyne incognita* (root knot nematode), *Onchocerca volvulus* (hook-tail worm), *Pratylenchus spp.* (lesion nematodes), *Radopholus spp.* (burrowing nematodes), and *Rotylenchus reniformis* (kidney-shaped nematode).

In another embodiment, the invention disclosed in this document can be used to control **Symphyla (symphylans)**. A non-exhaustive list of these pests includes, but is not limited to, *Scutigera immaculata*.

For more detailed information consult “**HANDBOOK OF PEST CONTROL – THE BEHAVIOR, LIFE HISTORY, AND CONTROL OF HOUSEHOLD PESTS**” by Arnold Mallis, 9th Edition, copyright 2004 by GIE Media Inc.

MIXTURES

5 The invention disclosed in this document can also be used with various insecticides, both for reasons of economy and synergy. Such insecticides include, but are not limited to, antibiotic insecticides, macrocyclic lactone insecticides (for example, avermectin insecticides, milbemycin insecticides, and spinosyn insecticides), arsenical insecticides, botanical insecticides, carbamate insecticides (for example, benzofuranyl methylcarbamate
10 insecticides, dimethylcarbamate insecticides, oxime carbamate insecticides, and phenyl methylcarbamate insecticides), diamide insecticides, desiccant insecticides, dinitrophenol insecticides, fluorine insecticides, formamidine insecticides, fumigant insecticides, inorganic insecticides, insect growth regulators (for example, chitin synthesis inhibitors, juvenile hormone mimics, juvenile hormones, moulting hormone agonists, moulting hormones,
15 moulting inhibitors, precocenes, and other unclassified insect growth regulators), nereistoxin analogue insecticides, nicotinoid insecticides (for example, nitroguanidine insecticides, nitromethylene insecticides, and pyridylmethylamine insecticides), organochlorine insecticides, organophosphorus insecticides, oxadiazine insecticides, oxadiazolone insecticides, phthalimide insecticides, pyrazole insecticides, pyrethroid insecticides,
20 pyrimidinamine insecticides, pyrrole insecticides, tetramic acid insecticides, tetrionic acid insecticides, thiazole insecticides, thiazolidine insecticides, thiourea insecticides, urea insecticides, as well as, other unclassified insecticides.

Some of the particular insecticides that can be employed beneficially in combination with the invention disclosed in this document include, but are not limited to, the following
25 1,2-dichloropropane, 1,3-dichloropropene, abamectin, acephate, acetamiprid, acethion, acetoprole, acrinathrin, acrylonitrile, alanycarb, aldicarb, aldoxycarb, aldrin, allethrin, allosamidin, allyxycarb, alpha-cypermethrin, alpha-endosulfan, amidithion, aminocarb, amiton, amitraz, anabasine, athidathion, azadirachtin, azamethiphos, azinphos-ethyl, azinphos-methyl, azothoate, barium hexafluorosilicate, barthrin, bendiocarb, benfuracarb,
30 bensultap, beta-cyfluthrin, beta-cypermethrin, bifenthrin, bioallethrin, bioethanomethrin, biopermethrin, bioresmethrin, bistrifluron, borax, boric acid, boric acid, bromfeninfos, bromocyclen, bromo-DDT, bromophos, bromophos-ethyl, bufencarb, buprofezin, butacarb,

butathiofos, butocarboxim, butonate, butoxycarboxim, cadusafos, calcium arsenate, calcium polysulfide, camphechlor, carbanolate, carbaryl, carbofuran, carbon disulfide, carbon tetrachloride, carbophenothion, carbosulfan, cartap, chlorantraniliprole, chlorbicyclen, chlordane, chlordecone, chlordimeform, chlorethoxyfos, chlorfenapyr, chlorfenvinphos,

5 chlorfluazuron, chlormephos, chloroform, chloropicrin, chlorphoxim, chlorprazophos, chlorpyrifos, chlorpyrifos-methyl, chlorthiophos, chromafenozide, cinerin I, cinerin II, cismethrin, cloethocarb, closantel, clothianidin, copper acetoarsenite, copper arsenate, copper naphthenate, copper oleate, coumaphos, coumithoate, crotamiton, crotoxyphos, crufomate, cryolite, cyanofenphos, cyanophos, cyanthoate, cyantraniliprole, cyclethrin, cycloprothrin,

10 cyfluthrin, cyhalothrin, cypermethrin, cyphenothrin, cyromazine, cythioate, DDT, decarbofuran, deltamethrin, demephion, demephion-O, demephion-S, demeton, demeton-methyl, demeton-O, demeton-O-methyl, demeton-S, demeton-S-methyl, demeton-S-methylsulphon, diafenthiuron, dialifos, diatomaceous earth, diazinon, dicapthon, dichlofenthion, dichlorvos, dicresyl, dicrotophos, dicyclanil, dieldrin, diflubenzuron, dilor,

15 dimefluthrin, dimefox, dimetan, dimethoate, dimethrin, dimethylvinphos, dimetilan, dinex, dinoprop, dinosam, dinotefuran, diofenolan, dioxabenzofos, dioxacarb, dioxathion, disulfoton, dithicrofos, *d*-limonene, DNOC, doramectin, ecdysterone, emamectin, EMPC, empenthrin, endosulfan, endothion, endrin, EPN, epofenonane, eprinomectin, esfenvalerate, etaphos, ethiofencarb, ethion, ethiprole, ethoate-methyl, ethoprophos, ethyl formate, ethyl-

20 DDD, ethylene dibromide, ethylene dichloride, ethylene oxide, etofenprox, etrimfos, EXD, famphur, fenamiphos, fenazaflor, fenchlorphos, fenethacarb, fenfluthrin, fenitrothion, fenobucarb, fenoxacrim, fenoxycarb, fensulfathion, fenthion, fenthion-ethyl, fenvalerate, fipronil, flonicamid, flubendiamide, flucofuron, flucycloxuron, flucythrinate, flufenerim, flufenoxuron, flufenprox, fluvalinate, fonofos, formetanate,

25 formothion, formparanate, fosmethilan, fospirate, fosthietan, furathiocarb, furethrin, gamma-cyhalothrin, gamma-HCH, halfenprox, halofenozide, HCH, HEOD, heptachlor, heptenophos, heterophos, hexaflumuron, HHDN, hydramethylnon, hydrogen cyanide, hydroprene, hyquincarb, imidacloprid, imiprothrin, indoxacarb, iodomethane, IPSP, isazofos, isobenzan, isocarbophos, isodrin, isofenphos, isoprocab, isoprothiolane, isothioate, isoxathion,

30 ivermectin, jasmolin I, jasmolin II, jodfenphos, juvenile hormone I, juvenile hormone II, juvenile hormone III, kelevan, kinoprene, lambda-cyhalothrin, lead arsenate, lepimectin, leptophos, lindane, lirimfos, lufenuron, lythidathion, malathion, malonoben, mazidox, mecarbam, mecarphon, menazon, mephosfolan, mercurous chloride, mesulfenfos,

metaflumizone, methacrifos, methamidophos, methidathion, methiocarb, methocrotophos, methomyl, methoprene, methoxychlor, methoxyfenozide, methyl bromide, methylchloroform, methylene chloride, metofluthrin, metolcarb, metoxadiazone, mevinphos, mexacarbate, milbemectin, milbemycin oxime, mipafox, mirex, monocrotophos, morphothion, moxidectin, naftalofos, naled, naphthalene, nicotine, nifluridide, nitenpyram, nithiazine, nitrilacarb, novaluron, noviflumuron, omethoate, oxamyl, oxydemeton-methyl, oxydeprofos, oxydisulfoton, para-dichlorobenzene, parathion, parathion-methyl, penfluron, pentachlorophenol, permethrin, phenkapton, phenothrin, phenthoate, phorate, phosalone, phosfolan, phosmet, phosnichlor, phosphamidon, phosphine, phoxim, phoxim-methyl, pirimetaphos, pirimicarb, pirimiphos-ethyl, pirimiphos-methyl, potassium arsenite, potassium thiocyanate, pp'-DDT, prallethrin, precocene I, precocene II, precocene III, primidophos, profenofos, profluthrin, promacyl, promecarb, propaphos, propetamphos, propoxur, prothidathion, prothiofos, prothoate, protrifenbute, pyraclofos, pyrafluprole, pyrazophos, pyresmethrin, pyrethrin I, pyrethrin II, pyridaben, pyridalyl, pyridaphenthion, pyrifluquinazon, pyrimidifen, pyrimitate, pyriprole, pyriproxifen, quassia, quinalphos, quinalphos-methyl, quinothion, rafoxanide, resmethrin, rotenone, ryania, sabadilla, schradan, selamectin, silafluofen, silica gel, sodium arsenite, sodium fluoride, sodium hexafluorosilicate, sodium thiocyanate, sophamide, spinetoram, spinosad, spiromesifen, spirotetramat, sulcofuron, sulfoxaflor, sulfluramid, sulfotep, sulfuryl fluoride, sulprofos, tau-fluvalinate, tazimcarb, TDE, tebufenozide, tebufenpyrad, tebupirimfos, teflubenzuron, tefluthrin, temephos, TEPP, terallethrin, terbufos, tetrachloroethane, tetrachlorvinphos, tetramethrin, theta-cypermethrin, thiacloprid, thiamethoxam, thicrofos, thiocarboxime, thiocyclam, thiodicarb, thiofanox, thiometon, thiosultap, thuringiensin, tolfenpyrad, tralomethrin, transfluthrin, transpermethrin, triarathene, triazamate, triazophos, trichlorfon, trichlormetaphos-3, trichloronat, trifenofos, triflumuron, trimethacarb, triprene, vamidothion, vaniliprole, XMC, xylylcarb, zeta-cypermethrin, zolaprofos, and α -ecdysone.

Additionally, any combination of the above insecticides can be used.

The invention disclosed in this document can also be used, for reasons of economy and synergy, with acaricides, algicides, antifeedants, avicides, bactericides, bird repellents, chemosterilants, fungicides, herbicide safeners, herbicides, insect attractants, insect repellents, mammal repellents, mating disrupters, molluscicides, plant activators, plant

growth regulators, rodenticides, synergists, defoliants, desiccants, disinfectants, semiochemicals, and virucides (these categories not necessarily mutually exclusive).

For more information consult “**COMPENDIUM OF PESTICIDE COMMON NAMES**” located at <http://www.alanwood.net/pesticides/index.html>. Also consult “**THE PESTICIDE**
5 **MANUAL**” 14th Edition, edited by C D S Tomlin, copyright 2006 by British Crop Production Council.

SYNERGISTIC MIXTURES

The invention disclosed in this document can be used with other compounds such as the ones mentioned under the heading “Mixtures” to form synergistic mixtures where the
10 mode of action of the compounds in the mixtures are the same, similar, or different.

Examples of mode of actions include, but are not limited to: acetylcholinesterase inhibitor; sodium channel modulator; chitin biosynthesis inhibitor; GABA-gated chloride channel antagonist; GABA- and glutamate-gated chloride channel agonist; acetylcholine receptor agonist; MET I inhibitor; Mg-stimulated ATPase inhibitor; nicotinic acetylcholine
15 receptor; Midgut membrane disrupter; oxidative phosphorylation disrupter, and ryanodine receptor (RyRs).

Additionally, the following compounds are known as synergists and can be used with the invention disclosed in this document: piperonyl butoxide, piprotal, propyl isome, sesamex, sesamolin, and sulfoxide.

FORMULATIONS

A pesticide is rarely suitable for application in its pure form. It is usually necessary to add other substances so that the pesticide can be used at the required concentration and in an appropriate form, permitting ease of application, handling, transportation, storage, and maximum pesticide activity. Thus, pesticides are formulated into, for example, baits,
25 concentrated emulsions, dusts, emulsifiable concentrates, fumigants, gels, granules, microencapsulations, seed treatments, suspension concentrates, suspoemulsions, tablets, water soluble liquids, water dispersible granules or dry flowables, wettable powders, and ultra low volume solutions.

For further information on formulation types see “**CATALOGUE OF PESTICIDE**
30 **FORMULATION TYPES AND INTERNATIONAL CODING SYSTEM**” Technical Monograph n°2, 5th Edition by CropLife International (2002).

Pesticides are applied most often as aqueous suspensions or emulsions prepared from concentrated formulations of such pesticides. Such water-soluble, water-suspendable, or emulsifiable formulations, are either solids, usually known as wettable powders, or water dispersible granules, or liquids usually known as emulsifiable concentrates, or aqueous suspensions. Wettable powders, which may be compacted to form water dispersible granules, comprise an intimate mixture of the pesticide, a carrier, and surfactants. The concentration of the pesticide is usually from about 10% to about 90% by weight. The carrier is usually chosen from among the attapulgite clays, the montmorillonite clays, the diatomaceous earths, or the purified silicates. Effective surfactants, comprising from about 0.5% to about 10% of the wettable powder, are found among sulfonated lignins, condensed naphthalenesulfonates, naphthalenesulfonates, alkylbenzenesulfonates, alkyl sulfates, and nonionic surfactants such as ethylene oxide adducts of alkyl phenols.

Emulsifiable concentrates of pesticides comprise a convenient concentration of a pesticide, such as from about 50 to about 500 grams per liter of liquid dissolved in a carrier that is either a water miscible solvent or a mixture of water-immiscible organic solvent and emulsifiers. Useful organic solvents include aromatics, especially xylenes and petroleum fractions, especially the high-boiling naphthalenic and olefinic portions of petroleum such as heavy aromatic naphtha. Other organic solvents may also be used, such as the terpenic solvents including rosin derivatives, aliphatic ketones such as cyclohexanone, and complex alcohols such as 2-ethoxyethanol. Suitable emulsifiers for emulsifiable concentrates are chosen from conventional anionic and nonionic surfactants.

Aqueous suspensions comprise suspensions of water-insoluble pesticides dispersed in an aqueous carrier at a concentration in the range from about 5% to about 50% by weight. Suspensions are prepared by finely grinding the pesticide and vigorously mixing it into a carrier comprised of water and surfactants. Ingredients, such as inorganic salts and synthetic or natural gums, may also be added, to increase the density and viscosity of the aqueous carrier. It is often most effective to grind and mix the pesticide at the same time by preparing the aqueous mixture and homogenizing it in an implement such as a sand mill, ball mill, or piston-type homogenizer.

Pesticides may also be applied as granular compositions that are particularly useful for applications to the soil. Granular compositions usually contain from about 0.5% to about 10% by weight of the pesticide, dispersed in a carrier that comprises clay or a similar

substance. Such compositions are usually prepared by dissolving the pesticide in a suitable solvent and applying it to a granular carrier which has been pre-formed to the appropriate particle size, in the range of from about 0.5 to about 3 mm. Such compositions may also be formulated by making a dough or paste of the carrier and compound and crushing and drying to obtain the desired granular particle size.

Dusts containing a pesticide are prepared by intimately mixing the pesticide in powdered form with a suitable dusty agricultural carrier, such as kaolin clay, ground volcanic rock, and the like. Dusts can suitably contain from about 1% to about 10% of the pesticide. They can be applied as a seed dressing or as a foliage application with a dust blower machine.

It is equally practical to apply a pesticide in the form of a solution in an appropriate organic solvent, usually petroleum oil, such as the spray oils, which are widely used in agricultural chemistry.

Pesticides can also be applied in the form of an aerosol composition. In such compositions the pesticide is dissolved or dispersed in a carrier, which is a pressure-generating propellant mixture. The aerosol composition is packaged in a container from which the mixture is dispensed through an atomizing valve.

Pesticide baits are formed when the pesticide is mixed with food or an attractant or both. When the pests eat the bait they also consume the pesticide. Baits may take the form of granules, gels, flowable powders, liquids, or solids. They are used in pest harborages.

Fumigants are pesticides that have a relatively high vapor pressure and hence can exist as a gas in sufficient concentrations to kill pests in soil or enclosed spaces. The toxicity of the fumigant is proportional to its concentration and the exposure time. They are characterized by a good capacity for diffusion and act by penetrating the pest's respiratory system or being absorbed through the pest's cuticle. Fumigants are applied to control stored product pests under gas proof sheets, in gas sealed rooms or buildings or in special chambers.

Pesticides can be microencapsulated by suspending the pesticide particles or droplets in plastic polymers of various types. By altering the chemistry of the polymer or by changing factors in the processing, microcapsules can be formed of various sizes, solubility, wall thicknesses, and degrees of penetrability. These factors govern the speed with which the

active ingredient within is released, which in turn, affects the residual performance, speed of action, and odor of the product.

Oil solution concentrates are made by dissolving pesticide in a solvent that will hold the pesticide in solution. Oil solutions of a pesticide usually provide faster knockdown and kill of pests than other formulations due to the solvents themselves having pesticidal action and the dissolution of the waxy covering of the integument increasing the speed of uptake of the pesticide. Other advantages of oil solutions include better storage stability, better penetration of crevices, and better adhesion to greasy surfaces.

Another embodiment is an oil-in-water emulsion, wherein the emulsion comprises oily globules which are each provided with a lamellar liquid crystal coating and are dispersed in an aqueous phase, wherein each oily globule comprises at least one compound which is agriculturally active, and is individually coated with a monolamellar or oligolamellar layer comprising: (1) at least one nonionic lipophilic surface-active agent, (2) at least one nonionic hydrophilic surface-active agent and (3) at least one ionic surface-active agent, wherein the globules having a mean particle diameter of less than 800 nanometers. Further information on the embodiment is disclosed in U.S. patent publication 20070027034 published February 1, 2007, having Patent Application serial number 11/495,228. For ease of use this embodiment will be referred to as "OIWE".

For further information consult "INSECT PEST MANAGEMENT" 2nd Edition by D. Dent, copyright CAB International (2000). Additionally, for more detailed information consult "HANDBOOK OF PEST CONTROL – THE BEHAVIOR, LIFE HISTORY, AND CONTROL OF HOUSEHOLD PESTS" by Arnold Mallis, 9th Edition, copyright 2004 by GIE Media Inc.

OTHER FORMULATION COMPONENTS

Generally, the invention disclosed in this document when used in a formulation, such formulation can also contain other components. These components include, but are not limited to, (this is a non-exhaustive and non-mutually exclusive list) wetters, spreaders, stickers, penetrants, buffers, sequestering agents, drift reduction agents, compatibility agents, anti-foam agents, cleaning agents, and emulsifiers. A few components are described forthwith.

A wetting agent is a substance that when added to a liquid increases the spreading or penetration power of the liquid by reducing the interfacial tension between the liquid and the

surface on which it is spreading. Wetting agents are used for two main functions in agrochemical formulations: during processing and manufacture to increase the rate of wetting of powders in water to make concentrates for soluble liquids or suspension concentrates; and during mixing of a product with water in a spray tank to reduce the wetting time of wettable
5 powders and to improve the penetration of water into water-dispersible granules. Examples of wetting agents used in wettable powder, suspension concentrate, and water-dispersible granule formulations are: sodium lauryl sulfate; sodium dioctyl sulfosuccinate; alkyl phenol ethoxylates; and aliphatic alcohol ethoxylates.

A dispersing agent is a substance which adsorbs onto the surface of a particles and
10 helps to preserve the state of dispersion of the particles and prevents them from reaggregating. Dispersing agents are added to agrochemical formulations to facilitate dispersion and suspension during manufacture, and to ensure the particles redisperse into water in a spray tank. They are widely used in wettable powders, suspension concentrates and water-dispersible granules. Surfactants that are used as dispersing agents have the ability to
15 adsorb strongly onto a particle surface and provide a charged or steric barrier to reaggregation of particles. The most commonly used surfactants are anionic, nonionic, or mixtures of the two types. For wettable powder formulations, the most common dispersing agents are sodium lignosulfonates. For suspension concentrates, very good adsorption and stabilization are obtained using polyelectrolytes, such as sodium naphthalene sulfonate
20 formaldehyde condensates. Tristyrylphenol ethoxylate phosphate esters are also used. Nonionics such as alkylarylethylene oxide condensates and EO-PO block copolymers are sometimes combined with anionics as dispersing agents for suspension concentrates. In recent years, new types of very high molecular weight polymeric surfactants have been developed as dispersing agents. These have very long hydrophobic 'backbones' and a large
25 number of ethylene oxide chains forming the 'teeth' of a 'comb' surfactant. These high molecular weight polymers can give very good long-term stability to suspension concentrates because the hydrophobic backbones have many anchoring points onto the particle surfaces. Examples of dispersing agents used in agrochemical formulations are: sodium lignosulfonates; sodium naphthalene sulfonate formaldehyde condensates; tristyrylphenol
30 ethoxylate phosphate esters; aliphatic alcohol ethoxylates; alky ethoxylates; EO-PO block copolymers; and graft copolymers.

An emulsifying agent is a substance which stabilizes a suspension of droplets of one liquid phase in another liquid phase. Without the emulsifying agent the two liquids would separate into two immiscible liquid phases. The most commonly used emulsifier blends contain alkylphenol or aliphatic alcohol with twelve or more ethylene oxide units and the oil-soluble calcium salt of dodecylbenzenesulfonic acid. A range of hydrophile-lipophile balance (“HLB”) values from 8 to 18 will normally provide good stable emulsions. Emulsion stability can sometimes be improved by the addition of a small amount of an EO-PO block copolymer surfactant.

A solubilizing agent is a surfactant which will form micelles in water at concentrations above the critical micelle concentration. The micelles are then able to dissolve or solubilize water-insoluble materials inside the hydrophobic part of the micelle. The type of surfactants usually used for solubilization are nonionics: sorbitan monooleates; sorbitan monooleate ethoxylates; and methyl oleate esters.

Surfactants are sometimes used, either alone or with other additives such as mineral or vegetable oils as adjuvants to spray-tank mixes to improve the biological performance of the pesticide on the target. The types of surfactants used for bioenhancement depend generally on the nature and mode of action of the pesticide. However, they are often nonionics such as: alkyl ethoxylates; linear aliphatic alcohol ethoxylates; aliphatic amine ethoxylates.

A carrier or diluent in an agricultural formulation is a material added to the pesticide to give a product of the required strength. Carriers are usually materials with high absorptive capacities, while diluents are usually materials with low absorptive capacities. Carriers and diluents are used in the formulation of dusts, wettable powders, granules and water-dispersible granules.

Organic solvents are used mainly in the formulation of emulsifiable concentrates, ULV (ultra low volume) formulations, and to a lesser extent granular formulations. Sometimes mixtures of solvents are used. The first main groups of solvents are aliphatic paraffinic oils such as kerosene or refined paraffins. The second main group and the most common comprises the aromatic solvents such as xylene and higher molecular weight fractions of C9 and C10 aromatic solvents. Chlorinated hydrocarbons are useful as cosolvents to prevent crystallization of pesticides when the formulation is emulsified into water. Alcohols are sometimes used as cosolvents to increase solvent power.

Thickeners or gelling agents are used mainly in the formulation of suspension concentrates, emulsions and suspoemulsions to modify the rheology or flow properties of the liquid and to prevent separation and settling of the dispersed particles or droplets. Thickening, gelling, and anti-settling agents generally fall into two categories, namely water-insoluble particulates and water-soluble polymers. It is possible to produce suspension concentrate formulations using clays and silicas. Examples of these types of materials, include, but are limited to, montmorillonite, e.g. bentonite; magnesium aluminum silicate; and attapulgite. Water-soluble polysaccharides have been used as thickening-gelling agents for many years. The types of polysaccharides most commonly used are natural extracts of seeds and seaweeds or are synthetic derivatives of cellulose. Examples of these types of materials include, but are not limited to, guar gum; locust bean gum; carrageenan; alginates; methyl cellulose; sodium carboxymethyl cellulose (SCMC); hydroxyethyl cellulose (HEC). Other types of anti-settling agents are based on modified starches, polyacrylates, polyvinyl alcohol and polyethylene oxide. Another good anti-settling agent is xanthan gum.

Microorganisms cause spoilage of formulated products. Therefore preservation agents are used to eliminate or reduce their effect. Examples of such agents include, but are not limited to: propionic acid and its sodium salt; sorbic acid and its sodium or potassium salts; benzoic acid and its sodium salt; *p*-hydroxybenzoic acid sodium salt; methyl *p*-hydroxybenzoate; and 1,2-benzisothiazalin-3-one (BIT).

The presence of surfactants, which lower interfacial tension, often causes water-based formulations to foam during mixing operations in production and in application through a spray tank. In order to reduce the tendency to foam, anti-foam agents are often added either during the production stage or before filling into bottles. Generally, there are two types of anti-foam agents, namely silicones and non-silicones. Silicones are usually aqueous emulsions of dimethyl polysiloxane while the non-silicone anti-foam agents are water-insoluble oils, such as octanol and nonanol, or silica. In both cases, the function of the anti-foam agent is to displace the surfactant from the air-water interface.

For further information, see “**CHEMISTRY AND TECHNOLOGY OF AGROCHEMICAL FORMULATIONS**” edited by D.A. Knowles, copyright 1998 by Kluwer Academic Publishers. Also see “**INSECTICIDES IN AGRICULTURE AND ENVIRONMENT – RETROSPECTS AND PROSPECTS**” by A.S. Perry, I. Yamamoto, I. Ishaaya, and R. Perry, copyright 1998 by Springer-Verlag.

APPLICATIONS

The actual amount of pesticide to be applied to loci of pests is generally not critical and can readily be determined by those skilled in the art. In general, concentrations from about 0.01 grams of pesticide per hectare to about 5000 grams of pesticide per hectare are expected to provide good control.

The locus to which a pesticide is applied can be any locus inhabited by an pest, for example, vegetable crops, fruit and nut trees, grape vines, ornamental plants, domesticated animals, the interior or exterior surfaces of buildings, and the soil around buildings. Controlling pests generally means that pest populations, activity, or both, are reduced in a locus. This can come about when: pest populations are repulsed from a locus; when pests are incapacitated in or around a locus; or pests are exterminated, in whole or in part, in or around a locus. Of course a combination of these results can occur. Generally, pest populations, activity, or both are desirably reduced more than fifty percent, preferably more than 90 percent.

Generally, with baits, the baits are placed in the ground where, for example, termites can come into contact with the bait. Baits can also be applied to a surface of a building, (horizontal, vertical, or slant surface) where, for example, ants, termites, cockroaches, and flies, can come into contact with the bait.

Because of the unique ability of the eggs of some pests to resist pesticides repeated applications may be desirable to control newly emerged larvae.

Systemic movement of pesticides in plants may be utilized to control pests on one portion of the plant by applying the pesticides to a different portion of the plant. For example, control of foliar-feeding insects can be controlled by drip irrigation or furrow application, or by treating the seed before planting. Seed treatment 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* or other insecticidal toxins, those expressing herbicide resistance, such as "Roundup Ready" seed, or those with "stacked" foreign genes expressing insecticidal toxins, herbicide resistance, nutrition-enhancement or any other beneficial traits. Furthermore, such seed treatments with the invention disclosed in this document can further enhance the ability of a plant to better withstand stressful growing conditions. This results in a healthier, more vigorous plant, which can lead to higher yields at harvest time.

It should be readily apparent that the invention can be used with plants genetically transformed to express specialized traits, such as *Bacillus thuringiensis* or other insecticidal toxins, or those expressing herbicide resistance, or those with “stacked” foreign genes expressing insecticidal toxins, herbicide resistance, nutrition-enhancement or any other beneficial traits.

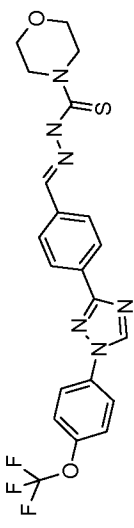
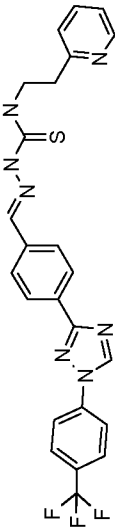
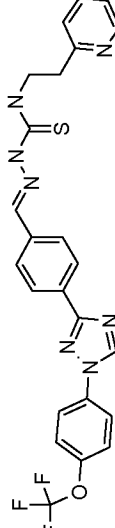
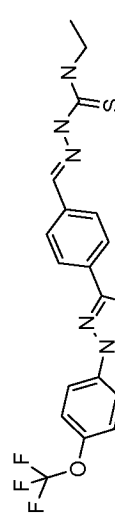
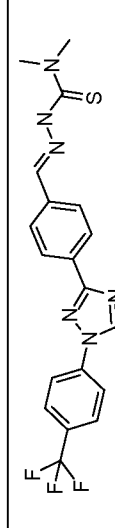
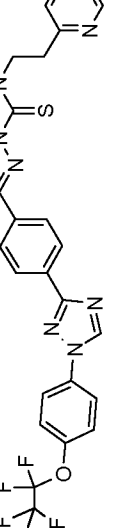
The invention disclosed in this document is suitable for controlling endoparasites and ectoparasites in the veterinary medicine sector or in the field of animal keeping. Compounds are applied in a known manner, such as by oral administration in the form of, for example, tablets, capsules, drinks, granules, by dermal application in the form of, for example, dipping, spraying, pouring on, spotting on, and dusting, and by parenteral administration in the form of, for example, an injection.

The invention disclosed in this document can also be employed advantageously in livestock keeping, for example, cattle, sheep, pigs, chickens, and geese. Suitable formulations are administered orally to the animals with the drinking water or feed. The dosages and formulations that are suitable depend on the species.

Before a pesticide can be used or sold commercially, such pesticide undergoes lengthy evaluation processes by various governmental authorities (local, regional, state, national, international). Voluminous data requirements are specified by regulatory authorities and must be addressed through data generation and submission by the product registrant or by another on the product registrant's behalf. These governmental authorities then review such data and if a determination of safety is concluded, provide the potential user or seller with product registration approval. Thereafter, in that locality where the product registration is granted and supported, such user or seller may use or sell such pesticide.

The headings in this document are for convenience only and must not be used to interpret any portion thereof.

Table 1

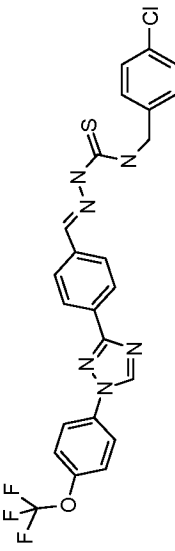
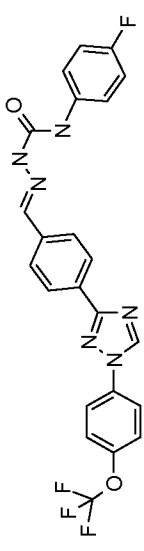
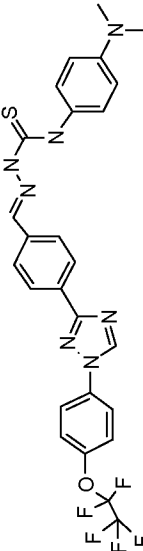
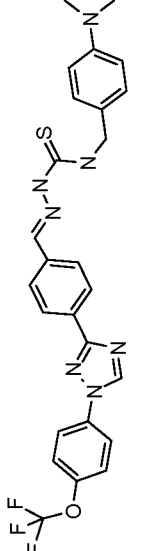
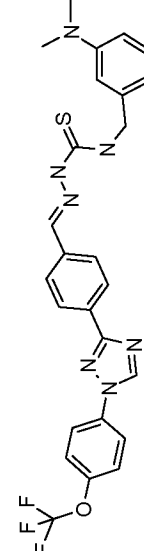
#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
4		C	461 (M+H)	107–114	10.50 (s, 1H), 9.42 (s, 1H), 8.16 (s, 1H), 8.14 (d, <i>J</i> = 8.1 Hz, 2H), 7.80 (d, <i>J</i> = 9.0 Hz, 2H), 7.76 (d, <i>J</i> = 8.4 Hz, 2H), 7.62 (d, <i>J</i> = 8.7 Hz, 2H), 3.60 (t, <i>J</i> = 4.5 Hz, 4H), 3.42 (t, <i>J</i> = 4.2 Hz, 4H)
5		C	496 (M+H)	207–220	11.64 (s, 1H), 9.57 (s, 1H), 8.88 (t, <i>J</i> = 5.6 Hz, 1H), 8.63–8.50 (m, 1H), 8.20 (m, 5H), 8.13 (s, 1H), 8.00 (d, <i>J</i> = 8.6 Hz, 2H), 7.94 (d, <i>J</i> = 8.4 Hz, 2H), 7.40–7.19 (m, 2H), 3.93 (dd, <i>J</i> = 13.2, 7.0 Hz, 2H), 3.11 (t, <i>J</i> = 7.3 Hz, 2H)
6		C	512 (M+H)	211–217	11.67 (s, 1H), 9.46 (s, 1H), 8.80 (br s, 2H), 8.41–8.38 (m, 1H), 8.15 (d, <i>J</i> = 8.0 Hz, 2H), 8.10 (d, <i>J</i> = 8.0 Hz, 2H), 7.93 (d, <i>J</i> = 8.0 Hz, 2H), 7.86–7.82 (m, 3H), 7.64 (d, <i>J</i> = 8.0 Hz, 2H), 4.07–4.02 (m, 2H), 3.36 (t, <i>J</i> = 8.0 Hz, 2H)
7		C	403 (M+H)	237–247	10.44 (s, 1H), 9.56 (s, 1H), 8.21 (d, <i>J</i> = 8.0 Hz, 2H), 8.14 (d, <i>J</i> = 8.0 Hz, 2H), 8.02 (d, <i>J</i> = 8.0 Hz, 2H), 7.89 (d, <i>J</i> = 8.0 Hz, 3H), 7.14 (t, <i>J</i> = 8.0 Hz, 1H), 3.25–3.16 (m, 2H), 1.10 (t, <i>J</i> = 8.0 Hz, 3H)
8		C	419 (M+H)		10.43 (s, 1H), 9.43 (s, 1H), 8.13–8.07 (m, 4H), 7.88 (d, <i>J</i> = 8.0 Hz, 3H), 7.63 (d, <i>J</i> = 12.0 Hz, 2H), 7.13 (t, <i>J</i> = 8.0 Hz, 1H), 3.20–3.16 (m, 2H), 1.10 (t, <i>J</i> = 8.0 Hz, 3H)
9		C	562 (M+H)	221–227	11.64 (br s, 1H), 9.46 (s, 1H), 8.88 (t, <i>J</i> = 4.0 Hz, 1H), 8.58 (d, <i>J</i> = 4.0 Hz, 1H), 8.17 (d, <i>J</i> = 8.0 Hz, 2H), 8.11 (d, <i>J</i> = 8.0 Hz, 3H), 7.93 (d, <i>J</i> = 8.0 Hz, 2H), 7.76 (td, <i>J</i> = 8.0, 1.7 Hz, 1H), 7.64 (d, <i>J</i> = 8.0 Hz, 2H), 7.34 (d, <i>J</i> = 8.0 Hz, 1H), 7.28 (dd, <i>J</i> = 8.0, 4.0 Hz, 1H), 3.92 (q, <i>J</i> = 8.0 Hz, 2H), 3.10 (t, <i>J</i> = 8.0 Hz, 2H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO-d ₆ , δ) ¹
10		C	501 (M+H)	194-196	(CDCl ₃) 9.65 (s, 1H), 9.12 (s, 1H), 8.60 (s, 1H), 8.27 (d, J = 8.4 Hz, 2H), 7.90 (s, 1H), 7.81 (m, 4H), 7.62 (m, 2H), 7.41 (d, J = 8.3 Hz, 2H), 7.15-7.09 (m, 2H)
11		C	435 (M+H)	151 dec	(CDCl ₃) 8.83 (s, 1H), 8.59 (s, 1H), 8.22 (d, J = 8.4 Hz, 2H), 7.81 (d, J = 9.0 Hz, 2H), 7.74-7.68 (m, 3H), 7.40 (d, J = 8.5 Hz, 2H), 3.48 (s, 6H)
12		C	447 (M+H)	220-225	(CDCl ₃) 9.17 (s, 1H), 8.60 (s, 1H), 8.25 (d, J = 8.4 Hz, 2H), 7.84-7.79 (m, 3H), 7.76 (d, J = 8.4 Hz, 2H), 7.56 (s, 1H), 7.41 (d, J = 8.4 Hz, 2H), 6.08-5.96 (m, 1H), 5.30 (m, J = 13.7, 11.6, 1.3 Hz, 2H), 4.43 (m, 2H)
13		C	421 (M+H)	239-241	(CDCl ₃) 9.20 (s, 1H), 8.60 (s, 1H), 8.24 (d, J = 8.4 Hz, 2H), 7.79 (m, 5H), 7.52 (s, 1H), 7.41 (d, J = 8.5 Hz, 2H), 3.30 (s, J = 4.8 Hz, 3H)
14		C	483 (M+H)	215-220	(CDCl ₃) 9.47 (s, 1H), 9.23 (s, 1H), 8.60 (s, 1H), 8.27 (d, J = 8.4 Hz, 2H), 7.91 (s, 1H), 7.81 (m, 4H), 7.70 (d, J = 7.6 Hz, 2H), 7.43 (m, 4H), 7.29 (d, J = 7.4 Hz, 1H)
15		C	404 (M+H)		10.72 (s, 1H), 8.77 (s, 1H), 8.19 (d, J = 8.2 Hz, 2H), 7.94 (s, 1H), 7.86 (d, J = 8.3 Hz, 2H), 7.78-7.64 (m, 4H), 7.58 (m, 1H), 3.21 (d, J = 4.9 Hz, 3H)
16		B	520 (M+H)	207-209	11.62 (s, 1H), 9.40 (s, 1H), 8.55 (br s, 1H), 8.19-8.06 (m, 5H), 7.92 (d, J = 8.2 Hz, 2H), 7.62 (d, J = 8.2 Hz, 2H), 3.78-3.58 (m, 6H), 2.58-2.42 (m, 6H)

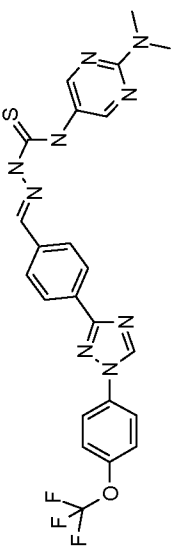
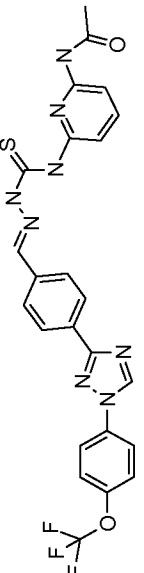
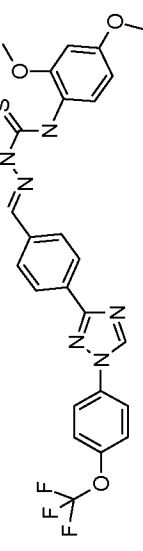
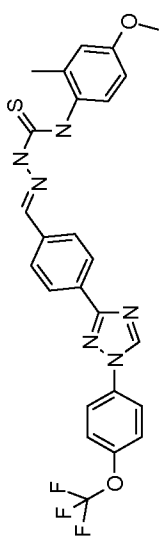
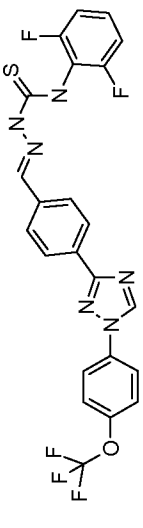
#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO-d ₆ , δ) ¹
17		B	528 (M+H)	178–185	11.63 (s, 1H), 9.41 (s, 1H), 8.78 (br s, 1H), 8.18–8.02 (m, 6H), 7.94 (d, <i>J</i> = 8.3 Hz, 2H), 7.68–7.58 (m, 3H), 6.99 (m, 1H), 6.82 (m, 1H), 4.44 (t, <i>J</i> = 7.2 Hz, 2H), 3.98 (t, <i>J</i> = 7.1 Hz, 2H)
18		B	464 (M+H)	200–203	9.82 (s, 1H), 8.61 (s, 1H), 8.21 (d, <i>J</i> = 8.3 Hz, 2H), 7.89 (s, 1H), 7.82–7.78 (m, 3H), 7.74 (d, <i>J</i> = 8.3 Hz, 2H), 7.39 (d, <i>J</i> = 8.2 Hz, 2H), 3.97 (t, <i>J</i> = 7.2 Hz, 2H), 3.66 (t, <i>J</i> = 7.1 Hz, 2H), 3.42 (s, 3H)
19		B	492 (M+H)	212–215	11.57 (s, 1H), 9.42 (s, 1H), 8.88 (br s, 1H), 8.18–8.06 (m, 5H), 7.89 (d, <i>J</i> = 8.3 Hz, 2H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 3.64–3.57 (m, 2H), 2.38 (t, <i>J</i> = 7.3 Hz, 2H), 2.19 (s, 6H), 1.76 (t, <i>J</i> = 7.1 Hz, 2H)
20		B	515 (M+H)	211–215	11.59 (s, 1H), 9.40 (s, 1H), 8.42 (br s, 1H), 8.17–8.02 (m, 5H), 7.91 (d, <i>J</i> = 8.2 Hz, 2H), 7.62 (d, <i>J</i> = 8.2 Hz, 2H), 5.50 (br s, 1H), 3.68–3.59 (m, 2H), 2.22 (t, <i>J</i> = 7.2 Hz, 2H), 2.02–1.87 (m, 4H), 1.62–1.48 (m, 4H)
21		A	483 (M+H)	206–210	12.04 (s, 1H), 10.32 (s, 1H), 9.42 (s, 1H), 8.68 (m, 1H), 8.41 (m, 1H), 8.24–7.97 (m, 8H), 7.62 (d, <i>J</i> = 8.3 Hz, 2H), 7.42 (m, 1H)
22		A	515 (M+H)	209–211	11.78 (s, 1H), 9.41 (s, 1H), 9.18 (br s, 1H), 8.18–8.02 (m, 5H), 7.98 (d, <i>J</i> = 8.3 Hz, 2H), 7.62 (d, <i>J</i> = 8.3 Hz, 2H), 7.38–7.22 (m, 2H), 7.20–7.17 (m, 2H), 4.89 (br s, 2H)

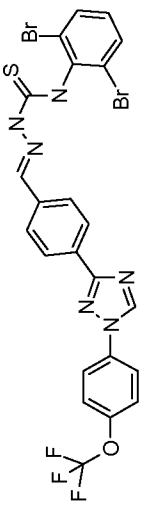
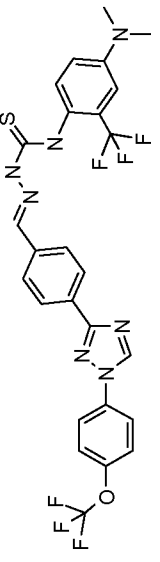
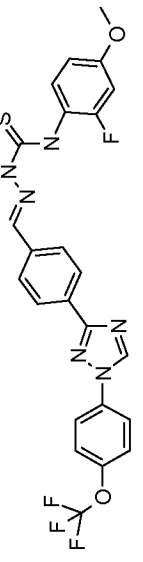
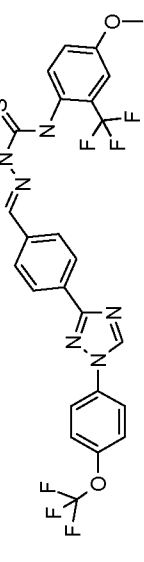
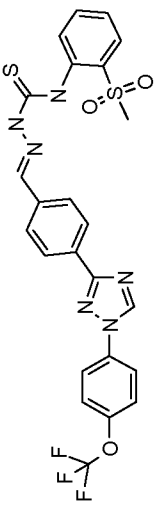
#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
23		A	446	220-222	11.60 (s, 1H), 9.44 (s, 1H), 8.39 (br s, 1H), 8.18-8.02 (m, 5H), 7.96 (d, <i>J</i> = 8.2 Hz, 2H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 3.08 (m, 1H), 0.78 (m, 4H)
24		A	477 (M+H)	221-224	11.43 (s, 1H), 9.39 (s, 1H), 8.58 (br s, 1H), 8.14-7.99 (m, 5H), 7.95 (d, <i>J</i> = 8.4 Hz, 2H), 7.62 (d, <i>J</i> = 8.2 Hz, 2H), 3.59-3.49 (m, 2H), 1.68-1.55 (m, 2H), 1.39-1.22 (m, 4H), 0.98 (t, <i>J</i> = 7.2 Hz, 3H)
25		A	489 (M+H)	208-210	11.48 (s, 1H), 9.42 (s, 1H), 8.18-8.04 (m, 5H), 7.92 (d, <i>J</i> = 8.2 Hz, 2H), 7.61 (d, <i>J</i> = 8.3 Hz, 2H), 4.24-4.18 (m, 1H), 1.91-1.87 (m, 2H), 1.84-1.76 (m, 2H), 1.74-1.62 (m, 2H), 1.60-1.44 (m, 2H), 1.43-1.18 (m, 2H)
26		A	566	204-206	11.99 (s, 1H), 10.24 (s, 1H), 9.41 (s, 1H), 8.22 (s, 1H), 8.18-8.00 (m, 6H), 7.67 (d, <i>J</i> = 8.2 Hz, 2H), 7.58 (d, <i>J</i> = 8.3 Hz, 2H), 7.37 (d, <i>J</i> = 8.2 Hz, 2H)
27		A	486	213-217	11.71 (s, 1H), 9.44 (s, 1H), 9.06 (br s, 1H), 8.18-8.03 (m, 5H), 7.97 (d, <i>J</i> = 8.2 Hz, 2H), 7.64-7.58 (m, 3H), 6.41 (m, 1H), 6.28 (m, 1H), 4.83 (d, <i>J</i> = 6.0 Hz, 2H)
28		A	513 (M+H)	208-210	11.82 (s, 1H), 10.06 (s, 1H), 9.42 (s, 1H), 8.20 (s, 1H), 8.18-8.01 (m, 6H), 7.62 (d, <i>J</i> = 8.2 Hz, 2H), 7.39 (d, <i>J</i> = 8.2 Hz, 2H), 6.94 (d, <i>J</i> = 8.2 Hz, 2H), 3.78 (s, 3H)

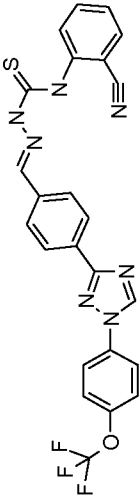
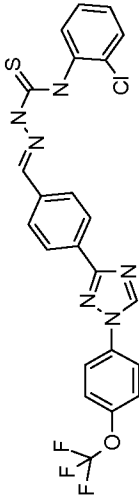
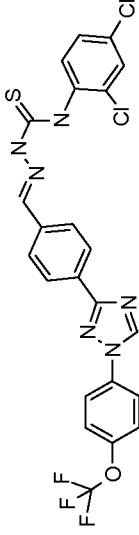
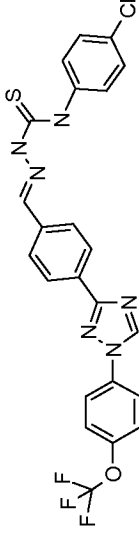
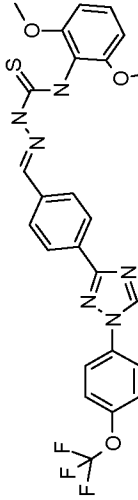
#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
29		A	551	209–211	12.06 (s, 1H), 10.19 (s, 1H), 9.42 (s, 1H), 8.22 (s, 1H), 8.17–8.03 (m, 5H), 7.66–7.57 (m, 4H), 7.42–7.38 (m, 2H)
30		A	492	233–235	11.82 (s, 1H), 9.42 (s, 1H), 8.89 (br s, 1H), 8.17–8.05 (m, 5H), 7.96 (d, <i>J</i> = 8.3 Hz, 2H), 7.64 (d, <i>J</i> = 8.3 Hz, 2H), 4.34 (d, <i>J</i> = 6.2 Hz, 2H), 4.17 (q, <i>J</i> = 7.3 Hz, 2H), 1.22 (t, <i>J</i> = 7.1 Hz, 3H)
31		A	555	154–157	12.78 (s, 1H), 11.32 (s, 1H), 9.39 (s, 1H), 8.38–8.02 (m, 9H), 7.61–7.54 (m, 4H)
32		A	550	228–230	12.12 (s, 1H), 10.38 (s, 1H), 9.44 (s, 1H), 8.26 (s, 1H), 8.18 (d, <i>J</i> = 8.3 Hz, 2H), 8.14–8.03 (m, 4H), 7.92 (d, <i>J</i> = 8.2 Hz, 2H), 7.61 (d, <i>J</i> = 8.3 Hz, 2H), 7.64 (d, <i>J</i> = 8.2 Hz, 2H)
33		A	525 (M+H)	233–236	12.12 (s, 1H), 10.38 (s, 1H), 9.43 (s, 1H), 8.24 (s, 1H), 8.12 (d, <i>J</i> = 8.2 Hz, 2H), 8.10–8.02 (m, 4H), 7.96 (d, <i>J</i> = 8.3 Hz, 2H), 7.82 (d, <i>J</i> = 8.3 Hz, 2H), 7.61 (d, <i>J</i> = 8.2 Hz, 2H), 2.58 (s, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
34		A	531 (M+H)	230–232	11.72 (s, 1H), 9.41 (s, 1H), 9.18 (br s, 1H), 8.16–8.02 (m, 5H), 7.97 (d, <i>J</i> = 8.3 Hz, 2H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 7.38 (m, 4H), 4.84 (d, <i>J</i> = 6.2 Hz, 2H)
35		A	484 (M+H)	221–224	10.82 (s, 1H), 9.43 (s, 1H), 9.04 (s, 1H), 8.18–7.97 (m, 7H), 7.69–7.58 (m, 4H), 7.18–7.06 (m, 2H)
36		A	576 (M+H)	200–203	11.78 (s, 1H), 9.98 (s, 1H), 9.42 (s, 1H), 8.19–8.02 (m, 7H), 7.64 (d, <i>J</i> = 8.2 Hz, 2H), 7.28 (d, <i>J</i> = 8.2 Hz, 2H), 6.73 (d, <i>J</i> = 8.2 Hz, 2H), 2.91 (s, 6H)
37		B	540 (M+H)	193–196	11.61 (s, 1H), 9.42 (s, 1H), 9.00 (br s, 1H), 8.17–8.04 (m, 5H), 7.94 (d, <i>J</i> = 8.3 Hz, 2H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 7.22 (d, <i>J</i> = 8.3 Hz, 2H), 6.65 (d, <i>J</i> = 8.2 Hz, 2H), 4.74 (d, <i>J</i> = 6.0 Hz, 2H), 2.86 (s, 6H)
38		B	540 (M+H)	181–183	11.64 (s, 1H), 9.41 (s, 1H), 9.08 (br s, 1H), 8.18–8.02 (m, 4H), 7.97 (d, <i>J</i> = 8.3 Hz, 2H), 7.62 (d, <i>J</i> = 8.3 Hz, 2H), 7.16 (m, 2H), 6.78 (br s, 1H), 6.64–6.55 (m, 2H), 4.79 (d, <i>J</i> = 6.0 Hz, 2H), 2.84 (s, 6H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
39		B	540 (M+H)	165–167	11.74 (s, 1H), 9.41 (s, 1H), 9.18 (br s, 1H), 8.17–8.04 (m, 4H), 7.93 (d, <i>J</i> = 8.2 Hz, 2H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 7.24–7.18 (m, 4H), 7.03 (m, 1H), 4.92 (d, <i>J</i> = 6.2 Hz, 2H), 2.68 (s, 6H)
40		B	554 (M+H)	153 dec	10.18 (s, 1H), 9.33 (s, 1H), 8.62 (s, 1H), 8.26 (d, <i>J</i> = 8.2 Hz, 2H), 8.02 (s, 1H), 7.84–7.77 (m, 6H), 7.41 (d, <i>J</i> = 8.2 Hz, 2H), 7.26 (d, <i>J</i> = 8.3 Hz, 2H), 3.31 (s, 3H), 1.97 (s, 3H)
41		B	540 (M+H)	205 dec	11.84 (s, 1H), 10.18 (s, 1H), 9.98 (s, 1H), 9.42 (s, 1H), 8.19 (s, 1H), 8.17–8.03 (m, 6H), 7.66–7.57 (m, 4H), 7.41 (d, <i>J</i> = 8.2 Hz, 2H), 2.04 (s, 3H)
42		B	512 (M+H)	196–199	11.68 (s, 1H), 9.97 (s, 1H), 9.40 (s, 1H), 8.19–7.99 (m, 7H), 7.62 (d, <i>J</i> = 8.3 Hz, 2H), 7.17 (d, <i>J</i> = 8.3 Hz, 2H), 6.48 (d, <i>J</i> = 8.3 Hz, 2H), 5.63 (m, 1H), 2.64 (d, <i>J</i> = 4.9 Hz, 3H)

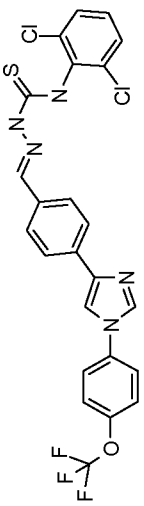
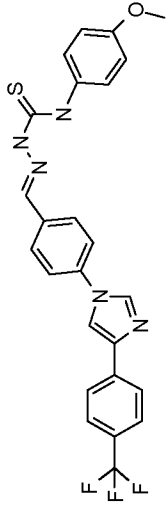
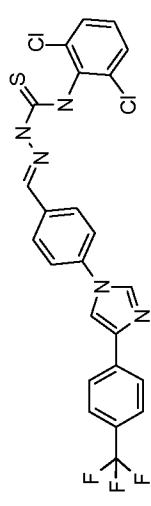
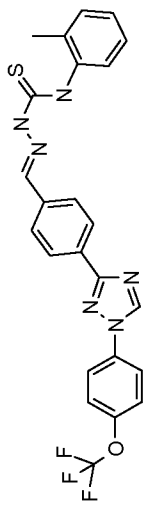
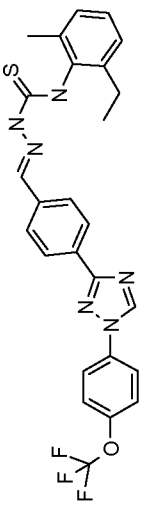
#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
43		B	528 (M+H)	219–222	12.02 (s, 1H), 10.03 (s, 1H), 9.42 (s, 1H), 8.38 (s, 2H), 8.22–8.01 (m, 7H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 3.17 (s, 6H)
44		B	541 (M+H)	206–209	12.22 (s, 1H), 10.46 (s, 1H), 9.98 (s, 1H), 9.42 (s, 1H), 8.84 (br s, 1H), 8.31–8.18 (m, 3H), 8.12–8.04 (d, <i>J</i> = 8.2 Hz, 2H), 7.98–7.63 (m, 4H), 7.61 (d, <i>J</i> = 8.2 Hz, 2H), 2.06 (s, 3H)
45		B	543 (M+H)	193–196	11.82 (s, 1H), 9.81 (s, 1H), 9.42 (s, 1H), 8.21–8.14 (m, 3H), 8.08 (d, <i>J</i> = 8.3 Hz, 2H), 7.96 (d, <i>J</i> = 8.3 Hz, 2H), 7.74 (m, 1H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 6.64 (m, 1H), 6.57 (m, 1H), 3.82 (s, 3H), 3.78 (s, 3H)
46		B	527 (M+H)	198–201	11.81 (s, 1H), 9.96 (s, 1H), 9.41 (s, 1H), 8.18 (s, 1H), 8.14–8.02 (m, 6H), 7.62 (d, <i>J</i> = 8.2 Hz, 2H), 7.18 (m, 1H), 6.84 (m, 1H), 6.77 (m, 1H), 3.78 (s, 3H), 2.21 (s, 3H)
47		B	518	209–211	12.20 (s, 1H), 9.89 (s, 1H), 9.43 (s, 1H), 8.22 (s, 1H), 8.19–8.01 (m, 6H), 7.61 (d, <i>J</i> = 8.2 Hz, 2H), 7.48–7.39 (m, 1H), 7.23 (m, 2H)

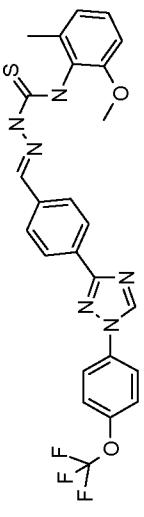
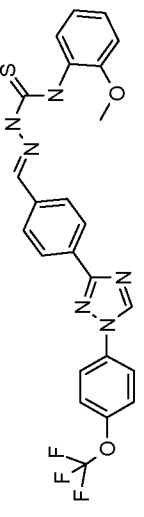
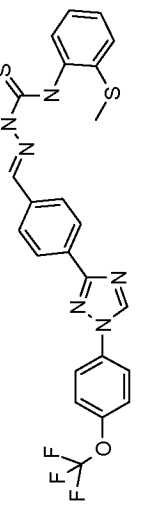
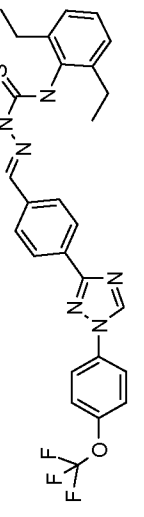
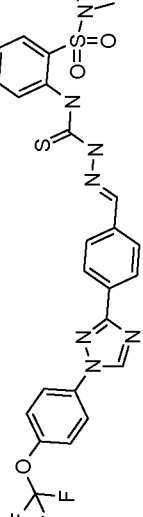
#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
48		B	640	198–201	12.04 (s, 1H), 10.22 (s, 1H), 9.41 (s, 1H), 8.23 (s, 1H), 8.18–8.04 (m, 6H), 7.76 (d, <i>J</i> = 8.2 Hz, 2H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 7.22 (m, 1H)
49		B	594 (M+H)	205–208	11.98 (s, 1H), 9.82 (s, 1H), 9.41 (s, 1H), 8.19–7.96 (m, 7H), 7.62 (d, <i>J</i> = 8.2 Hz, 2H), 7.31 (m, 1H), 6.98 (m, 1H), 6.84 (m, 1H), 2.99 (s, 6H)
50		B	531 (M+H)	198–201	11.98 (s, 1H), 9.96 (s, 1H), 9.43 (s, 1H), 8.20 (s, 1H), 8.17–8.03 (m, 6H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 7.34 (m, 1H), 6.96 (m, 1H), 6.78 (m, 1H), 3.78 (s, 3H)
51		B	581 (M+H)	205–208	12.03 (s, 1H), 9.97 (s, 1H), 9.42 (s, 1H), 8.18 (s, 1H), 8.16–8.01 (m, 6H), 7.62 (d, <i>J</i> = 8.3 Hz, 2H), 7.48 (m, 1H), 7.33–7.18 (m, 2H), 3.84 (s, 3H)
52		B	561 (M+H)	183–186	9.42 (s, 1H), 8.42 (m, 1H), 8.24 (s, 1H), 8.18 (d, <i>J</i> = 8.3 Hz, 2H), 8.16–8.04 (m, 5H), 7.99–7.89 (m, 2H), 7.78 (m, 1H), 7.62 (d, <i>J</i> = 8.3 Hz, 2H), 7.45 (m, 1H), 3.26 (s, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
53		B	507		10.03 (s, 1H), 9.48 (s, 1H), 8.42 (d, <i>J</i> = 8.2 Hz, 2H), 8.37 (d, <i>J</i> = 8.2 Hz, 2H), 8.17-8.06 (m, 2H), 7.86-7.75 (m, 4H), 7.71-7.54 (m, 4H)
54		B	517 (M+H)	211-214	12.08 (s, 1H), 10.18 (s, 1H), 9.43 (s, 1H), 8.21 (s, 1H), 8.16-7.99 (m, 6H), 7.71-7.57 (m, 4H), 7.42-7.28 (m, 2H)
55		B	551	215-218	12.17 (s, 1H), 10.17 (s, 1H), 9.41 (s, 1H), 8.22 (s, 1H), 8.17-7.98 (m, 6H), 7.74-7.58 (m, 4H), 7.43 (m, 1H)
56		B	517 (M+H)	214-217	11.98 (s, 1H), 10.22 (s, 1H), 9.41 (s, 1H), 8.21 (s, 1H), 8.19-8.03 (m, 8H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 7.42 (d, <i>J</i> = 8.3 Hz, 2H)
57		B	543 (M+H)	197-199	11.76 (s, 1H), 9.42 (s, 1H), 9.38 (s, 1H), 8.17-8.01 (m, 7H), 7.61 (d, <i>J</i> = 8.3 Hz, 2H), 7.23 (m, 1H), 6.68 (d, <i>J</i> = 8.3 Hz, 2H), 3.78 (s, 6H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
58		B	527 (M+H)	195–197	11.81 (s, 1H), 10.07 (s, 1H), 9.42 (s, 1H), 8.19 (s, 1H), 8.16–8.01 (m, 6H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 7.38 (d, <i>J</i> = 8.2 Hz, 2H), 6.91 (d, <i>J</i> = 8.2 Hz, 2H), 4.04 (q, <i>J</i> = 7.3 Hz, 2H), 1.38 (t, <i>J</i> = 7.2 Hz, 3H)
59		B	518 (M+H)	202–204	12.28 (s, 1H), 10.32 (s, 1H), 9.42 (s, 1H), 8.46 (m, 1H), 8.24 (s, 1H), 8.21–7.96 (m, 8H), 7.63 (d, <i>J</i> = 8.2 Hz, 2H)
60		B	608 (M+H)	135 dec	10.86 (s, 1H), 10.04 (s, 1H), 9.41 (s, 1H), 8.18 (d, <i>J</i> = 8.3 Hz, 2H), 8.14–8.02 (m, 3H), 7.84–7.78 (m, 3H), 7.62 (d, <i>J</i> = 8.3 Hz, 2H), 7.42 (m, 1H), 7.33 (m, 1H), 7.12 (m, 1H)
61		B	579 (M+H)	128 dec	(CDCl ₃) 10.09 (s, 1H), 8.62 (m, 2H), 8.38 (d, <i>J</i> = 8.2 Hz, 1H), 8.31 (d, <i>J</i> = 8.6 Hz, 2H), 8.01 (d, <i>J</i> = 8.5 Hz, 1H), 7.85–7.76 (m, 6H), 7.41 (m, 3H)
62		B	511 (M+H)	189–194	(CDCl ₃) 9.06 (s, 1H), 8.63 (s, 1H), 8.26 (d, <i>J</i> = 8.4 Hz, 2H), 7.93 (s, 1H), 7.85–7.76 (m, 5H), 7.70 (s, 1H), 7.41 (d, <i>J</i> = 9.0 Hz, 2H), 7.32–7.27 (m, 3H), 2.73 (q, <i>J</i> = 7.6 Hz, 2H), 1.30 (t, <i>J</i> = 7.6 Hz, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
63		B	535 (M+H)	175–187	11999688 (CDCl ₃) 9.49 (s, 1H), 8.63 (d, <i>J</i> = 8.4 Hz, 2H), 8.26 (d, <i>J</i> = 8.3 Hz, 2H), 7.91 (s, 1H), 7.86–7.79 (m, 4H), 7.41 (d, <i>J</i> = 8.1 Hz, 2H), 7.33 (d, <i>J</i> = 8.2 Hz, 2H)
64		B	573 (M+H)	190 dec	12.47 (s, 1H), 10.07 (s, 1H), 9.45 (s, 1H), 8.25 (s, 1H), 8.23–8.02 (m, 6H), 7.64 (d, <i>J</i> = 8.4 Hz, 2H)
65		B	531 (M+H)	197–205	(CDCl ₃) 11.65 (s, 1H), 9.88 (s, 1H), 8.93 (dd, <i>J</i> = 8.2, 1.4 Hz, 1H), 8.70 (s, 1H), 8.24 (d, <i>J</i> = 8.4 Hz, 2H), 8.18 (s, 1H), 7.89–7.80 (m, <i>J</i> = 15.8, 8.7 Hz, 4H), 7.41 (d, <i>J</i> = 8.4 Hz, 2H), 7.34–7.31 (m, 1H), 7.28–7.16 (m, 1H), 2.45 (s, 3H)
66		B	567 (M+H)	200–210	(CDCl ₃) 11.65 (s, 1H), 9.88 (s, 1H), 8.93 (dd, <i>J</i> = 8.2, 1.4 Hz, 1H), 8.70 (s, 1H), 8.24 (d, <i>J</i> = 8.4 Hz, 2H), 8.18 (s, 1H), 7.89–7.79 (m, 5H), 7.45–7.38 (m, <i>J</i> = 8.3 Hz, 3H), 7.21 (dd, <i>J</i> = 8.4, 1.5 Hz, 1H)
67		C	513 (M+2) 510 (M-1)	199–200	11.74 (br s, 1H), 10.87 (br s, 1H), 10.04 (s, 1H), 8.43 (dd, <i>J</i> = 10.2, 1.2 Hz, 2H), 8.16 (s, 1H), 7.87–7.96 (m, 6H), 7.60 (d, <i>J</i> = 8.1 Hz, 2H), 7.41 (d, <i>J</i> = 8.7 Hz, 2H), 6.95 (d, <i>J</i> = 9.0 Hz, 1H), 3.78 (s, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO-d ₆ , δ) ¹
68		C	552 (M+2)	195–196	12.02 (br s, 1H), 10.12 (br s, 1H), 8.46 (d, <i>J</i> = 1.5 Hz, 1H), 8.42 (d, <i>J</i> = 1.2 Hz, 1H), 8.16 (s, 1H), 7.86–7.96 (m, 6H), 7.60 (d, <i>J</i> = 7.8 Hz, 2H), 7.57 (d, <i>J</i> = 7.8 Hz, 2H), 7.39 (dd, <i>J</i> = 8.7, 7.5 Hz, 1H)
69		C	495	209–210	11.77 (br s, 1H), 10.10 (br s, 1H), 8.57 (s, 1H), 8.52 (d, <i>J</i> = 1.5 Hz, 1H), 8.16 (s, 1H), 8.15 (d, <i>J</i> = 5.4 Hz, 2H), 8.06 (d, <i>J</i> = 4.8 Hz, 2H), 7.80 (d, <i>J</i> = 8.4 Hz, 2H), 7.38 (d, <i>J</i> = 7.2 Hz, 2H), 7.37 (d, <i>J</i> = 6.9 Hz, 2H), 6.92 (dd, <i>J</i> = 8.2, 2.1 Hz, 1H), 3.76 (s, 3H)
70		C	536 (M+2) 535 (M+H)	218–219	12.07 (br s, 1H), 10.18 (br s, 1H), 8.57 (d, <i>J</i> = 1.2 Hz, 1H), 8.52 (d, <i>J</i> = 1.2 Hz, 1H), 8.17 (s, 1H), 8.05–8.17 (m, 4H), 7.80 (d, <i>J</i> = 8.4 Hz, 2H), 7.75 (d, <i>J</i> = 8.4 Hz, 2H), 7.55 (d, <i>J</i> = 8.4 Hz, 2H), 7.39 (dd, <i>J</i> = 9.3 Hz, 1H)
71		B		189–198	(CDCl ₃) 9.57 (s, 1H), 9.02 (s, 1H), 8.60 (s, 1H), 8.26 (d, <i>J</i> = 8.3 Hz, 2H), 7.93 (s, 1H), 7.85 (m, 4H), 7.71 (d, <i>J</i> = 7.5 Hz, 1H), 7.41 (d, <i>J</i> = 8.9 Hz, 2H), 7.34–7.24 (m, 3H), 2.39 (s, 3H)
72		B		198–218	(CDCl ₃) 9.55 (s, 1H), 8.70 (s, 1H), 8.60 (s, 1H), 8.3 (d, <i>J</i> = 8.7 Hz, 2H), 7.9 (s, 1H), 7.85–7.7 (m, 4H), 7.4 (d, <i>J</i> = 8.4 Hz, 2H), 7.25–7.20 (m, 3H), 2.75 (q, <i>J</i> = 7 Hz, 2H), 2.45 (s, 3H), 1.30 (t, <i>J</i> = 7 Hz, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO-d ₆ , δ) ¹
73		B		184–190	(CDCl ₃) 9.42 (s, 1H), 8.60 (s, 2H), 8.26 (d, <i>J</i> = 8.3 Hz, 2H), 7.88 (s, 1H), 7.85–7.74 (m, 4H), 7.41 (d, <i>J</i> = 8.8 Hz, 2H), 7.3–7.25 (m, 1H), 6.92 (d, <i>J</i> = 8.1 Hz, 1H), 6.85 (d, <i>J</i> = 8.1 Hz, 1H), 3.85 (s, 3H), 2.38 (s, 3H)
74		B	513 (M+1)	195–208	(CDCl ₃) 9.00 (s, 1H), 8.85 (d, <i>J</i> = 8.2 Hz, 1H), 8.60 (s, 1H), 8.28 (d, <i>J</i> = 8.4 Hz, 2H), 7.90–7.75 (m, 5H), 7.41 (d, <i>J</i> = 8.9 Hz, 2H), 7.26 (m, 1H), 7.17 (t, <i>J</i> = 7.8 Hz, 1H), 7.09–6.92 (m, 2H), 3.99 (s, 3H)
75		B	529 (M+H)	170–230 dec	(CDCl ₃) 11.45 (s, 1H), 10.24 (s, 1H), 8.70 (s, 1H), 8.62 (d, <i>J</i> = 8.1 Hz, 1H), 8.25 (d, <i>J</i> = 8.4 Hz, 2H), 8.16 (s, 1H), 7.94–7.81 (m, 4H), 7.59–7.09 (m, 5H), 2.45 (s, 3H)
76		B	539 (M+1)	212–219	(CDCl ₃) 9.41 (s, 1H), 8.71 (s, 1H), 8.60 (s, 1H), 8.26 (d, <i>J</i> = 8.3 Hz, 2H), 7.91 (s, 1H), 7.86–7.69 (m, 4H), 7.41 (d, <i>J</i> = 8.8 Hz, 2H), 7.36–7.16 (m, 3H), 2.71 (q, <i>J</i> = 7.6 Hz, 4H), 1.27 (t, <i>J</i> = 7.6 Hz, 6H)
77		B	570 (M+1)	213–215	(CDCl ₃) 11.11 (s, 1H), 9.16 (s, 1H), 8.71 (d, <i>J</i> = 8.3 Hz, 2H), 8.60 (s, 1H), 8.29 (d, <i>J</i> = 8.3 Hz, 2H), 8.01–7.77 (m, 5H), 7.66 (t, <i>J</i> = 7.9 Hz, 1H), 7.46–7.29 (m, 3H), 2.75 (s, 6H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
78		C	511 (M+1)	220–225	(CDCl ₃) 9.30 (s, 1H), 8.69 (s, 1H), 8.60 (s, 1H), 8.26 (d, <i>J</i> = 8.4 Hz, 2H), 7.89 (s, 1H), 7.81 (m, 4H), 7.41 (d, <i>J</i> = 8.4 Hz, 2H), 7.19 (m, 3H), 2.35 (s, 6H)
79		B	496 (M+H)	206–208	11.78 (s, 1H), 9.41 (s, 1H), 9.37 (s, 1H), 8.22–7.99 (m, 6H), 7.63 (d, <i>J</i> = 8.26 Hz, 2H), 7.23 (m, 1H), 6.70 (d, <i>J</i> = 8.24 Hz, 2H), 6.48 (m, 1H), 4.12–3.98 (m, 4H), 1.39–1.22 (m, 6H)
80		B	525 (M+H)	168–180	(CDCl ₃) 10.2 (s, 1H), 9.07 (s, 1H), 8.63 (s, 1H), 8.25 (d, <i>J</i> = 8.4 Hz, 2H), 8.0 (s, 1H), 7.9–7.7 (m, 4H), 7.65 (d, <i>J</i> = 8 Hz, 1H), 7.4–7.25 (m, 5H), 3.25 (heptet, <i>J</i> = 7 Hz, 1H), 1.35 (d, <i>J</i> = 7 Hz, 6H)
81		B	498 (M+H)	191–195	11.72 (s, 1H), 9.96 (s, 1H), 9.42 (s, 1H), 8.21–8.01 (m, 5H), 7.63 (d, <i>J</i> = 8.26 Hz, 2H), 7.08 (d, <i>J</i> = 8.22 Hz, 2H), 6.58 (d, <i>J</i> = 8.22 Hz, 2H), 5.19 (br s, 2H)
82		B		184–189	9.5 (br s, 1H), 9.11 (s, 1H), 8.61 (s, 1H), 8.27 (d, <i>J</i> = 8 Hz, 2H), 7.92 (s, 1H), 7.81 (m, 5H), 7.41 (d, <i>J</i> = 8 Hz, 2H), 7.28 (m, 3H), 2.67 (t, <i>J</i> = 8 Hz, 2H), 1.70 (m, 2H), 1.01 (t, <i>J</i> = 7.5 Hz, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
83		B	536 (M+H)	--	(CDCl ₃) 10.1 (s, 1H), 8.62 (s, 1H), 8.4 (s, 1H), 8.36 (d, <i>J</i> = 8.4 Hz, 2H), 8.03 (d, <i>J</i> = 8.6 Hz, 2H), 7.85 (d, <i>J</i> = 8.4 Hz, 2H), 7.45–7.38 (m, 3H), 7.30–7.19 (m, 3H), 6.9 (d, <i>J</i> = 7 Ha, 1H), 1.50 (s, 9H)
84		B	541 (M+1)	160–170	12.25 (s, 1H), 12.24 (s, 1H), 20117139.5 (s, 1H), 9.23 (s, 1H), 8.4–8.05 (m, 8H), 7.68 (m, 3H), 7.4 (t, <i>J</i> = 7 Hz, 1H), 3.50 (s, 3H)
85		A	541 (M+H)	171–173	10.22 (s, 1H), 9.41 (s, 1H), 8.23–8.04 (m, 7H), 7.62 (d, <i>J</i> = 8.24 Hz, 2H), 7.10 (m, 1H), 6.83–6.77 (m, 2H), 3.96 (s, 3H), 3.78 (s, 3H), 2.00 (s, 3H)
86		A	555 (M+H)	188–190	10.17 (s, 1H), 9.42 (s, 1H), 8.23 (d, <i>J</i> = 8.26 Hz, 2H), 8.17–8.03 (m, 5H), 7.63 (d, <i>J</i> = 8.24 Hz, 2H), 7.11 (m, 1H), 6.85–6.76 (m, 2H), 4.68 (q, <i>J</i> = 7.26 Hz, 2H), 3.78 (s, 3H), 2.19 (s, 3H), 1.24 (t, <i>J</i> = 7.36 Hz, 3H)
87		A	569 (M+H)	195–197	10.18 (s, 1H), 9.41 (s, 1H), 8.23 (d, <i>J</i> = 8.26 Hz, 2H), 8.17–8.05 (m, 5H), 7.63 (d, <i>J</i> = 8.24 Hz, 2H), 7.12 (m, 1H), 6.86–6.78 (m, 2H), 4.61–4.58 (m, 2H), 3.79 (s, 3H), 2.18 (s, 3H), 1.76–1.60 (m, 2H), 1.01–0.97 (t, <i>J</i> = 7.38 Hz, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
88		B	573 (M+1)	--	11.72 (s, 1H), 9.44 (s, 1H), 9.28 (s, 1H), 8.14-8.1 (m, 7H), 7.63 (d, <i>J</i> = 8 Hz, 2H), 7.63 (s, 2H), 3.81 (s, 3H), 3.74 (s, 6H)
89		B	527 (M+H)	210-217	11.96 (s, 1H), 10.0 (s, 1H), 9.42 (s, 1H), 8.2-7.9 (m, 8H), 7.6 (d, <i>J</i> = 8.5 Hz, 2H), 6.96 (s, 2H), 3.85 (s, 3H), 4.27 (s, 3H)
90		B	527 (M+H)	85 dec	11.85 (s, 1H), 10.04 (s, 1H), 9.41 (s, 1H), 8.19 (s, 1H), 8.17-8.0 (m, 6H), 7.6 (d, <i>J</i> = 8.5 Hz, 2H), 7.17 (t, <i>J</i> = 7 Hz, 1H), 6.9 (m, 2H), 3.80 (s, 3H), 2.03 (s, 3H)
91		B	523 (M+1)	186-194	11.93 (s, 1H), 10.0 (s, 1H), 9.44 (s, 1H), 8.18 (d, <i>J</i> = 8.4 Hz, 2H), 8.15 (s, 1H), 8.10 (d, <i>J</i> = 9.1 Hz, 2H), 7.98 (d, <i>J</i> = 7.6 Hz, 2H), 7.74 (d, <i>J</i> = 7.6 Hz, 1H), 7.64 (d, <i>J</i> = 8.6 Hz, 2H), 7.34-7.25 (m, 3H), 5.28 (s, 1H), 5.12 (s, 1H), 2.96 (s, 3H)
92		B	497 (M+1)	204-211	11.88 (s, 1H), 10.13 (s, 1H), 9.44 (s, 1H), 8.21 (s, 1H), 8.15 (d, <i>J</i> = 8.4 Hz, 2H), 8.11-8.04 (m, 4H), 7.64 (d, <i>J</i> = 8.6 Hz, 2H), 7.43 (d, <i>J</i> = 8.2 Hz, 2H), 7.19 (d, <i>J</i> = 8.2 Hz, 2H), 2.32 (s, 3H)

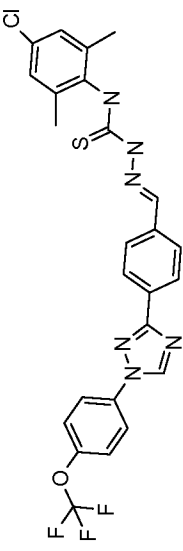
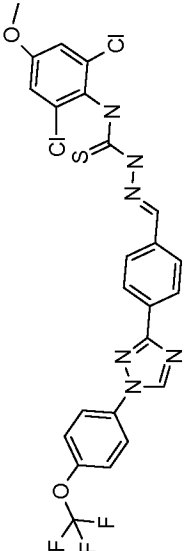
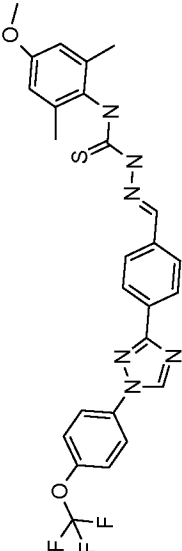
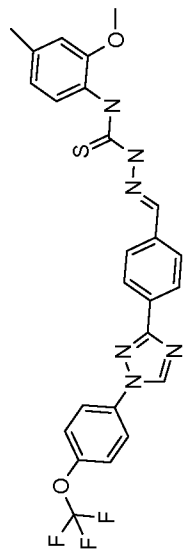
#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO-d ₆ , δ) ¹
93		B	525 (M+1)	218-225	(CDCl ₃) 9.37 (s, 1H), 8.63 (s, 1H), 8.60 (s, 1H), 8.26 (d, J = 8.4 Hz, 2H), 7.89 (s, 1H), 7.85-7.76 (m, 4H), 7.41 (d, J = 8.4 Hz, 2H), 6.97 (s, 2H), 2.32 (s, 3H), 2.30 (s, 6H)
94		B	513 (M+1)	80 dec	11.94 (s, 1H), 10.15 (s, 1H), 9.44 (s, 1H), 8.22 (s, 1H), 8.20-8.02 (m, 6H), 7.64 (d, J = 8.7 Hz, 2H), 7.28 (m, 2H), 7.19 (d, J = 8.6 Hz, 1H), 6.80 (d, J = 6.5 Hz, 1H), 3.78 (s, 3H)
95		B	511 (M+1)	201-207	(CDCl ₃) 9.26 (s, 1H), 8.92 (s, 1H), 8.60 (s, 1H), 8.26 (d, J = 8.3 Hz, 2H), 7.88 (s, 1H), 7.84-7.77 (m, 4H), 7.50 (d, J = 7.8 Hz, 1H), 7.41 (m, 2H), 7.14-7.07 (m, 2H), 2.36 (s, 3H), 2.34 (s, 3H)
96		B		205 dec	(CDCl ₃) 9.82 (s, 1H), 8.60 (s, 1H), 8.26 (d, J = 8.3 Hz, 2H), 7.96 (s, 1H), 7.85-7.75 (m, 5H), 7.40 (d, J = 8.8 Hz, 2H), 7.34-7.23 (m, 2H), 7.16 (d, J = 7.2 Hz, 1H), 3.23-3.12 (m, 1H), 2.36 (s, 3H), 1.33 (d, J = 6.8 Hz, 3H), 1.23 (d, J = 6.9 Hz, 3H)
97		C	561 (M+H)	234-238	(CDCl ₃) 9.62 (s, 1H), 8.70 (s, 1H), 8.60 (s, 1H), 8.26 (d, J = 8.4 Hz, 2H), 7.92 (s, 1H), 7.86-7.75 (m, 4H), 7.41 (d, J = 9.0 Hz, 2H), 7.18 (m, 3H), 2.35 (s, 6H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
98		B	537 (M+H)	200–205	12.2 (s, 1H), 10.85 (s, 1H), 9.39 (s, 1H), 8.20 (s, 1H), 8.18–7.97 (m, 6H), 7.6 (d, <i>J</i> = 8.5 Hz, 2H), 7.45 (m, 2H)
99		B		190 dec	12.05 (s, 1H), 10.17 (s, 1H), 9.44 (s, 1H), 8.37 (d, <i>J</i> = 3.7 Hz, 1H), 8.22 (s, 1H), 8.20–8.00 (m, 6H), 7.75–7.57 (m, 3H), 7.38–7.24 (m, 1H), 2.44 (s, 3H)
100		B	557 (M+1)	213–220	11.86 (s, 1H), 9.90 (s, 1H), 9.44 (s, 1H), 8.24 (s, 1H), 8.20–7.98 (m, 6H), 7.63 (d, <i>J</i> = 8.5 Hz, 2H), 7.02 (s, 2H), 2.48 (s, 3H), 2.18 (s, 6H)
101		B	545 (M+1)	211–217	11.97 (s, 1H), 10.07 (s, 1H), 9.44 (s, 1H), 8.20 (s, 1H), 8.17–8.03 (m, 6H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 7.34 (d, <i>J</i> = 8.3 Hz, 1H), 7.17 (d, <i>J</i> = 8.3 Hz, 1H), 2.23 (s, 3H), 2.19 (s, 3H)

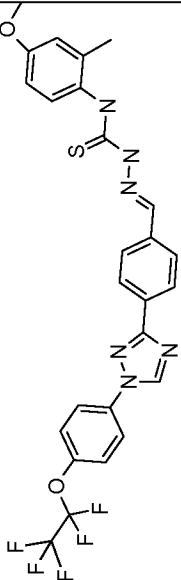
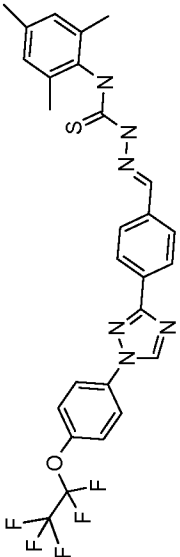
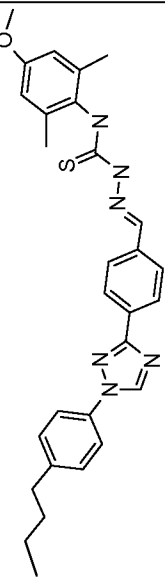
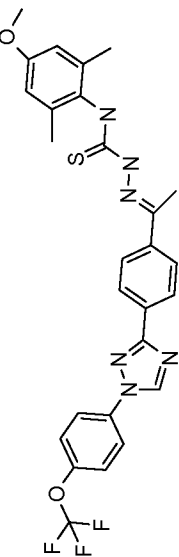
#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
102		B	512 (M+1)	193 dec	12.01 (s, 1H), 10.05 (s, 1H), 9.44 (s, 1H), 8.26 (d, <i>J</i> = 4.9 Hz, 1H), 8.21 (s, 1H), 8.19-8.02 (m, 6H), 7.63 (d, <i>J</i> = 8.8 Hz, 2H), 7.19 (d, <i>J</i> = 4.9 Hz, 1H), 2.38 (s, 3H), 2.22 (s, 3H)
103		B	541 (M+1)	214-219	11.77 (s, 1H), 9.59 (s, 1H), 9.44 (s, 1H), 8.23 (s, 1H), 8.20-7.98 (m, 6H), 7.63 (d, <i>J</i> = 8.9 Hz, 2H), 6.74 (s, 1H), 6.68 (s, 1H), 2.92 (s, 3H), 2.31 (s, 3H), 2.15 (s, 3H)
104		B	545 (M+H)	215-220	11.91 (s, 1H), 9.93 (s, 1H), 9.40 (s, 1H), 8.2 (s, 1H), 8.20-8.0 (m, 6H), 7.58 (d, <i>J</i> = 8.4 Hz, 2H), 7.20 (s, 1H), 7.02 (s, 1H), 2.24 (s, 3H), 2.21 (s, 3H)
105		B	580, 582 (M+1)	194-209	(CDCl ₃) 9.60 (s, 1H), 8.67 (s, 1H), 8.60 (s, 1H), 8.27 (d, <i>J</i> = 8.3 Hz, 2H), 7.93 (s, 1H), 7.89-7.77 (m, 4H), 7.51 (d, <i>J</i> = 8.2 Hz, 2H), 7.41 (d, <i>J</i> = 8.7 Hz, 2H), 7.20 (t, <i>J</i> = 8.7 Hz, 1H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
106		B	526 (M+1)	195–207	11.97 (s, 1H), 9.96 (s, 1H), 9.40 (s, 1H), 8.21 (s, 1H), 8.19–8.02 (m, 6H), 7.63 (d, <i>J</i> = 8.6 Hz, 2H), 7.0 (s, 1H), 2.38 (s, 3H), 2.26 (s, 3H), 2.15 (s, 3H)
107		B	567 (M+H)	217–224	11.80 (s, 1H), 9.85 (s, 1H), 9.40 (s, 1H), 8.2 (s, 1H), 8.18–8.0 (m, 6H), 7.6 (d, <i>J</i> = 8.4 Hz, 2H), 7.5–7.1 (m, 3H), 3.05 (m, 2H), 1.17 (m, 12H)
108		B	549 (M+H)	206–213	12.14 (s, 1H), 10.88 (s, 1H), 10.42 (s, 1H), 8.22 (s, 1H), 8.2–8.0 (m, 6H), 7.65 (d, <i>J</i> = 8.4 Hz, 2H), 6.87 (d, <i>J</i> = 9 Hz, 2H), 3.82 (s, 3H)
109		C	541 (M+H)	198–201	10.57 (s, 1H), 9.84 (s, 1H), 9.41 (s, 1H), 8.21 (d, <i>J</i> = 8.26 Hz, 2H), 8.17–8.03 (m, 4H), 7.63 (d, <i>J</i> = 8.26 Hz, 2H), 7.18 (m, 1H), 6.87–6.77 (m, 2H), 3.77 (s, 3H), 2.41 (s, 3H), 2.24 (s, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
110		C	553 (M+H)	208–213	9.86 (s, 1H), 9.41 (s, 1H), 8.24 (d, <i>J</i> = 8.26 Hz, 2H), 8.14–8.03 (m, 5H), 7.63 (d, <i>J</i> = 8.26 Hz, 2H), 7.27 (m, 1H), 7.18–7.11 (m, 2H), 2.65–2.57 (m, 4H), 2.41 (s, 3H), 1.24–1.09 (m, 6H)
111		B	541 (M+H)	191–194	11.82 (s, 1H), 9.96 (s, 1H), 9.42 (s, 1H), 8.21–8.01 (m, 7H), 7.63 (d, <i>J</i> = 8.26 Hz, 2H), 7.13 (m, 1H), 6.84–6.78 (m, 2H), 3.78 (s, 3H), 2.58 (q, <i>J</i> = 7.22 Hz, 2H), 1.97 (t, <i>J</i> = 9.40 Hz, 3H)
112		B	529 (M+H)	214 dec	11.89 (s, 1H), 10.90 (s, 1H), 9.42 (s, 1H), 8.21 (s, 1H), 8.2–8.0 (m, 6H), 7.6 (d, <i>J</i> = 8.4 Hz, 2H), 6.99 (d, <i>J</i> = 9 Hz, 2H), 2.2 (s, 6H)
113		B	552	142–162 dec	12.16 (s, 1H), 10.52 (s, 1H), 9.43 (s, 1H), 8.59 (s, 1H), 8.40 (s, 1H), 8.25–8.0 (m, 7H), 7.6 (d, <i>J</i> = 8.4 Hz, 2H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
114		B	545 (M+H)	238–245	11.89 (s, 1H), 9.90 (s, 1H), 9.42 (s, 1H), 8.21 (s, 1H), 8.2–8.0 (m, 6H), 7.6 (d, <i>J</i> = 8.4 Hz, 2H), 7.20 (s, 2H), 2.2 (s, 6H)
115		B	581	195–199	(CDCl ₃) 10.2 (s, 1H), 8.7 (s, 1H), 8.6 (s, 1H), 8.25 (d, <i>J</i> = 8.4 Hz, 2H), 8.0 (s, 1H), 7.82 (m, 4H), 7.4 (d, <i>J</i> = 8.4 Hz, 2H), 7.0 (s, 2H), 3.82 (s, 3H)
116		C	541 (M+H)	202–210	(CDCl ₃) 9.88 (s, 1H), 8.61 (s, 1H), 8.60 (s, 1H), 8.27 (d, <i>J</i> = 8.4 Hz, 2H), 7.9 (s, 1H), 7.9–7.7 (m, 4H), 7.4 (d, <i>J</i> = 8.6 Hz, 2H), 6.7 (s, 2H), 3.81 (s, 3H), 2.33 (s, 6H)
117		C	527 (M+H)	210–214	(CDCl ₃) 9.89 (s, 1H), 9.02 (s, 1H), 8.6 (m, 3H), 8.3 (d, <i>J</i> = 8.5 Hz, 2H), 7.9–7.8 (m, 4H), 7.43 (d, <i>J</i> = 8.5 Hz, 2H), 6.85 (d, <i>J</i> = 6 Hz, 1H), 6.8 (s, 1H), 3.95 (s, 3H), 2.38 (s, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
118		B	509 (M+H)	246-249	10.65 (s, 1H), 10.07 (s, 1H), 9.40 (s, 1H), 8.5 (s, 1H), 8.15-7.9 (m, 6H), 7.61 (d, <i>J</i> = 8.5 Hz, 2H), 6.89 (s, 2H), 2.27 (s, 3H), 2.19 (s, 6H)
119		C	calcd for C ₂₅ H ₂₁ F ₃ N ₃ O ₃ , 510.1627; found, 510.165	240-241	10.72 (s, 1H), 9.41 (s, 1H), 8.49 (s, 1H), 8.14 (d, <i>J</i> = 8.4 Hz, 2H), 8.09 (d, <i>J</i> = 9.1 Hz, 2H), 8.00 (s, 1H), 7.94 (d, <i>J</i> = 8.4 Hz, 2H), 7.62 (d, <i>J</i> = 8.4 Hz, 2H), 7.37 (d, <i>J</i> = 8.7 Hz, 1H), 6.83 (d, <i>J</i> = 2.8 Hz, 1H), 6.76 (dd, <i>J</i> = 8.7, 2.9 Hz, 1H), 3.74 (s, 3H), 2.25 (s, 3H)
120		C	535 (M+H)	222-223	10.92 (s, 1H), 9.42 (s, 1H), 9.03 (s, 1H), 8.13 (d, <i>J</i> = 8.5 Hz, 2H), 8.09 (d, <i>J</i> = 9.1 Hz, 2H), 7.99 (s, 2H), 7.97 (s, 1H), 7.63 (d, <i>J</i> = 8.3 Hz, 2H), 7.56 (d, <i>J</i> = 8.1 Hz, 2H), 7.41-7.32 (m, 1H)
121		B	555 (M+H)	186-192	(CDCl ₃) 10.42 (s, 1H), 8.88 (s, 1H), 8.60 (s, 1H), 8.22 (d, <i>J</i> = 8.4 Hz, 2H), 8.0 (s, 1H), 7.9-7.7 (m, 4H), 7.45-7.38 (m, 3H), 6.9-6.7 (m, 2H), 3.83 (s, 3H), 3.12 (m, 1H), 1.25 (d, <i>J</i> = 6.5 Hz, 6H)

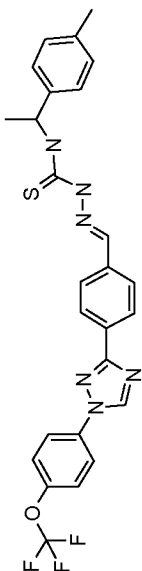
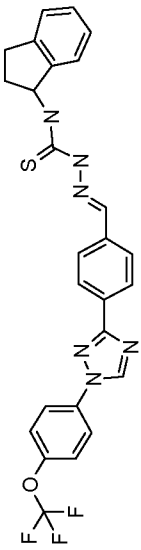
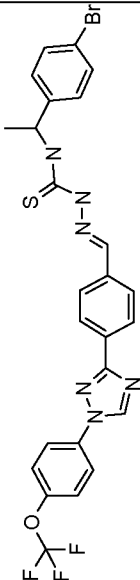
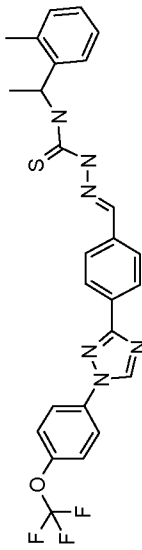
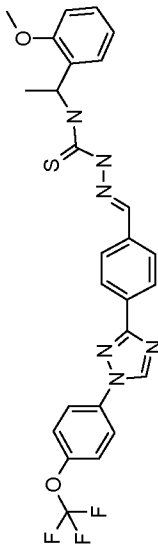
#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
122		C	577 (M+H)	197-200	(CDCl ₃) 10.2 (s, 1H), 8.90 (s, 1H), 8.62 (s, 1H), 8.25 (d, <i>J</i> = 8.4 Hz, 2H), 7.98 (s, 1H), 7.9-7.7 (m, 4H), 7.4 (m, 3H), 6.8 (m, 2H), 3.82 (s, 3H), 2.37 (s, 3H)
123		B	575 (M+H)	237-240	(CDCl ₃) 9.85 (s, 1H), 8.63 (s, 1H), 8.60 (s, 1H), 8.26 (d, <i>J</i> = 8.4 Hz, 2H), 7.89 (s, 1H), 7.85-7.76 (m, 4H), 7.41 (d, <i>J</i> = 8.4 Hz, 2H), 6.97 (s, 2H), 2.32 (s, 3H), 2.30 (s, 6H)
124		C	513 (M+H)	240-248	(CDCl ₃) 9.57 (s, 1H), 8.60 (s, 1H), 8.54 (s, 1H), 8.26 (d, <i>J</i> = 8.4 Hz, 2H), 7.91 (s, 1H), 7.77 (d, <i>J</i> = 8.4 Hz, 2H), 7.64 (d, <i>J</i> = 8.5 Hz, 2H), 7.33 (d, <i>J</i> = 8.6 Hz, 2H), 6.69 (s, 2H), 3.81 (s, 3H), 2.76-2.59 (m, 2H), 2.31 (s, 6H), 1.75-1.57 (m, 2H), 1.48-1.30 (m, 2H), 0.95 (t, <i>J</i> = 7.3 Hz, 3H)
125		C	555 (M+H)	206-209	(CDCl ₃) 8.90 (s, 1H), 8.80 (s, 1H), 8.6 (s, 1H), 8.28 (d, <i>J</i> = 8.4 Hz, 2H), 8.9-8.7 (m, 4H), 7.4 (d, <i>J</i> = 8.6 Hz, 2H), 6.7 (s, 2H), 3.80 (s, 3H), 2.39 (s, 3H), 2.32 (s, 6H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO-d ₆ , δ) ¹
126		C	525 (M+H)	209–215	(CDCl ₃) 8.92 (s, 1H), 8.90 (s, 1H), 8.80 (s, 1H), 8.26 (d, <i>J</i> = 8.4 Hz, 2H), 8.9–8.8 (m, 4H), 7.4 (d, <i>J</i> = 8.6 Hz, 2H), 7.25–7.15 (m, 3H), 2.40 (s, 3H), 2.36 (s, 6H)
127		C	525 (M+H)	230–240	(CDCl ₃) 9.93 (s, 1H), 8.69 (s, 1H), 8.60 (s, 1H), 8.26 (d, <i>J</i> = 8.4 Hz, 2H), 7.93 (d, <i>J</i> = 9.5 Hz, 2H), 7.95 (s, 1H), 7.86–7.75 (m, 4H), 6.69 (s, 2H), 3.81 (s, 3H), 2.31 (s, 6H)
128		C	592 (M+H)	233–236	(CDCl ₃) 9.89 (s, 1H), 8.60 (s, 2H), 8.25 (d, <i>J</i> = 8.5 Hz, 2H), 7.95 (s, 1H), 7.88–7.70 (m, 4H), 7.41 (d, <i>J</i> = 9.0 Hz, 2H), 6.70 (s, 2H), 3.81 (s, 3H), 2.31 (s, 6H)
129		C	542 (M+1)	215–219	(CDCl ₃) 9.98 (s, 1H), 8.63–8.52 (m, 2H), 8.26 (d, <i>J</i> = 8.5 Hz, 2H), 7.97 (s, 1H), 7.84–7.69 (m, 4H), 7.46–7.32 (m, 2H), 6.53 (s, 1H), 3.93 (s, 3H), 2.45 (s, 3H), 2.29 (s, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
130		C	570 (M+H)	221-223	11.82 (s, 1H), 9.98 (s, 1H), 8.17 (s, 1H), 7.97 (d, <i>J</i> = 8.26 Hz, 2H), 7.76 (d, <i>J</i> = 8.26 Hz, 2H), 7.29 (d, <i>J</i> = 8.22 Hz, 2H), 7.18-7.04 (m, 5H), 5.22-5.16 (m, 1H), 3.88-3.76 (m, 1H), 3.71 (s, 3H), 3.64-3.58 (m, 1H), 2.21 (s, 6H)
131		C	611 (M+H)	215-217	12.03 (s, 1H), 10.21 (s, 1H), 8.17 (s, 1H), 7.98 (d, <i>J</i> = 8.24 Hz, 2H), 7.76 (d, <i>J</i> = 8.24 Hz, 2H), 7.59-7.56 (m, 2H), 7.41-7.39 (m, 1H), 7.27 (d, <i>J</i> = 8.26 Hz, 2H), 7.08 (d, <i>J</i> = 8.26 Hz, 2H), 5.22-5.19 (m, 1H), 3.84-3.76 (m, 1H), 3.71 (s, 3H), 3.64-3.59 (m, 1H)
132		C	601 (M+H)	205-211	(CDCl ₃) 9.31 (s, 1H), 8.69 (s, 1H), 8.56 (s, 1H), 8.03-7.40 (m, 6H), 7.18 (d, <i>J</i> = 8.4 Hz, 2H), 6.69 (s, 2H), 4.87 (dd, <i>J</i> = 12.7, 6.6 Hz, 1H), 3.72 (s, 3H), 3.9-3.6 (m, 2H), 3.49 (s, 3H), 2.23 (s, 6H)
133		C	585 (M+H)	250 dec	(CDCl ₃) 9.27 (s, 1H), 8.69 (s, 1H), 8.56 (s, 1H), 8.05-7.55 (m, 6H), 7.24-6.96 (m, 2H), 6.69 (s, 2H), 6.22 (s, 1H), 5.40 (s, 1H), 4.62 (m, 1H), 3.9-3.75 (m, 1H), 3.81 (s, 3H), 3.52-3.42 (m, 1H), 2.30 (s, 6H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO-d ₆ , δ) ¹
134		C	509 (M+H)	200–202	11.78 (s, 1H), 9.81 (s, 1H), 8.17 (s, 1H), 8.06 (s, 1H), 7.84 (d, J = 8.24 Hz, 2H), 7.81 (d, J = 8.26 Hz, 2H), 7.76 (d, J = 8.24 Hz, 2H), 7.53–7.48 (m, 3H), 7.13–7.09 (m, 2H), 7.04–7.02 (m, 1H), 6.83–6.80 (m, 1H), 2.21 (s, 6H)
135		C	550 (M+H)	218–220	12.00 (s, 1H), 10.12 (s, 1H), 8.18 (s, 1H), 8.06 (s, 1H), 7.89 (d, J = 8.22 Hz, 2H), 7.81 (d, J = 8.24 Hz, 2H), 7.75 (d, J = 8.24 Hz, 2H), 7.59–7.47 (m, 5H), 7.41–7.38 (m, 1H), 6.83–6.81 (m, 1H)
136		C	510 (M+H)	216–218	11.81 (s, 1H), 9.97 (s, 1H), 8.62 (s, 1H), 8.21–8.19 (m, 1H), 8.10–8.07 (d, J = 8.26 Hz, 2H), 8.04–7.99 (m, 4H), 7.58 (d, J = 8.24 Hz, 2H), 7.19–7.06 (m, 4H), 2.21 (s, 6H)
137		C	551 (M+H)	220–222	12.02 (s, 1H), 10.18 (s, 1H), 8.62 (s, 1H), 8.19–8.17 (m, 1H), 8.09–7.97 (m, 6H), 7.61–7.57 (m, 4H), 7.42–7.37 (m, 1H), 7.21–7.19 (m, 1H)
138		C	510 (M+H)	250–260	(CDCl ₃) 9.75 (s, 1H), 8.70 (s, 1H), 8.21 (s, 1H), 8.07 (s, 1H), 7.92 (s, 1H), 7.8 (d, J = 8.4 Hz, 2H), 7.71 (d, J = 8.6 Hz, 2H), 7.62 (d, J = 8.4 Hz, 2H), 7.35 (d, J = 8.6 Hz, 2H), 7.3–7.1 (m, 3H), 2.33 (s, 6H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO-d ₆ , δ) ¹
139		C	524 (M+H)	235-242	(CDCl ₃) Major isomer: 8.87 (s, 1H), 8.85 (s, 1H), 8.19 (s, 1H), 8.02 (s, 1H), 7.86-7.74 (m, 4H), 7.6 (d, J = 8.6 Hz, 2H), 7.35 (d, J = 8.3 Hz, 2H), 7.23-7.06 (m, 3H), 2.38 (s, 3H), 2.34 (s, 6H)
140		C	512 (M+H)	238-240	11.79 (s, 1H), 10.96 (s, 1H), 8.17 (s, 1H), 7.98 (d, J = 8.22 Hz, 2H), 7.76 (d, J = 8.22 Hz, 2H), 7.26 (d, J = 8.26 Hz, 2H), 7.18-7.06 (m, 5H), 3.97-3.91 (m, 2H), 3.39-3.34 (m, 2H), 2.20 (s, 6H)
141		C	553 (M+H)	224-226	12.03 (s, 1H), 10.17 (s, 1H), 8.18 (s, 1H), 7.96 (d, J = 8.24 Hz, 2H), 7.76 (d, J = 8.24 Hz, 2H), 7.59-7.54 (m, 2H), 7.42-7.39 (m, 1H), 7.37 (d, J = 8.26 Hz, 2H), 7.17 (d, J = 8.26 Hz, 2H), 3.98-3.84 (m, 2H), 3.43-3.37 (m, 2H)
142		B	541 (M+H)	195-200	(CDCl ₃) 10.33 (s, 1H), 8.6 (s, 1H), 8.21 (d, J = 8.4 Hz, 2H), 7.92 (s, 1H), 7.8 (d, J = 8.6 Hz, 2H), 7.75 (d, J = 8.4 Hz, 2H), 7.68 (d, J = 7 Hz, 1H), 7.45-7.35 (m, 4H), 6.91 (d, J = 8 Hz, 2H), 5.73 (m, 1H), 3.80 (s, 3H), 1.65 (d, J = 7.2 Hz, 3H)
143		B	541 (M+H)	180-186	(CDCl ₃) 9.9 (s, 1H), 8.6 (s, 1H), 8.23 (d, J = 8.4 Hz, 2H), 7.9 (s, 1H), 7.8 (d, J = 8.6 Hz, 2H), 7.75 (d, J = 8.4 Hz, 2H), 7.7 (d, J = 7 Hz, 1H), 7.45-7.35 (m, 4H), 6.91 (d, J = 8 Hz, 2H), 5.73 (m, 1H), 3.80 (s, 3H), 1.65 (d, J = 7.2 Hz, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
144		B	525 (M+H)	193–198	(CDCl ₃) 9.02 (s, 1H), 8.60 (s, 1H), 8.42 (d, <i>J</i> = 8.4 Hz, 2H), 7.8–7.6 (m, 6H), 7.4 (d, <i>J</i> = 8 Hz, 2H), 7.32 (d, <i>J</i> = 8.5 Hz, 2H), 7.21 (d, <i>J</i> = 8.4 Hz, 2H), 5.71 (m, 1H), 2.37 (s, 3H), 1.69 (d, <i>J</i> = 7.2 Hz, 3H)
145		B	523 (M+H)	160–220 dec	(CDCl ₃) 10.21 (s, 1H), 8.60 (s, 1H), 8.2 (d, <i>J</i> = 8.4 Hz, 2H), 7.99 (s, 1H), 7.8 (d, <i>J</i> = 8.6 Hz, 2H), 7.8–7.6 (m, 3H), 7.55–7.2 (m, 6H), 6.17 (m, 1H), 3.2–2.8 (m, 3H), 2.1–1.95 (m, 1H)
146		B	591 (M+H)	205–210	(CDCl ₃) 9.12 (s, 1H), 8.60 (s, 1H), 8.25 (d, <i>J</i> = 8.4 Hz, 2H), 7.78 (d, <i>J</i> = 8.5 Hz, 2H), 7.77 (s, 1H), 7.71 (d, <i>J</i> = 8.4 Hz, 2H), 7.63 (d, <i>J</i> = 7 Hz, 1H), 7.5 (d, <i>J</i> = 8.5 Hz, 2H), 7.4 (d, <i>J</i> = 8.4 Hz, 2H), 7.35 (d, <i>J</i> = 8.4 Hz, 2H), 5.8–5.6 (m, 1H), 1.67 (d, <i>J</i> = 7 Hz, 3H)
147		B	525 (M+H)	209–213	(CDCl ₃) 9.27 (s, 1H), 8.6 (s, 1H), 8.25 (d, <i>J</i> = 8.4 Hz, 2H), 7.8 (m, 3H), 7.77 (d, <i>J</i> = 8.6 Hz, 2H), 7.63 (d, <i>J</i> = 7 Hz, 1H), 7.42 (d, <i>J</i> = 8.5 Hz, 2H), 7.4 (s, 1H), 7.35–7.22 (m, 3H), 5.78 (m, 1H), 2.28 (s, 3H), 1.62 (d, <i>J</i> = 7 Hz, 3H)
148		B	541 (M+H)	216–220	(CDCl ₃) 9.4 (s, 1H), 8.8 (d, <i>J</i> = 8 Hz, 1H), 8.62 (s, 1H), 8.3 (d, <i>J</i> = 8.4 Hz, 2H), 7.9–7.7 (m, 5H), 7.4 (d, <i>J</i> = 8.5 Hz, 2H), 7.4–7.3 (m, 2H), 6.93 (m, 2H), 5.78 (m, 1H), 4.03 (s, 3H), 1.62 (d, <i>J</i> = 6 Hz, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO-d ₆ , δ) ¹
149		B	553 (M+H)	165 dec	(CDCl ₃) 9.1 (s, 1H), 8.6 (s, 1H), 8.22 (d, <i>J</i> = 8.4 Hz, 2H), 7.85-7.6 (m, 6H), 7.4 (d, <i>J</i> = 8.5 Hz, 2H), 7.23 (m, 2H), 6.82 (d, <i>J</i> = 6 Hz, 1H), 5.68 (m, 1H), 3.81 (s, 3H), 2.25 (s, 3H), 1.62 (d, <i>J</i> = 6 Hz, 3H)
150		B	541 (M+H)	196-203	(CDCl ₃) 9.32 (s, 1H), 8.6 (s, 1H), 8.22 (d, <i>J</i> = 8.4 Hz, 2H), 7.85-7.7 (m, 5H), 7.6 (d, <i>J</i> = 6 Hz, 1H), 7.4 (d, <i>J</i> = 8.5 Hz, 2H), 7.25-7.15 (m, 2H), 6.93 (m, 1H), 5.7 (m, 1H), 3.89 (s, 3H), 1.67 (d, <i>J</i> = 6 Hz, 3H)
151		B	571 (M+H)	165 dec	(CDCl ₃) 9.41 (s, 1H), 8.6 (s, 1H), 8.22 (d, <i>J</i> = 8.4 Hz, 2H), 7.85-7.6 (m, 6H), 7.4 (d, <i>J</i> = 8.5 Hz, 2H), 7.05 (m, 2H), 6.91 (m, 1H), 5.7 (m, 1H), 3.92 (s, 3H), 3.89 (s, 3H), 1.68 (d, <i>J</i> = 6 Hz, 3H)
152		B	511 (M+H)	201-206	(CDCl ₃) 9.32 (s, 1H), 8.61 (s, 1H), 8.27 (d, <i>J</i> = 8.4 Hz, 2H), 7.9-7.7 (m, 6H), 7.5-7.3 (m, 7H), 5.76 (m, 1H), 1.67 (d, <i>J</i> = 7 Hz, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
153		B	541 (M+H)	185–190	(CDCl ₃) 9.85 (s, 1H), 8.6 (s, 1H), 8.23 (d, <i>J</i> = 8.4 Hz, 2H), 7.9 (s, 1H), 7.87–7.7 (m, 5H), 7.4 (d, <i>J</i> = 8.5 Hz, 2H), 7.4–7.4 (m, 1H), 7.1–6.95 (m, 2H), 6.85 (m, 1H), 5.73 (m, 1H), 3.81 (s, 3H), 1.69 (d, <i>J</i> = 6 Hz, 3H)
154		B	503 (M+H)	214–218	(CDCl ₃) 9.36 (s, 1H), 8.60 (s, 1H), 8.21 (d, <i>J</i> = 8.4 Hz, 2H), 7.9–7.7 (m, 5H), 7.4–7.25 (m, 5H), 7.2 (d, <i>J</i> = 3 Hz, 1H), 5.0 (s, 2 H)
155		B	517 (M+H)	171–180	9.36 (s, 1H), 8.59 (s, 1H), 8.23 (d, <i>J</i> = 8.4 Hz, 2H), 7.85–7.77 (m, 3H), 7.72 (d, <i>J</i> = 8.4 Hz, 2H), 7.61 (d, <i>J</i> = 8.9 Hz, 1H), 7.40 (d, <i>J</i> = 8.3 Hz, 2H), 7.35 (m, 1H), 7.30–7.26 (m, 1H), 7.19 (dd, <i>J</i> = 5.0, 1.3 Hz, 1H), 5.96–5.75 (m, 1H), 1.72 (d, <i>J</i> = 6.8 Hz, 3H)
156		B		205–213	11.68 (s, 1H), 9.42 (s, 1H), 9.05 (br s, 1H), 8.2–8.0 (m, 5H), 7.95 (d, <i>J</i> = 8.5 Hz, 2H), 7.6 (d, <i>J</i> = 8.4 Hz, 2H), 7.23 (d, <i>J</i> = 5 Hz, 1H), 6.8 (d, <i>J</i> = 5 Hz, 1H), 4.9 (d, <i>J</i> = 6 Hz, 2H), 2.25 (s, 3H)

#	Structure	Synthesis Method	MS	mp (°C)	¹ H NMR (DMSO- <i>d</i> ₆ , δ) ¹
157		B	555 (M+H)	174–178	(CDCl ₃) 9.20 (s, 1H), 8.8 (s, 1H), 8.23 (d, <i>J</i> = 8.4 Hz, 2H), 7.85–7.65 (m, 6H), 7.5–7.4 (m, 6H), 5.75 (q, <i>J</i> = 7 Hz, 1H), 4.46 (s, 2H), 3.20 (s, 3H), 1.71 (d, <i>J</i> = 7 Hz, 3H)
158		B	512 (M+H)	--	11.7 (s, 1H), 9.42 (s, 1H), 8.87 (d, <i>J</i> = 8.4 Hz, 1H), 8.6 (s, 1H), 8.42 (d, <i>J</i> = 2 Hz, 1H), 8.2–7.95 (m, 7H), 7.8 (d, <i>J</i> = 5.4 Hz, 1H), 7.6 (d, <i>J</i> = 8.4 Hz, 2H), 7.38 (m, 1H), 5.8 (m, 1H), 1.6 (d, <i>J</i> = 6 Hz, 3H)
159		B	555 (M+H)	188–191	(CDCl ₃) 9.16 (s, 1H), 8.0 (s, 1H), 8.23 (d, <i>J</i> = 8.4 Hz, 2H), 7.8 (m, 3H), 7.72 (d, <i>J</i> = 8.5 Hz, 2H), 7.6 (d, <i>J</i> = 7 Hz, 1H), 7.4 (d, <i>J</i> = 8.6 Hz, 2H), 6.9 (m, 2H), 6.8 (d, <i>J</i> = 7 Hz, 1H), 5.96 (s, 2H), 5.65 (m, 1H), 1.62 (d, <i>J</i> = 7.5 Hz, 3H)

¹ All NMR data measured in DMSO-*d*₆ at 300 or 400 MHz unless otherwise noted

Table 2

Compound	Mortality CEW 50 μg/cm ²	Mortality BAW 50 μg/cm ²	Mortality GPA 200 ppm
1	A	A	B
2	A	A	B
3	B	A	B
4	A	A	B
5	A	A	B
6	A	A	B
7	A	B	B
8	A	A	B
9	A	A	B
10	A	A	B
11	A	A	B
12	A	A	B
13	A	A	B
14	A	A	B
15	A	A	B
16	A	A	B
17	A	A	B
18	A	A	B
19	B	B	B
20	A	A	B
21	A	A	B
22	A	A	B
23	A	A	B
24	B	A	B
25	A	A	B
26	A	A	B
27	A	A	B
28	A	A	B
29	A	A	B
30	A	A	B
31	B	B	B
32	B	B	B
33	A	A	B
34	A	A	B
35	B	B	B
36	A	A	B
37	A	A	B
38	A	A	B
39	A	A	B
40	A	A	B
41	A	A	B
42	A	A	B
43	A	A	B
44	B	B	B
45	A	A	B

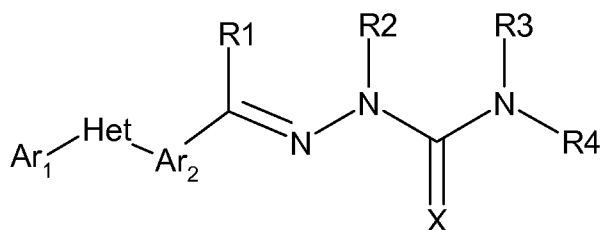
46	A	A	B
47	A	A	B
48	A	A	C
49	A	A	B
50	A	A	B
51	A	A	B
52	A	A	B
53	A	A	B
54	B	B	B
55	B	B	B
56	A	A	B
57	A	A	B
58	A	A	B
59	B	B	B
60	A	A	C
61	A	A	B
62	A	A	B
63	A	A	B
64	A	A	B
65	A	A	B
66	A	A	B
67	A	A	B
68	A	A	B
69	A	A	B
70	A	A	B
71	A	A	B
72	A	A	B
73	A	A	B
74	A	A	B
75	A	A	B
76	A	A	B
77	A	A	B
78	A	A	B
79	A	A	B
80	A	A	C
81	A	A	B
82	A	A	C
83	B	B	C
84	B	B	C
85	A	A	C
86	A	A	C
87	B	B	C
88	A	A	C
89	A	A	C
90	A	A	C
91	A	A	C
92	A	A	C
93	A	A	C
94	A	A	C
95	A	A	C
96	A	A	C
97	A	A	B
98	A	A	C

99	A	A	C
100	A	A	C
101	A	A	C
102	A	A	C
103	A	A	C
104	A	A	C
105	A	A	C
106	A	A	C
107	A	A	C
108	A	A	C
109	A	A	B
110	A	A	C
111	A	A	C
112	A	A	C
113	B	B	C
114	A	A	C
115	A	A	C
116	A	A	C
117	A	A	C
118	A	A	C
119	A	A	B
120	A	A	B
121	A	A	C
122	A	A	C
123	A	A	C
124	A	A	C
125	A	A	B
126	A	A	B
127	A	A	B
128	A	A	B
129	A	A	B
130	A	A	C
131	A	A	C
132	A	A	B
133	A	A	B
134	A	A	C
135	A	A	C
136	A	A	C
137	A	A	C
138	A	A	C
139	A	A	C
140	A	A	C
141	A	A	C
142	A	A	C
143	A	A	C
144	A	A	C
145	A	A	C
146	A	A	C
147	A	A	C
148	A	A	C
149	A	A	C
150	A	A	C
151	A	A	C

152	A	A	C
153	A	A	C
154	A	A	C
155	A	A	C
156	A	A	C
157	A	A	C
158	A	A	C
159	A	A	C

WE CLAIM

1. A molecule of the following formula:



wherein:

5 (a) Ar₁ is

(1) furanyl, phenyl, pyridazinyl, pyridyl, pyrimidinyl, thienyl, or

(2) substituted furanyl, substituted phenyl, substituted pyridazinyl, substituted pyridyl, substituted pyrimidinyl, or substituted thienyl,

wherein said substituted furanyl, substituted phenyl, substituted pyridazinyl, substituted pyridyl, substituted pyrimidinyl, and substituted thienyl, have one or more substituents independently selected from H, F, Cl, Br, I, CN, NO₂, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, phenoxy, substituted phenyl, and substituted phenoxy,

wherein such substituted phenyl and substituted phenoxy have one or more substituents independently selected from H, F, Cl, Br, I, CN, NO₂, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl),

C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl) phenyl, and phenoxy;

(b) Het is a 5 or 6 membered, saturated or unsaturated, heterocyclic ring, containing one or more heteroatoms independently selected from nitrogen, sulfur, or oxygen, and where Ar₁ and Ar₂ are not ortho to each other (but may be meta or para, such as, for a five membered ring they are 1,3 and for a 6 membered ring they are either 1,3 or 1,4), and where said heterocyclic ring may also be substituted with one or more substituents independently selected from H, OH, F, Cl, Br, I, CN, NO₂, oxo, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, phenoxy, substituted phenyl and substituted phenoxy

wherein such substituted phenyl and substituted phenoxy have one or more substituents independently selected from H, F, Cl, Br, I, CN, NO₂, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)H, C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, and phenoxy;

(c) Ar₂ is

(1) furanyl, phenyl, pyridazinyl, pyridyl, pyrimidinyl, thienyl, or

(2) substituted furanyl, substituted phenyl, substituted pyridazinyl, substituted pyridyl, substituted pyrimidinyl, or substituted thienyl,

wherein said substituted furanyl, substituted phenyl, substituted

pyridazinyl, substituted pyridyl, substituted pyrimidinyl, and substituted thienyl, have one or more substituents independently selected from H, F, Cl, Br, I, CN, NO₂, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, phenoxy, substituted phenyl and substituted phenoxy

wherein such substituted phenyl and substituted phenoxy have one or more substituents independently selected from H, F, Cl, Br, I, CN, NO₂, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ hydroxycycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)H, C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, and phenoxy;

(d) X is O or S;

(e) R₁ is selected from H, CN, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, phenoxy;

(f) R₂, R₃ and R₄ are independently selected from H, C₁-C₆ alkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl),

C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), C(=O)phenyl, phenyl, C₁-C₆ alkylphenyl, C₁-C₆ alkylphenoxy, indanyl, C(=O)Het-1, Het-1, (C₁-C₆ alkyl)Het-1, or C₁-C₆ alkyl-O-Het-1,

5 wherein each alkyl, cycloalkyl, cycloalkoxy, halocycloalkoxy, alkoxy, haloalkoxy, alkenyl, alkynyl, C₁-C₆ alkylphenyl, phenyl, phenoxy, and Het-1, are optionally substituted with one or more substituents independently selected from F, Cl, Br, I, CN, NO₂, NR_xR_y, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyl, C₃-C₆ cycloalkenyl, C₂-C₆ alkynyl, C₃-C₆ cycloalkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), S(=O)₂N(C₁-C₆ alkyl)₂, OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)H, C(=O)NR_xR_y, (C₁-C₆ alkyl)NR_xR_y, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), phenyl, phenoxy, O-Het-1, and Het-1,

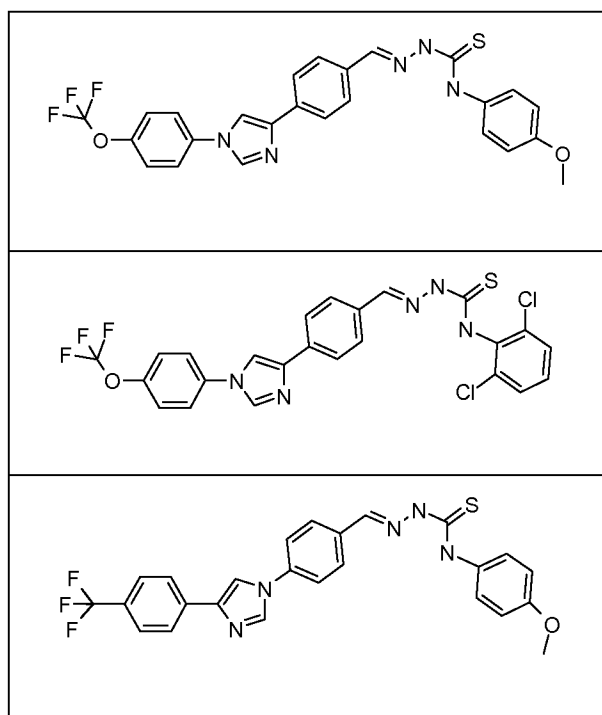
wherein Het-1 is a 5- or 6-membered, saturated or unsaturated, heterocyclic ring, containing one or more heteroatoms independently selected from nitrogen, sulfur or oxygen,

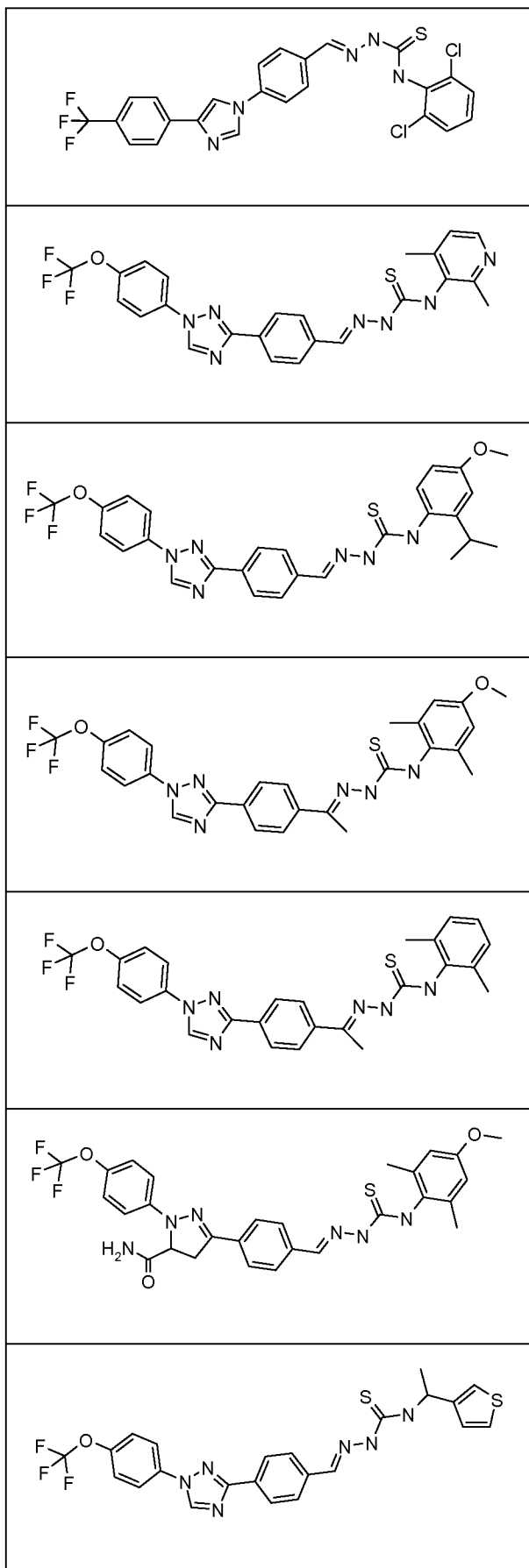
wherein R₃ and R₄ together can optionally form a 3- to 8-membered saturated or unsaturated cyclic group which may contain one or more heteroatoms selected from nitrogen, sulfur, and oxygen;

(g) n = 0, 1, or 2;

(h) R_x and R_y are independently selected from H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), OSO₂(C₁-C₆ alkyl), OSO₂(C₁-C₆ haloalkyl), C(=O)H, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), C(=O)O(C₁-C₆ haloalkyl), C(=O)(C₃-C₆ cycloalkyl), C(=O)O(C₃-C₆ cycloalkyl), C(=O)(C₂-C₆ alkenyl), C(=O)O(C₂-C₆ alkenyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), (C₁-C₆ alkyl)S(C₁-C₆ alkyl), C(=O)(C₁-C₆ alkyl)C(=O)O(C₁-C₆ alkyl), and phenyl.

2. A molecule according to claim 1 wherein Ar₁ is a substituted phenyl wherein said substituted phenyl, has one or more substituents independently selected from C₁-C₆ alkyl, C₁-C₆ haloalkyl, and C₁-C₆ haloalkoxy.
3. A molecule according to claim 1 wherein Het is a triazolyl, imidazolyl, pyrrolyl, or
5 pyrazolyl.
4. A molecule according to claim 1 wherein Ar₂ is a phenyl.
5. A molecule according to claim 1 wherein R₄ is a C₁-C₆ alkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkenyl, C(=O)phenyl, C₁-C₆ alkylphenyl, Het-1, or (C₁-C₆ alkyl)Het-1.
6. A molecule according to claim 1 wherein R₄ is a C₁-C₆ alkyl, C₁-C₆ alkylphenyl,
10 phenyl, or Het-1, wherein each is substituted with one or more substituents independently selected from F, Cl, Br, I, CN, NO₂, NR_xR_y, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkenyl, S(=O)_n(C₁-C₆ alkyl), S(=O)_n(C₁-C₆ haloalkyl), S(=O)₂N(C₁-C₆ alkyl)₂, C(=O)(C₁-C₆ alkyl), C(=O)O(C₁-C₆ alkyl), C(=O)(C₁-C₆ haloalkyl), (C₁-C₆ alkyl)O(C₁-C₆ alkyl), phenyl, O-Het-1, and Het-1.
- 15 7. A molecule according to claim 1 having one of the following structures





8. A process to apply a molecule according to claim 1 said process comprising applying a molecule according to claim 1, to an area to control a pest, in an amount sufficient to control such pest.

5 9. A process according to claim 8 wherein said pest is BAW, CEW, or GPA.

10. A molecule that is a pesticidally acceptable acid addition salt, a salt derivative, a solvate, or an ester derivative, of a molecule according to claim 1.

10 11. A molecule according to claim 1 wherein at least one H is ^2H or at least one C is ^{14}C .

12. A composition comprising a molecule according to claim 1 and at least one other compound having insecticidal, herbicidal, acaricidal, nematocidal, or fungicidal activity.

15 13. A composition comprising a molecule according to claim 1 and a seed.

14. A process comprising applying a molecule according to claim 1 to a genetically modified plant, or genetically-modified seed, which has been genetically modified to express one or more specialized traits.

20

15. A process comprising: orally administering; or topically applying; a molecule according to claim 1, to a non-human animal, to control endoparasites, ectoparasites, or both.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 10/44525

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A01N 43/64 (2010.01)

USPC - 514/359

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

USPC: 514/359

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

USPC: 514/359 ; 514/91 ; 514/92 ; 514/96 ; 548/476 (see keywords below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WEST: PGPB, USPT, USOC, EPAB, JPAB

Google: Scholar/patents: pesticidal composition thioureas hydrazones diphenyl imidazole antiparasitic insecticide benzylidene thiosemicarbazone aryl genetically modified plant beet armyworm pesticides parasites

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,417,187 B2 (HEGDE et al) 09 July 2002 (09.07.2002) Col 1, ln 40-67; Col 2, ln 22-23; Col 4, ln 8-21; Col 39, ln 64-67; Col 40, ln 63-67; Col 41, ln 1-12; Col 41, ln 23-29; Col 16, ln 42-45; Col 39, Table 7	1-15
Y	PEDERSEN et al. Synthesis and Insect Growth Regulating Activity of Thiosemicarbazones of Methyl 2-Pyridyl Ketones in Pest. Sci. 1984, Vol 25, pp 462-470 pg 462, para 3; pg 463, Tables 1 and 2	1-15
Y	US 2008/0262057 A1 (TISDELL et al) 23 October 2008 (23.10.2008) para [0089]-[0116]; [0150]-[0152]	12;14;15
Y	ELMARAKBY et al. Degradation of [14C]-Carfentrazone-ethyl under Aerobic Aquatic Conditions in Journal of Agricultural Food Chemistry, 2001, Vol 49, pp 5285-5293. pg 5285, abstract; Col 2, para 2; Col 3, para 1, Figure 1	11

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

* Special categories of cited documents:

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

16 September 2010 (16.09.2010)

Date of mailing of the international search report

23 SEP 2010

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