Public Health Pesticides

An Inventory of Chemical Tools for Vector Control

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The IR-4 Project, Princeton, NJ

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The IR-4 Project is a U.S. federally funded partnership of the U.S.D.A. and the state land grant universities and agricultural experiment stations, with headquarters at Rutgers University, and a mission of providing regulatory support for pest management technology for specialty crops and other minor uses.

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Contents

Introduction:

Public health pesticides, or PHP's, are critical tools for the control and prevention of many vector-borne diseases, such as malaria, dengue, West Nile virus, or Lyme Disease, but it is not easy to identify which insecticides, acaracides, repellents, attractants, and other semiochemicals can be used effectively, safety, and legally for vector control. This inventory of public health pesticides is intended to address two primary topics: the status of chemical tools available for vector control in major markets in mid-2012, and the status of other pesticides and other chemicals that are not generally registered for vector control but that could be useful additions to the vector control chemical toolbox. For either purpose, it is recognized that any list will inevitably become incomplete or inaccurate over time, and to help ensure the ongoing utility of this project, a web-based Public Health Pesticide Database has also been created (ir4.rutgers.edu/PublicHealth/publichealthDB.cfm) and is maintained as information becomes available on vector control tools that enter or exit from global market, and, to the extent feasible, other major national markets.

The primary focus of this inventory is control of mosquitoes and ticks. The scope of vector control in contrast to control of "nuisance" arthropods has been debated, but for the purposes of this inventory, any arthropod that is known to transmit infectious disease to humans or, because of its blood-feeding habit, could transmit pathogenic organisms, is considered a "vector". Many materials used primarily against veterinary pest insects (in particular, some repellents) are also potentially useful for combatting human-biting arthropods and human diseases, and are included in this inventory. Some primarily pharmaceutical materials are included if they have significant use in treatment of known vectors or ectoparasites that could transmit pathogenic disease. Bed bug treatments are included because of the great public concern over these pests in many locations in recent years, despite their apparent inability to transmit pathogens.

This inventory is organized around PHP active ingredients (AI's), rather than end-use formulated products, although it is recognized that formulation can greatly influence the efficacy, safety, ease of use, and cost of vector control products. There are two reasons for this decision – first, pesticide products can only be legally formulated from those AI's which are approved for use against a pest, so a list of approved AI's in any jurisdiction comprehensively shows what pesticidal materials may be marketed or used in end-use products there. Second, there is simply too much turnover in specific products to allow any printed inventory to be accurate for any length of time. However, where specific trade names are well-known and sold over extended periods of time, the most prominent of these are listed as examples of products that include the AI's that are discussed.

On the global scale, the World Health Organization Pesticide Evaluation Scheme (WHOPES) has been the primary institution evaluating vector control tools for the past 50 years, and Table D in this volume lists PHP AI's that are recognized by WHOPES through Specifications and Recommendations, with some information about use patterns and current evaluations of new products. We note that WHOPES is not a regulatory body, and their recommendations and standards do not necessarily indicate that materials are superior to others that may be available. WHOPES recognition does, however, indicate that significant evaluation has been done by a credible, neutral program, and that a material is widely accepted as effective against vectors and reasonably safe when used appropriately.

Tables A, B, and C constitute an expansive list of recognized and high-potential PHP's that includes all WHO-recognized PHP's as well as other materials that have substantial evidence of efficacy against arthropod vectors of human disease. Table A focuses on specification and identification of materials, Table B on regulatory status, and Table C on mode of action and use pattern. For clarity, ISO 1750 Common Names and CAS Registry Numbers are provided where possible. Table B addresses regulatory approval by presenting accepted international norms and a review of regulatory status in the U.S., Australia, Canada, China, the European Union, India, and/or South Africa. While not exhaustive, these jurisdictions provide a nearly comprehensive list of PHP materials in the global market at this time. Despite substantial efforts to coordinate and harmonize regulatory processes, there are significant differences between the lists of products which are registered for use in different countries and regions. This reflects to some extent variations in regulatory processes and requirements, but equally it reflects market conditions, which often dictate to companies that the potential rewards for obtaining or maintaining pesticide registration in some areas do not justify the costs. Therefore, lack of regulatory approval for a PHP in the U.S. or any other jurisdiction should not that interpreted as a rejection of that material by regulatory authorities.

Funding for the development of this inventory was from the United States government, and the remaining tables in this volume are organized with a focus on vector control tools available or potentially available to public and private entities within the U.S. However, much of the in the information is general in nature, and it is expected that it will also be useful to those in other jurisdictions.

Within the U.S., the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and subsequent amendments allow for the use of pesticides (a statutory term which includes repellents, attractants, and other semiochemicals) against specific pests if these chemicals are either specifically registered for that purpose by the U.S. Environmental Protection Agency (EPA) or if they are listed as exempt from registration requirements (so-called 25(b) materials, after that section of FIFRA). Table E lists PHP's currently available for use in the U.S., including both registered and exempt materials, and focuses on their regulatory status. For Table E, PHP's are defined as chemicals which may be legally used against mosquitoes, ticks, sand flies, or bed bugs. Some attractants for filth and stable flies are included. These pests are diverse enough that almost all PHP AI's should be covered.

FIFRA has provisions that material registrations may be cancelled, so that previously acceptable materials may no longer be legally used. Cancellation of the registration of an active ingredient can be a result of analysis by EPA that a pesticide poses unreasonable harm to human health or the environment, but it is much more commonly the result of prohibitively expensive new data requirements to maintain registration, or of voluntary business decisions by registrant(s) to remove a material from the market for other business reasons. Table E5 lists PHP's that have been registered in the U.S. but that are no longer registered, or that have lost vector control registrations. Table E3 summarizes the status of PHP's, and E4 the status of pesticides with high-potential as PHP's, that are under some form of regulatory review in the U.S., current as of April-July 2012. Updates will be posted on the IR-4 Public Health Pesticides website listed above. While potential use patterns are not explicitly considered in most regulatory actions, it seems useful to be aware of the timing of reviews that may impact the availability or the potential range of uses of materials.

Historically, the bulk of organized vector control in the U.S. and elsewhere has focused on mosquitoes, and Tables F1-F7 covers mosquito control chemicals, with subdivisions organized around use patterns. Tables G1-G2 covers tick control materials with a similar organization. While most of the sections of Tables F and G should not be surprising, there is included a table of many materials not typically considered mosquitocides or tick control agents, but which are incorporated into pesticide products registered for mosquito and/or tick control. The bulk of these materials are disinfectants, microbicides, or fumigants that are incorporated into general purpose products that can be used vs. mosquitoes and/or ticks.

Potential PHP's are a diverse collection of materials, with widely differing histories and use patterns, including 1) materials with wide utility in other sectors such as agriculture, but that have not been fully utilized in public health; 2) materials registered in some jurisdictions, whether for vector control or other purposes, but that are not legally available elsewhere; 3) materials that were previously registered for these uses but that have been withdrawn from registration; 4) materials with local or folk use but little formal evaluation or regulation; 5) materials evaluated earlier but not fully developed at the time; and 6) materials that have only recently been developed.

Table H1 lists vector control chemicals that are registered in the U.S. for some vector control purposes (defined as control of mosquitoes, ticks, sand flies, other biting flies, or bed bugs), and that have potential for expanded PHP use. These expanded uses can be new use patterns for currently labeled targets or new vector targets. The table presents chemical identifiers, mode of action, current and most likely expanded use patterns, and regulatory status.

Table H2 presents pesticides with vector control potential that are registered in the U.S., but only for use against other pests. Many of these are primarily agricultural products, while some are intended for household or veterinary use. Some are recently developed materials with registration numbers (EPA PC Codes) issued, but no registered end-use products to date. Table E5 identifies those materials in either Table H1 or H2 (i.e. registered for some uses in the U.S.) that are undergoing current regulatory review. While potential use patterns are not explicitly considered in most regulatory actions, it seems useful to be aware of the timing of reviews that may impact the availability or the potential range of uses of materials.

Materials that are registered for use in other countries but not in the U.S. are listed in Table I, which aggregates materials in three circumstances: those which have not yet been registered in the U.S., those which have been registered but that no longer have current registration, and those that are exempt. As noted before, U.S. law allows for product registrations to be cancelled either because of evidence of unreasonable risk or, much more commonly, because of business decisions by registrants, including evaluation that new data requirements are prohibitively costly relative to small markets. Materials that have been cancelled by EPA for safety reasons or that are on WHO's list of Obsolete Pesticides are not included in this table.

Table J1 presents novel materials which are not known to be registered for any purpose in any major jurisdiction. Many of these are natural products, which may have local uses, while others are semi-synthetic analogues to natural products or purely synthetic chemicals. In all cases, chemical or botanical

identifiers are included together with mode of action (if known), observations on efficacy in the lab (and field, where available), and the most likely potential PHP use patterns as indicated in the current scientific and other public access literature. Many biological pest control strategies, such as microbes or fungal spores, can be formulated and distributed in a manner identical to chemical pesticides, and these are included in this table. Table J2 is a short list of underutilized biological vector control agents which are not likely to be readily formulated and packaged as pesticides.

Finally, while it is impossible to list all the materials which have been screened for vector control uses and judged to have little potential, it is helpful to comment on novel pest control technologies that have been screened for PHP potential as part of their development process. Thus, Table K presents new pesticides coming onto the market, or older ones recently reevaluated for vector control, that have little apparent utility. While none of these should be rejected out of hand, it is hoped that this list may help direct scarce research resources away from unproductive paths if these have already been adequately explored.

Abbreviations used:

CS = Capsule Suspension
DP = Dustable Powder
EC = Emulsifiable Concentrate
EW = Emulsion, oil-in-Water
IRS = Indoor Residual Spraying
ITN = Insecticide-Treated Net
LLIN = Long-Lasting Insecticidal mosquito Net
OC = Organo-Chlorine
OP = OrganoPhosphate
SC = Suspension Concentrate
ULV = Ultra-Low-Volume
WDG = Water Dispersible Granules
WDT = Water Dispersible Tablets
WP = Wettable Powder

Part A. Identification, Specification, & Characterization of Public Health Pesticides

Precise specification and characterization of all chemicals is important for clear communication, but it is particularly critical for public health pesticides, where the efficacy and safety of materials can vary considerably depending on the ratio of stereoisomers, the source material for botanical extracts, etc. In addition to the usual challenges faced by attempting global standardization of anything, two major challenges are apparent when discussing PHP's and potential PHP's, and much of this discussion is focused on clarifying the stereochemistry of molecules, and in particular of the pyrethroids, and in establishing the taxonomic system used when discussing plants and other natural sources of pesticidal materials.

ISO indicates a common name of an active ingredient approved by the International Organization for Standardization, and these names, where available, are universally recognized as authoritative for regulation and trade. ISO Standard 1750, "Pesticides and other Agrochemicals - Common Names" was first published in 1981, followed by Amendment 1 (1982), Addenda 1 & 2 (1983), and Amendments 2 (1999), 3 (2001), 4 (2008), and 5 (2008). A compilation of the original document and all addenda and amendments under a single cover has not yet been issued. ISO Standard 765 "Pesticides considered not to require common names" was published in 1976 (ISO 765-1976).

Where ISO names have not been published, authorities recognized here include the World Health Organization (WHO), Chemical Abstracts Service (CAS), U.S. Environmental Protection Agency (EPA), British Standards Institution, (BS 1831: 1969), Standards Press of China (GB 4839: 2009), and the Entomological Society of America (ESA).

Primary sources for taxonomic treatment of natural sources of insecticides include the U.S. National Center for Biotechnology Information Taxonomy Browser (NCBI = ncbi.nlm.nih.gov/taxonomy), the USDA PLANTS database (PLANTS = plants.usda.gov/java/), the USDA ARS Germplasm Resources Information Network (GRIN = sun.ars-grin.gov/), and the U.S. government's Integrated Taxonomic Information System (ITIS = itis.gov/); NCBI, GRIN, and ITIS citations include numeric identifiers.

Table A. Names and Specifications of Recognized or Potential Public Health Pesticides, July 2012

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
(+)-Citronellol (= d- or R-Citronellol)	CAS	1117-61-9	6-Octen-1-ol, 3,7-dimethyl-, (3R)-	-	-	-
(-)-Citronellol (= l- or S- Citronellol)	CAS	7540-51-4	6-Octen-1-ol, 3,7-dimethyl-, (3S)-	-	-	-
(-)-Isolongifolenone	CAS	26839-52-1	7H-2,4a-Methanonaphthalen-7-one, 1,2,3,4,5,6-hexahydro-1,1,5,5-tetramethyl-, (2S,4aR)-	-	-	-
1,3,3-trimethylcyclohex-1-ene-4-carboxaldehyde	CAS	1726-47-2	3-Cyclohexene-1-carboxaldehyde, 2,2,4-trimethyl-	-	-	-
1-Octen-3-ol[1]	EPA	3391-86-4	1-Octen-3-ol	-	-	69037
2-Butyl-2-ethyl-1,3-propanediol	EPA	115-84-4	1,3-Propanediol, 2-butyl-2-ethyl-	-	-	41003
2-Hexenamide, N-cyclohexyl-N-ethyl-, (2E)-: see (E)-N-cyclohexyl-N-ethyl-2-hexenamide						
2-Hydroxyethyl Octyl Sulfide (= MGK® Repellent 874)	WHO 2009	3547-33-9	Ethanol, 2-(octylthio)-	-	-	46301
2-Phenethyl Propionate	EPA	122-70-3	Propanoic acid, 2-phenylethyl ester	-	-	102601
2-Undecanone: see Undecan-2-one						
4,6-Dinitro-o-cresol: see DNOC						
4-Terpineol[f]	CAS	562-74-3	3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)-	-	-	-
Abamectin (= Avermectin B1)[g, 2]	ISO 1750: 2008	65195-56-4	Avermectin A1a, 5-O-demethyl-25-de(1-methylpropyl)-25-(1-methylethyl)-	-	-	122804
Acepromazine	CAS	61-00-7	Ethanone, 1-[10-[3-(dimethylamino)propyl]-10H-phenothiazin-2-yl]-	-	-	-
Acequinocyl	ISO 1750: 2001	57960-19-7	1,4-Naphthalenedione, 2-(acetyloxy)-3-dodecyl-	-	-	6329
Acetaminophen	EPA	103-90-2	Acetamide, N-(4-hydroxyphenyl)-	-	-	109509
Acetamiprid	ISO 1750: 1999	135410-20-7	Ethanimidamide, N-[(6-chloro-3-pyridinyl)methyl]-N'-cyano-N-methyl-, (1E)-	-	-	99050

[a] See description of codes for naming authorities in the text before this table.

[b] The CAS Registry Number (RN) is a global standard for identification of chemicals. Throughout this Inventory, the RN's and specifications published in the CAS SciFinder (scifinder.cas.org) in June-July 2012 are used.

[c] UN number refers to the UN Recommendations on the Transport of Dangerous Goods, Eleventh revision (1999), as reported in The WHO Recommended Classification of Pesticides by Hazard (2009; who.int/ipcs/publications/pesticides-hazard/en/).

[d] World Health Organization Pesticide Evaluation Scheme (WHOPES: who.int/whopes/en/) Specifications: SN = Issued under New Procedure; SO = Issued under Old Procedure; SW = Specification Withdrawn.

[e] USEPA Pesticide Constituent (PC) Code (epa.gov/pesticides/chemicalsearch).

[f] The specification of pine oils and their constituents, especially the pinene molecules and terpineols, is complex and inconsistently applied. See Tables A2 and A4.

[g] Eight different avermectins have been isolated in 4 pairs of homologue compounds. Abamectin is a specified mixture of avermectins containing more than 80% avermectin B_{1a} and less than 20% avermectin B_{1b}. EPA regulates Abamectin as Avermectic B1.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Acetic Acid[a] (= Ethanoic Acid = Vinegar)	EPA	64-19-7	Acetic acid	-	-	44001
Aedes aegypti male pheromone	Literature	-				
AI3-37220: see SS 220						
AI-35765 (= CHR 11)	CAS	52736-58-0	Methanone, 3-cyclohexen-1-yl-1-piperidinyl-	-	-	-
Allethrin[b]	ISO 1750	584-79-2	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, 2-methyl-4-oxo-3-(2-propen-1-yl)-2-cyclopenten-1-yl ester	-	-	4001
Allethrin II[b]	CAS	497-92-7	Cyclopropanecarboxylic acid, 3-(3-methoxy-2-methyl-3-oxo-1-propen-1-yl)-2,2-dimethyl-, 2-methyl-4-oxo-3-(2-propen-1-yl)-2-cyclopenten-1-yl ester	-	-	-
Allyl Isothiocyanate[c]	EPA	57-06-7	1-Propene, 3-isothiocyanato-	-	-	4901
Alpha-Cypermethrin[d]	ISO 1750: 1999	67375-30-8	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, (*R*)-cyano(3-phenoxyphenyl)methyl ester, (1*S*,3*S*)-*rel*-	3349	SN	209600
α-Humulene (= Alpha-Humulene = α-Caryophyllene)	CAS	6753-98-6	1,4,8-Cycloundecatriene, 2,6,6,9-tetramethyl-, (1*E*,4*E*,8*E*)-	-	-	-
α-Ionone[e] (= Alpha-Ionone)	EPA; CAS	127-41-3	3-Buten-2-one, 4-(2,6,6-trimethyl-2-cyclohexen-1-yl)-, (3*E*)-	-	-	129030
α-Pinene (= Alpha-Pinene = Alpha-(+)-Pinene)	EPA	80-56-8	Bicyclo[3.1.1]hept-2-ene, 2,6,6-trimethyl-	-	-	67004
α-Terpineol (= Alpha-Terpineol)	EPA	98-55-5	3-Cyclohexene-1-methanol, α,α,4-trimethyl-	-	-	224400
α-Thujone (= Alpha-Thujone)	CAS	546-80-5	Bicyclo[3.1.0]hexan-3-one, 4-methyl-1-(1-methylethyl)-, (1*S*,4*R*,5*R*)-	-	-	-
Aluminum Phosphide = Aluminium Phosphide	GB 4839: 2009	20859-73-8	Aluminum phosphide (AlP)	-	-	66501
Amitraz	ISO 1750:1981	33089-61-1	Methanimidamide, *N*'-(2,4-dimethylphenyl)-*N*-[[(2,4-dimethylphenyl)imino]methyl]-*N*-methyl-	-	-	106201
Ammonia	EPA	7664-41-7	Ammonia	-	-	5302
Ammonium Bicarbonate	EPA	1066-33-7	Carbonic acid, ammonium salt (1:1)	-	-	73401
Ammonium Fluorosilicate (= Ammonium Fluosilicate)	EPA	16919-19-0	Silicate(2-), hexafluoro-, ammonium (1:2)	-	-	75301
Anethole (= p-Propenylanisole)	EPA	104-46-1	Benzene, 1-methoxy-4-(1-propen-1-yl)-	-	-	15604

[a] Many simple carboxylic and fatty acids have been screened for PHP utility and those that seem most promising are reported individually in this table, but some groups are also discussed together because of similarities in their attributes. The very short chain (C1-C3) aliphatic acids are not generally considered fatty acids. Both the shorter carboxylic acids and the fatty acids up to C20 are summarized in Table A8.

[b] The Allethrin molecule has three stereocenters, resulting in eight specific stereoisomers and many possible isomer mixtures. Therefore, specification of allethrin-based materials, as with all pyrethroids, is complex and prone to inaccuracy or imprecision; see Table A1 for comprehensive specification. Note that the compound described here as Allethrin was originally known as Allethrin I to distinguish it from its Chrysanthemumdicarboxylic acid counterpart known as Allethrin II, which has not been commercialized developed.

[c] Allyl Isothiocyanate is the pungent constituent of mustard oil, and is at times treated synonymously with Oil of Mustard (e.g. U.S. pesticide registration treats has applied EPA PC Code 4901 to both the plant oil and the active molecule). The abundance of this compound in Mustard Oil depends on the species of mustard, the growing condition, etc.

[d] See Table A1 for stereochemical specification of pyrethroids.

[e] EPA and CAS use the CAS chemical name to identify this material, but both recognize the common name, which is used in publications, as an acceptable synonym.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Arsenenic Acid	CAS	10102-53-1	Arsenenic acid	-	-	-
Arsenic Acid	CAS	7778-39-4	Arsenic acid (H3AsO4)	-	-	6801
Arsenous Acid	CAS	13464-58-9	Arsenous acid	-	-	-
Atrazine	ISO 1750: 1981	1912-24-9	1,3,5-Triazine-2,4-diamine, 6-chloro-*N*^{2}-ethyl-*N*^{4}-(1-methylethyl)-	-	-	80803
Avermectin	CAS	73989-17-0	Avermectin	-	-	-
Avermectin B1: see Abamectin						
Azadirachtin (= Azadirachtin A)[a]	GB 4839: 2009	11141-17-6	[3]	-	-	121701
Azadirachtin B	EPA; CAS	95507-03-2	[4]	-	-	121700
Azadirachtin H	CAS	134788-15-1	[5]	-	-	-
Azocyclotin	ISO 1750: 1983	41083-11-8	1*H*-1,2,4-Triazole, 1-(tricyclohexylstannyl)-	2786	-	484600
Bacillus sphaericus; see *Lysinibacillus sphaericus* (Bacillaceae)						
Bacillus thuringiensis ssp. *israelensis* (= Bti), serotype H-14[b] (Bacillaceae)	N1430, EPA	68038-71-1	*Bacillus thuringiensis*	-	-	6401
Bti strain AM65-52	WHOPES	68038-71-1	*Bacillus thuringiensis*	-	SN	69162
Bti Strain BK, ATCC number 35646[c]	N339854	68038-71-1	*Bacillus thuringiensis*	-	-	
Bti strain BMP 144	EPA	68038-71-1	*Bacillus thuringiensis*	-	-	6520
Bti strain EG2215	EPA	68038-71-1	*Bacillus thuringiensis*	-	-	6476
Bti Strain IPS-78	Literature[6]	68038-71-1	*Bacillus thuringiensis*	-	-	
Bti strain SA3A	EPA	68038-71-1	*Bacillus thuringiensis*	-	-	69210
Beauveria alba: see *Engyodontium album* (Cordycipitaceae)						
Beauveria amorpha (Cordycipitaceae)	N37997	-	-	-	-	-
Beauveria bassiana (Cordycipitaceae)	N475271	63428-82-0	*Beauveria bassiana*	-	-	Many[d]
Beauveria brongniartii (Cordycipitaceae)	N475814	67891-89-8	*Beauveria tenella*	-	-	-
Beauveria velata (Cordycipitaceae)	N43683	-	-	-	-	-
Beauveria vermiconia (Cordycipitaceae)	N37996	-	-	-	-	-
Beauvericin	CAS	26048-05-5	[7]	-	-	-
Bendiocarb	ISO 1750: 1981	22781-23-3	1,3-Benzodioxol-4-ol, 2,2-dimethyl-, 4-(*N*-methylcarbamate)	2757	SN	105201

[a] The insecticidal constituents of neem oil are complex and only recently isolated, specified, and synthesized. The three most active materials are now commonly known as Azadirachtin A or simply Azadirachtin, Azadirachtin B, and Azadirachtin H (springerlink.com/content/wt7010w3w7866800/, pubs.acs.org/doi/abs/10.1021/jf0342167). Given the widespread use of the plant and the continuing incomplete description of its composition, it is not surprising that there is considerable inconsistency in terminology.

[b] Syn. = *Bacillus thuringiensis israelensis*, *B. thuringiensis* (subsp. *israelensis*), *B. thuringiensis* subsp. *israelensis*, *B. thuringiensis* var. *israelensis* (NCBI); *Bacillus thuringiensis* subsp. *israelensis*, Bti (EPA). Bti is generally treated as synonymous with Bti serotype H-14. CAS now ascribes only one Registry Number (RN) to all subspecies and strains of Bacillus thuringiensis, although deleted RN's 12673-85-7, 62628-54-0, and 67383-05-5 have been used. WHO 2009 refers simply to *Bacillus thuringiensis* or Bt. There are many described strains; for this table, registrations for Bti are considered equivalent to Bti serotype H-14, but specific registrations for specific strains are separated. Bti registered in South Africa is referred to as "Serotype H-7."

[c] Syn. = Bti Strain BK, ATCC number 35646 (EPA).

[d] *Beauveria bassiana* Strain ATCC 74040 = PC 128818; GHA = PC 128924; 447 = PC 128815; ESC 170 = PC 128817; HF 23 = PC 090305.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Benzyl Benzoate	EPA	120-51-4	Benzoic acid, phenylmethyl ester	-	-	9501
β-Alanine (= Beta-Alanine = B-Alanine = 3-Aminopropanoic Acid)	CAS	107-95-9	β-Alanine	-	-	-
Betabaculovirus (= *Granulovirus* = Granulosis virus = GV)[a] (Baculoviridae)	N558017	-	-	-	-	varied
β-Caryophyllene (= Beta-Caryophyllene)	CAS	87-44-5	Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-, (1*R*,4*E*,9*S*)-	-	-	-
Beta-Cyfluthrin[b]	ISO 1750: 1999	68359-37-5	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, cyano(4-fluoro-3-phenoxyphenyl)methyl ester	-	-	118831
Beta-Cypermethrin[b]	ISO 1750: 1999	1224510-29-5	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, (*R*)-cyano(3-phenoxyphenyl)methyl ester, (1*S*)-*rel*-	-	-	-
β-Ionone (= Beta-Ionone)	CAS	79-77-6	3-Buten-2-one, 4-(2,6,6-trimethyl-1-cyclohexen-1-yl)-, (3*E*)-	-	-	-
β-Pinene (= Beta-Pinene)	EPA	127-91-3	Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-	-	-	224300
β -Terpineol (= Beta-Terpineol)	EPA	138-87-4	Cyclohexanol, 1-methyl-4-(1-methylethenyl)-	-	-	67003
β-Thujone (= Beta-Thujone)	CAS	471-15-8	Bicyclo[3.1.0]hexan-3-one, 4-methyl-1-(1-methylethyl)-, (1*S*,4*S*,5*R*)-	-	-	-
BHT (= Butylated Hydroxytoluene)	CAS	128-37-0	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-	-	-	22105
Bifenthrin[b]	ISO 1750: 2008	82657-04-3	Cyclopropanecarboxylic acid, 3-[(1*Z*)-2-chloro-3,3,3-trifluoro-1-propen-1-yl]-2,2-dimethyl-, (2-methyl[1,1'-biphenyl]-3-yl)methyl ester, (1*R*,3*R*)-*rel*-	3349	SN	128825
Bioallethrin[b] (= d-trans-Allethrin)	WHOPES	260359-57-7	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, 2-methyl-4-oxo-3-(2-propen-1-yl)-2-cyclopenten-1-yl ester, (1*R*,3*R*)-	-	SN	4003
Bioresmethrin[b]	ISO 1750: 1981	28434-01-7	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, [5-(phenylmethyl)-3-furanyl]methyl ester, (1*R*,3*R*)-	-	-	97802
Bistrifluron (= DBI-3204)	ISO 1750: 2008	201593-84-2	Benzamide, *N*-[[[2-chloro-3,5-bis(trifluoromethyl)phenyl]amino]carbonyl]-2,6-difluoro-	-	-	-
Borax	ISO 765	1303-96-4	Borax ($B_4Na_2O_7.10H_2O$)	-	-	11102
Boric Acid	EPA	10043-35-3 11113-50-1	Boric acid (H_3BO_3)	-	-	11001
Bovidic Acid	CAS	765956-30-7	2-Furanpentanoic acid, tetrahydro-5-[(1*R*)-1-hydroxynonyl]-, (2*S*,5*R*)-	-	-	-
Buprofezin	ISO 1750: 2008	69327-76-0	4*H*-1,3,5-Thiadiazin-4-one, 2-[(1,1-dimethylethyl)imino]tetrahydro-3-(1-methylethyl)-5-phenyl-	-	-	275100
Butane	CAS	106-97-8	Butane	-	-	-
Butanoic Acid (= Butyric Acid)	CAS	107-92-6	Butanoic acid	-	-	-
Butopyronoxyl (= Indalone)	WHO	532-34-3	2*H*-Pyran-6-carboxylic acid, 3,4-dihydro-2,2-dimethyl-4-oxo-, butyl ester	-	-	-
Butoxy Poly Propylene Glycol (= BPG)	EPA	9003-13-8	Poly[oxy(methyl-1,2-ethanediyl)], α-butyl-ω-hydroxy-	-	-	11901

[a] Granulosis viruses = GV (NCBI); under this name, EPA has issued PC Codes for this virus from *Plutella xylostella* (PC 122812) and from *Choristoneura fumiferana* (PC 127985), but has not generally registerd Granulosis viruses.

[b] See Table A1 for stereochemical specification of pyrethroids.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Butyric Acid: see Butanoic Acid						
Calcium Arsenate	ISO 765	7778-44-1	Arsenic acid (H_3AsO_4), calcium salt (2:3)	1573	-	13501 613501
Callicarpenal	CAS	161105-12-0	1-Naphthaleneacetaldehyde, 1,2,3,4,4a,7,8,8a-octahydro-1,2,4a,5-tetramethyl-, (1*S*,2*R*,4a*R*,8a*R*)-	-	-	-
Camphor[a]	GB 4839: 2009	76-22-2	Bicyclo[2.2.1]heptan-2-one, 1,7,7-trimethyl-	-	-	15602
Capric Acid: see Decanoic Acid						
Caproic Acid: see Hexanoic Acid						
Caprylic Acid: see Octanoic Acid						
Carbaryl	ISO 1750-1981	63-25-2	1-Naphthalenol, 1-(*N*-methylcarbamate)	2757	-	56801
Carbon Dioxide	EPA	124-38-9	Carbon dioxide	-	-	16601
Carboxylic Acids, C1-C3[b]	EPA	Various	-	-	-	Mult.
Carvacrol (= Isopropyl-2-Cresol)	GB 4839: 2009 EPA	499-75-2	Phenol, 2-methyl-5-(1-methylethyl)-	-	-	22104
Carveol	CAS	99-48-9	2-Cyclohexen-1-ol, 2-methyl-5-(1-methylethenyl)-	-	-	-
Carvone[c]	ISO 1750: 2001	99-49-0	2-Cyclohexen-1-one, 2-methyl-5-(1-methylethenyl)-	-	-	-
Chlorantraniliprole	ISO 1750: 2008	500008-45-7	1*H*-Pyrazole-5-carboxamide, 3-bromo-*N*-[4-chloro-2-methyl-6-[(methylamino)carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-	-	-	90100
Chlordane (= Octachloro-4,7-methanotetrahydroindane)	ISO 1750: 1981	57-74-9	4,7-Methano-1*H*-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-	2996	-	58201
Chlorfenapyr	ISO 1750: 2001	122453-73-0	1*H*-Pyrrole-3-carbonitrile, 4-bromo-2-(4-chlorophenyl)-1-(ethoxymethyl)-5-(trifluoromethyl)-	-	SP	129093
Chlorfluazuron	ISO 1750: 2008	71422-67-8	Benzamide, *N*-[[[3,5-dichloro-4-[[3-chloro-5-(trifluoromethyl)-2-pyridinyl]oxy]phenyl]amino]carbonyl]-2,6-difluoro-	-	-	108202
Chloropicrin	ISO 765	76-06-2	Methane, trichloronitro-	-	-	81501
Chlorphoxim	ISO 1750: 1981	14816-20-7	Phosphorothioic acid, *O*-[[(2-chlorophenyl)cyanomethylene] azanyl]*O*,*O*-diethyl ester	-	-	-
Chlorpyrifos	ISO 1750: 1981	2921-88-2	Phosphorothioic acid, *O*,*O*-diethyl *O*-(3,5,6-trichloro-2-pyridinyl) ester	2783	SN	59101
Chlorpyrifos-methyl	ISO 1750: 1981	5598-13-0	Phosphorothioic acid, *O*,*O*-dimethyl *O*-(3,5,6-trichloro-2-pyridinyl) ester	-	-	59102
Chromafenozide	ISO 1750: 2001	143807-66-3	2*H*-1-Benzopyran-6-carboxylic acid, 3,4-dihydro-5-methyl-, 2-(3,5-dimethylbenzoyl)-2-(1,1-dimethylethyl)hydrazide	-	-	-
Chromobacterium subtsugae (Neisseriaceae)[a]	N251747	-	-	-	-	

[a] Camphor is a specific compound, usually seen as a waxy solid, derived traditionally from the wood of the camphor laurel, *Cinnamomum camphora*. However, this chemical is also found in many other plants and is now commercially produced from the wood of *Dryobalanops aromatica*, dried leaves of rosemary (*Rosmarinus officinalis*, which is up to 20% camphor), or synthetically produced from oil of turpentine. See Plant Oil – Camphor Laurel (*Cinnamomum camphora*).

[b] See Table A7 for a summary of the carboxylic acids and fatty acids potentially useful as PHP's. Multiple carboxylic acids are noted in the US EPA Chemical Search Database: Glycolic, Ethanoic (Vinegar), Propionic and Caproic acids are all recognized.

[c] Carvone is a chiral molecule. Carvone is registered in the EU, while only L-Carvone in the U.S.; at times the single stereoisomer and the racemate are treated synonymously.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Chrysoperla carnea (Chrysopidae)[b]	N189513	-	-	-	-	-
Cineole or 1,8-Cineole: see Eucalyptol						
Cinerin I[c]	ISO 765	25402-06-6	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propenyl) - ,(1*S*)-3-(2*Z*)-2-butenyl-2-methyl-4-oxo-2-cyclopenten-1-yl ester, (1*R*,3*R*)-	-	-	69009
Cinerin II	ISO 765	121-20-0	Cyclopropanecarboxylic acid, 3-[(1*E*)-3-methoxy-2-methyl-3-oxo-1-propen-1-yl]-2,2-dimethyl-, (1*S*)-3-(2*Z*)-2-buten-1-yl-2-methyl-4-oxo-2-cyclopenten-1-yl ester, (1*R*,3*R*)-	-	-	69010
Cinnamaldehyde	EPA	104-55-2	2-Propenal, 3-phenyl-	-	-	40506
Citral	EPA	5392-40-5	2,6-Octadienal, 3,7-dimethyl-	-	-	40510
Citric Acid	EPA	77-92-9	1,2,3-Propanetricarboxylic acid, 2-hydroxy-	-	-	21801
Citronellal[d]	CAS	106-23-0	6-Octenal, 3,7-dimethyl-	-	-	-
Citronellol[e]	EPA	106-22-9	6-Octen-1-ol, 3,7-dimethyl-	-	-	167004
Citronellyl Acetate	CAS	150-84-5	6-Octen-1-ol, 3,7-dimethyl-, 1-acetate	-	-	-
Coelomomyces spp. (Coelomomycetaceae)	N143959	-	-	-	-	-
Conidiobolus coronatus (Ancylistaceae)	N34488	-	-	-	-	-
Copper(II) Acetoarsenite: see Paris Green						
Copper Nanoparticles[f]	CAS	7440-50-8	Copper	-	-	22501
Corn (= Maize; *Zea mays* var. *mays,* Poaceae) Gluten Meal	EPA	66071-96-3	[g]	-	-	100137
Coumaphos	ISO 1750: 1981	56-72-4	Phosphorothioic acid, *O*-(3-chloro-4-methyl-2-oxo-2*H*-1-benzopyran-7-yl) *O*,*O*-diethyl ester	-	-	36501
Cryolite	WHO 2009	15096-52-3	Cryolite ($Na_3(AlF_6)$) = Trisodium Hexafluoroaluminate	-	-	75101
Culicinomyces spp. (Clavicipitaceae)	N150370	-	-	-	-	-

[a] *Chromobacterium subtsugae* Martin et al. 2007 (NCBI).

[b] *Chrysoperla carnea* (Stephens, 1836) (NCBI)

[c] The specification of the plant extracts known as pyrethrum and their constituents, including this molecule, is elaborated in Table A3.

[d] Citronellal has two stereoisomers, d and l, but the CAS RN provided refers to the racemate. CAS RN 26489-02-1 is sometimes cited for the material (e.g. Debboun et al 2007), but this number is now obsolete (CAS SciFinder 6/30/12).

[e] There are two stereoisomers of citronellol, and both are biologically active, although they are preferentially produced in different plants. The form that is found in citronella oil and some other repellent oils is (+)-Citronellol, also known as d-Citronellol or R-Citronellol. The form found in rose oil and geranium oil is (-)-Citronellol, also known as l-Citronellol or S-Citronellol.

[f] None of the authorities reviewed in this inventory have issued specific identifiers for nanoparticle-based insecticides, except for silver-based nanoparticles, which have an EPA PC code (primarily for their use as anti-microbials, not as vector control products). Therefore, nanoparticles are identified here by the CAS RN's and EPA PC Codes for their respective carrier materials. See Silver Nanoparticles for more detail on that specific case. Nanoparticles in general are undergoing Registration Review by USEPA.

[g] "The dried residue from corn after the removal of the larger part of the starch and germ and the separation of the bran in the wet-milling manufacture of corn starch or syrup, or by enzymatic treatment of the endosperm."

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Culex nigripalpus NPV (= CuniNPV) (nucleopolyhedrovirus) (Baculoviridae)	N130556	-	-	-	-	-
Cyantraniliprole	ISO 1750 pending	736994-63-1	1*H*-Pyrazole-5-carboxamide, 3-bromo-1-(3-chloro-2-pyridinyl)-*N*-[4-cyano-2-methyl-6-[(methylamino)carbonyl]phenyl]-	-	-	-
Cyflumetofen	ISO 1750: 2008	400882-07-7	Benzenepropanoic acid, α-cyano-α-[4-(1,1-dimethylethyl)phenyl]-β-oxo-2-(trifluoromethyl)-, 2-methoxyethyl ester	-	-	138831
Cyfluthrin[a]	ISO 1750: 2008	68359-37-5	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, cyano(4-fluoro-3-phenoxyphenyl)methyl ester	-	SN	128831
Cyhalothrin[b]	ISO 1750: 2008	68085-85-8	Cyclopropanecarboxylic acid, 3-(2-chloro-3,3,3-trifluoro-1-propen-1-yl)-2,2-dimethyl-, cyano(3-phenoxyphenyl)methyl ester	3352	-	128867
Cypermethrin[c]	ISO 1750: 1983	52315-07-8	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, cyano(3-phenoxyphenyl)methyl ester	3352	-	109702
Cyphenothrin[d]	ISO 1750: 2008	39515-40-7	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, cyano(3-phenoxyphenyl)methyl ester	3352	-	129013
d-Allethrin[e] (= Pynamin Forte)	WHOPES	584-79-2 231937-89-6	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, 2-methyl-4-oxo-3-(2-propen-1-yl)-2-cyclopenten-1-yl ester; Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, 2-methyl-4-oxo-3-(2-propen-1-yl)-2-cyclopenten-1-yl ester, (1*R*)-	-	SN	4005
d-α-Pinene (= d-Alpha-Pinene = d-Pinene = (+)-Alpha-Pinene)	CAS	7785-70-8	Bicyclo[3.1.1]hept-2-ene, 2,6,6-trimethyl-, (1*R*,5*R*)-	-	-	-
DDT[f]	ISO 1750: 1983	50-29-3	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-chloro-;	2761	SO	29201

[a] Cyfluthrin has multiple chiral centers and unique CAS RN's for some specific stereoisomers, but there is only one RN for the various stereoisomer mixtures. The RN listed is used for racemic or unspecified stereochemistry and also for the mixture of stereoisomers known as Beta-cyfluthrin; see Table A1 for comprehensive specification.

[b] The stereochemistry of cyhalothrin is moderately complex, but usage seems to be more consistent than with many other pyrethorids. Unlike most pyrethroids, for cyhalothrin the CAS RN and common name do not apply to a mixture of all stereoisomers, but only to the cis- configurations; see Table A1 for comprehensive specification.

[c] Cypermethrin has three stereocenters, resulting in eight specific stereoisomers and many possible isomer mixtures. Therefore, specification of cypermethrin-based materials, as with all pyrethroids, is complex and prone to inaccuracy or imprecision; see Table A1 for comprehensive specification.

[d] The stereochemistry and specification of cyphenothrin is complex, but there is only one CAS RN for the various stereoisomer mixtures; see Table A1 for elaboration. While some individual stereoisomers or enantiomeric pairs have their own RN's, the number listed is used for racemic or unspecified stereochemistry and also for the mixtures of stereoisomers known as d-cyphenothrin, d-trans-cyphenothrin, and d-d-trans-cyphenothrin. The specific stereoisomer d-d-trans-cyphenothrin does not have a unique RN.

[e] See Table A1 for stereochemical specification of pyrethroids.

[f] While DDT does not have optical stereoisomers, the orientation of chlorine atoms on the benzene rings does vary. The name "DDT" sometimes refers to mixed isomers and sometimes exclusively to the p-p' configuration.

Name	Orientation	CAS RN
p,p'-Dichlorodiphenyltrichloroethane = p,p'-DDT	p,p'	50-29-3
o,p'-Dichlorodiphenyltrichloroethane = o,p'-DDT	o,p'	789-02-6
Dichlorodiphenyltrichloroethane = DDT	mixed	8017-34-3

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
		8017-34-3	Benzene, 1-chloro-2-[2,2,2-trichloro-1-(4-chlorophenyl)ethyl]-, mixt. with 1,1'-(2,2,2-trichloroethylidene)bis[4-chlorobenzene]			
d-d, trans-Cyphenothrin[a]	WHOPES	39515-40-7	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, cyano(3-phenoxyphenyl)methyl ester	-	SN	129013
DDVP: see Dichlorvos						
Decanoic Acid (= Capric Acid)	EPA	334-48-5	Decanoic acid	-	-	128955
DEET (= N,N-Diethyl-meta-toluamide)	BS 1831: 1969	134-62-3	Benzamide, *N*,*N*-diethyl-3-methyl-	-	SW	80301
Dehydrolinalool[b]	CAS	29171-20-8	6-Octen-1-yn-3-ol, 3,7-dimethyl-	-	-	
Deltamethrin[c]	ISO 1750: 2008	52918-63-5	Cyclopropanecarboxylic acid, 3-(2,2-dibromoethenyl)-2,2-dimethyl-, (*S*)-cyano(3-phenoxyphenyl)methyl ester, (1*R*,3*R*)-	3349	SO	97805
DEPA (= N,N-Diethyl Phenylacetamide)	EPA	2431-96-1	Benzeneacetamide, *N*,*N*-diethyl-	-	-	-
Diafenthiuron	ISO 1750: 1999	80060-09-9	Thiourea, *N*-[2,6-bis(1-methylethyl)-4-phenoxyphenyl]-*N*'-(1,1-dimethylethyl)-	-	-	80251
Diazinon	ISO 1750: 1981	333-41-5	Phosphorothioic acid, *O*,*O*-diethyl *O*-[6-methyl-2-(1-methylethyl)-4-pyrimidinyl] ester	3018	SO	57801
Dibutyl Phthalate (= DBP)	WHO 2009	84-74-2	1,2-Benzenedicarboxylic acid, 1,2-dibutyl ester	-	-	28001
Dichlorvos (= DDVP)	ISO 1750: 1981	62-73-7	Phosphoric acid, 2,2-dichloroethenyl dimethyl ester	-	SO	84001
Dicofol	ISO 1750: 1981	115-32-2	Benzenemethanol, 4-chloro-α-(4-chlorophenyl)-α-(trichloromethyl)-	-	-	10501
Dieldrin	ISO 1750: 1981	60-57-1	2,7:3,6-Dimethanonaphth[2,3-*b*]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1a*R*,2*R*,2a*S*,3*S*,6*R*,6a*R*,7*S*,7a*S*)-*rel*-	-	-	45001
Diflubenzuron	ISO 1750: 1983	35367-38-5	Benzamide, *N*-[[(4-chlorophenyl)amino]carbonyl]-2,6-difluoro-	-	SN	108201
Dihydro-5-heptyl-2(3H)-furanone (= Gamma-Undeccalactone)	EPA	104-67-6	2(3*H*)-Furanone, 5-heptyldihydro-	-	-	122302
Dihydro-5-pentyl-2(3H)-furanone (= Gamma-Nonalactone)	EPA	104-61-0	2(3*H*)-Furanone, dihydro-5-pentyl-	-	-	122301
Dimethoate	ISO 1750: 1981	60-51-5	Phosphorodithioic acid, *O*,*O*-dimethyl *S*-[2-(methylamino)-2-oxoethyl] ester	2783	SN	35001
Dimethyl Phthalate (= DMP)	ISO 765; WHO	131-11-3	1,2-Benzenedicarboxylic acid, 1,2-dimethyl ester	-	-	28002
Dinotefuran	ISO 1750: 2001	165252-70-0	Guanidine, *N*''-methyl-*N*-nitro-*N*'-[(tetrahydro-3-furanyl)methyl]-	-	-	44312
Di-n-propyl Isocinchomeronate (= MGK® Repellent 326)	EPA	136-45-8	2,5-Pyridinedicarboxylic acid, 2,5-dipropyl ester	-	-	47201
Dioctyl Phthalate (= DEHP = Bis(2-ethylhexyl)phthalate)	EPA	117-81-7	1,2-Benzenedicarboxylic acid, 1,2-bis(2-ethylhexyl) ester	-	-	295200

[a] See Table A1 for stereochemical specification of pyrethroids.

[b] The CAS RN is for unspecified stereochemistry. This molecule has one chiral carbon, and the 3S form has CAS RN 125411-11-2.

[c] Syn. = Decamethrin (CAS). See Table A1 for stereochemical specification of pyrethroids. Obsolete (Deleted) RN's for this molecule cited in the literature include 55700-96-4 & 62229-77-0.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Dipropylene Glycol	CAS	110-98-5	2-Propanol, 1,1'-oxybis-	-	-	-
D-Limonene[a]	-	5989-27-5	Cyclohexene, 1-methyl-4-(1-methylethenyl)-, (4*R*)-	-	-	79701
DMC (= Dimethyl Carbate)	EPA	5826-73-3	Bicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid, 2,3-dimethyl ester	-	-	21501
DNOC (= 4,6-Dinitro-o-cresol)	ISO 1750: 1981	534-52-1	Phenol, 2-methyl-4,6-dinitro-	2779	-	600023 37507
Dodecanoic Acid[b] (= Lauric Acid)	EPA	143-07-7	Dodecanoic acid	-	-	128918
d-Phenothrin[c] (= Sumithrin)	WHOPES, EPA	188023-86-1	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, (3-phenoxyphenyl)methyl ester, (1*R*)-	-	SN	69005
Dried Blood / Blood Meal	EPA, CAS	68911-49-9 90989-74-5	Blood, glyoxal-denatured, dried; Blood, meal: A product obtained by the washing, solvent dehydration, and drying of coagulated blood.	-	-	611
d-trans-Allethrin: see Bioallethrin						
d-Verbenone	CAS	18309-32-5	Bicyclo[3.1.1]hept-3-en-2-one, 4,6,6-trimethyl-, (1*R*,5*R*)-	-	-	
Egg Solids[d]	EPA	-	-	-	-	105101
Elemol (= alpha-Elemol)	CAS	639-99-6	Cyclohexanemethanol, 4-ethenyl-α,α,4-trimethyl-3-(1-methylethenyl)-, (1*R*,3*S*,4*S*)-	-	-	-
(E)-N-cyclohexyl-N-ethyl-2-hexenamide	CAS	1263262-56-1	2-Hexenamide, *N*-cyclohexyl-*N*-ethyl-, (2*E*)-	-	-	-
Endosulfan	ISO 1750: 1981	115-29-7	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide	2761	SO	79401
Engyodontium album (= *Beauveria alba)*[e] (Cordycipitaceae)	N37998	-	-	-	-	
Esbiol: see S-Bioallethrin						
Esbiothrin[b] (= S-Biothrin)	WHOPES	584-79-2 260359-57-5	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, 2-methyl-4-oxo-3-(2-propen-1-yl)-2-cyclopenten-1-yl ester;	-	SN	4007
Esfenvalerate (= S-Fenvalerate)	ISO 1750: 2008	66230-04-4	Benzeneacetic acid, 4-chloro-α-(1-methylethyl)-, (*S*)-cyano(3-phenoxyphenyl)methyl ester, (α*S*)-	3349	-	109303
Ethanoic Acid: see Acetic Acid						
Ethyl Butylacetylaminopropionate: see IR3535						
Ethohexadiol (= Rutgers 612)[f]	WHO	94-96-2	1,3-Hexanediol, 2-ethyl-	-	-	41001
Etofenprox[b] (= Ethofenprox)	ISO 1750: 2008	80844-07-1	Benzene, 1-[[2-(4-ethoxyphenyl)-2-methylpropoxy]methyl]-3-phenoxy-	-	SN	128965

[a] The identification and specification of citrus oils and their constituents, including D-Limonene and Limonene, Oil of Orange, and Orange Oil is inconsistent, and the registration status of these materials is somewhat ambiguous; see Tables A2 and A6.

[b] CAS uses Dodecanotic Acid, but EPA registers this material as Lauric Acid.

[c] See Table A1 for stereochemical specification of pyrethroids.

[d] EPA has registered Egg Solids as a biopesticide, but also treats Putrescent Whole Egg Solids as a 25(b) FIFRA-exempt material.

[e] Syn. = *Tritirachium album* (NCBI)

[f] Syn. = Ethyl Hexanediol

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Etoxazole	ISO 1750: 2001	153233-91-1	Oxazole, 2-(2,6-difluorophenyl)-4-[4-(1,1-dimethylethyl)-2-ethoxyphenyl]-4,5-dihydro-	-	-	107091
Eucalyptol (=1,8-Cineole)	CAS	470-82-6	2-Oxabicyclo[2.2.2]octane, 1,3,3-trimethyl-	-	-	-
Eugenol	GB 4839: 2009	97-53-0	Phenol, 2-methoxy-4-(2-propen-1-yl)-	-	-	102701
Fatty Acids[a]: C4 – C20	CAS, etc.	67254-79-9	Fatty Acids	-	-	Mult.[a]
Fatty Acids: C7 – C20	CAS, etc.	67254-79-9	Fatty Acids	-	-	Mult.[a]
Fatty Acids, Long Chain (C14-C22)	CAS, etc.	67254-79-9	Fatty Acids	-	-	Mult.[a]
Fatty Acids, Medium Chain (C6-C12)	CAS, etc.	67254-79-9	Fatty Acids	-	-	Mult.[a]
Fatty Acids, Short Chain (C4-C5)	CAS, etc.	67254-79-9	Fatty Acids	-	-	Mult.[a]
Fatty Acids, Very Long Chain (C24+)	CAS, etc.	67254-79-9	Fatty Acids	-	-	Mult.[a]
Fenazaquin	ISO 1750: 1999	120928-09-8	Quinazoline, 4-[2-[4-(1,1-dimethylethyl)phenyl]ethoxy]-	2588	-	44501
Fenitrothion	ISO 1750: 1981	122-14-5	Phosphorothioic acid, *O*,*O*-dimethyl *O*-(3-methyl-4-nitrophenyl) ester	-	SN	105901
Fenoxycarb	ISO 1750: 2008	72490-01-8	Carbamic acid, *N*-[2-(4-phenoxyphenoxy)ethyl]-, ethyl ester	-	-	125301
Fenpropathrin[b] (= Fenproprathrin)	ISO 1750: 1983	39515-41-8	Cyclopropanecarboxylic acid, 2,2,3,3-tetramethyl-, cyano(3-phenoxy phenyl)methylester	3349	-	127901
Fenthion	ISO 1750: 1981	55-38-9	Phosphorothioic acid, *O*,*O*-dimethyl *O*-[3-methyl-4-(methylthio)phenyl] ester	3018	SN	53301
Fipronil	ISO 1750: 1999	120068-37-3	1*H*-Pyrazole-3-carbonitrile, 5-amino-1-[2,6-dichloro-4-(trifluoromethyl) phenyl]-4-[(trifluoromethyl)sulfinyl]-	2588	-	129121
Fish Oil / Cod Liver Oil[c]	EPA	8016-13-5	Fats and Glyceridic oils, fish:	-	-	122401
Flufenoxuron	ISO 1750: 2008	101463-69-8	Benzamide, *N*-[[[4-[2-chloro-4-(trifluoromethyl)phenoxy]-2-fluorophenyl] amino]carbonyl]-2,6-difluoro-	-	-	108203
Formic Acid (= Methanoic Acid)	EPA	64-18-6	Formic Acid	-	-	214900
Gamma-Cyhalothrin[b]	ISO 1750: 2008	76703-62-3	Cyclopropanecarboxylic acid, 3-[(1*Z*)-2-chloro-3,3,3-trifluoro-1-propen-1-yl]-2,2-dimethyl-, (*S*)-cyano(3-phenoxyphenyl)methyl ester, (1*R*,3*R*)-	-	-	128807
Gamma-HCH (= Gammexane): see Lindane[d]						
Gamma-Nonalactone: see Dihydro-5-pentyl-2(3H)-furanone						
Gamma-Undeccalactone: see Dihydro-5-heptyl-2(3H)-furanone						
Geraniol	EPA	106-24-1	2,6-Octadien-1-ol, 3,7-dimethyl-, (2*E*)-	-	-	597501
Geranyl Acetate	CAS	105-87-3	2,6-Octadien-1-ol, 3,7-dimethyl-, 1-acetate, (2*E*)-	-	-	-
Geranylacetone	CAS	3796-70-1	5,9-Undecadien-2-one, 6,10-dimethyl-, (5*E*)-	-	-	-

[a] The taxonomy of fatty acids is complex and inconsistent between jurisdictions, but all regulatory agencies surveyed allowed some of these products. There is no CAS RN for the specific set of fatty acids identified here, which is associated in the literature with most insecticidal effects; this RN is for unspecified fatty acids (see Table A7 for specifications for CAS and EPA). Many fatty acids are reviewed independently in this Inventory; the groupings made here have regulatory as well as scientific significance; see Table B.

[b] See Table A1 for stereochemical specification of pyrethroids.

[c] CAS RN 8016-13-5 is defined as "Extractives and their physically modified derivatives. It consists primarily of the glycerides of C14-C18 and C16-C22 unsatd. fatty acids. (mixed fish)."

[d] Lindane is a specific stereoisomer of hexachloro-cyclohexane, and has been cited under a wide range of names, including Gamexane. The unspecified molecule is CAS RN 608-73-1. See inchem.org/documents/pims/chemical/pim859.htm for other synonyms and specifications.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Granulovirus or Granulosis Virus: see *Betabaculovirus* (Baculoviridae)						
Haedoxane A	Literature[a]	-	-	-	-	
Haedoxane E	Literature	-	-	-	-	
HBTX (= Homobatrachotoxin)	CAS	23509-17-3	[8]	-	-	-
HCH (= 1,2,3,4,5,6-Hexachlorocyclohexane)[b]	WHO	608-73-1	Cyclohexane, 1,2,3,4,5,6-hexachloro-	2761	-	8901
Hendecanoic Acid: see Undecanoic Acid						
Heptanoic Acid	CAS	111-14-8	Heptanoic acid	-	-	-
Hexadecanoic Acid (= Palmitic Acid)	CAS	57-10-3	Hexadecanoic acid	-	-	-
Hexahydro-1-(1-oxohexyl)-1H-azepine	CAS	18494-57-0	1-Hexanone, 1-(hexahydro-1*H*-azepin-1-yl)-	-	-	-
Hexanal (= Aldehyde C6)	EPA	66-25-1	Hexanal	-	-	128950
Hexanoic Acid (= Caproic Acid)[c]	CAS	142-62-1	Hexanoic acid	-	-	128917
Humulene Epoxide II	CAS	19888-34-7	12-Oxabicyclo[9.1.0]dodeca-3,7-diene, 1,5,5,8-tetramethyl-, (1*R*,3*E*,7*E*,11*R*)-	-	-	-
Hydramethylnon	ISO 1750: 2008	67485-29-4	1,4-Pentadien-3-one, 1,5-bis[4-(trifluoromethyl)phenyl]-, 2-(1,4,5,6-tetrahydro-5,5-dimethyl-2-pyrimidinyl)hydrazone	-	-	118401
Icaridin: see Picaridin						
Imidacloprid	ISO 1750: 1999	105827-78-9	2-Imidazolidinimine, 1-[(6-chloro-3-pyridinyl)methyl]-*N*-nitro-, (2*E*)-	-	-	129099
Imiprothrin[d]	ISO 1750: 1999	72963-72-5	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, [2,5-dioxo-3-(2-propyn-1-yl)-1-imidazolidinyl] methyl ester	-	-	4006
Indalone: see Butopyronoxyl						
Indole	EPA	120-72-9	1*H*-Indole	-	-	25000
Indoxacarb	ISO 1750: 2001	173584-44-6	Indeno[1,2-*e*][1,3,4]oxadiazine-4a(3*H*)-carboxylic acid, 7-chloro-2,5-dihydro-2-[[(methoxycarbonyl)[4-(trifluoromethoxy) phenyl]amino]carbonyl]-, methyl ester, (4a*S*)-	-	-	67710
Intermedeol	CAS	6168-59-8	1-Naphthalenol, decahydro-1,4a-dimethyl-7-(1-methylethenyl)-, (1*S*,4a*S*,7*R*,8a*S*)-	-	-	-
Iodofenphos: see Jodfenphos						
IR3535 (= Ethyl Butylacetylaminopropionate)	WHOPES	52304-36-6	β-Alanine, *N*-acetyl-*N*-butyl-, ethyl ester	-	SN	113509
Isaria fumosorosea (= *Paecilomyces fumosoroseus*)[e] (Cordycipitaceae)	N114497	-	-	-	-	115002

[a] 1-hydroxy-6-[trans-7'-methoxy-3'-methoxymethyl-2'-(3,4-methylenedioxy)phenyl-1', 4'-benzodioxan-6'-yl]-2-aryloxy-3,7-dioxabicyclo[3.3.0]octane (Ar=2,6-dimethoxy-4,5-methylenedioxyphenyl for A. (http://kaken.nii.ac.jp/d/p/59470113/1986/6/en.en.html)

[b] Lindane is a specific stereoisomer of hexachloro-cyclohexane, and has been cited under a wide range of names, including Gamexane. The unspecified molecule is CAS RN 608-73-1. See inchem.org/documents/pims/chemical/pim859.htm for other synonyms and specifications.

[c] CAS and most references use Hexanoic Acid; EPA registers this material as Caproic Acid.

[d] See Table A1 for stereochemical specification of pyrethroids.

[e] Syn. = *Paecilomyces isarioides*, *Paecilomyces* sp. PBM003-11 (NCBI)

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Isaria fumosorosea (= *P. fumosoroseus*) Apopka Strain 97	EPA	-	-	-	-	115002
Isaria fumosorosea (= *P. fumosoroseus*) Strain FE 9901	EPA	-	-	-	-	115002
Isaria fumosorosea (= *P. fumosoroseus*) Lilacinus Strain 251	EPA	-	-	-	-	28826
Isoeugenol	CAS	97-54-1	Phenol, 2-methoxy-4-(1-propen-1-yl)-	-	-	-
Isopropyl Alcohol	EPA	67-63-0	2-Propanol	-	-	47501
Isopulegol	CAS	59905-53-2	Cyclohexanol, 5-methyl-2-(1-methylethenyl)-, (1*R*,2*S*,5*R*)-*rel*-	-	-	-
Ivermectin	WHO, CAS	70288-86-7	Ivermectin	-	-	-
Jasmolin I	GB 4839	4466-14-2	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, (1*S*)-2-methyl-4-oxo-3-(2*Z*)-2-penten-1-yl-2-cyclopenten-1-yl ester, (1*R*,3*R*)-	-	-	69011
Jasmolin II	GB 4839	1172-63-0	Cyclopropanecarboxylic acid, 3-[(1*E*)-3-methoxy-2-methyl-3-oxo-1-propen-1-yl]-2,2-dimethyl-, (1*S*)-2-methyl-4-oxo-3-(2*Z*)-2-penten-1-yl-2-cyclopenten-1-yl ester, (1*R*,3*R*)-	-	-	69012
Jodfenphos (= Iodofenphos)[a]	ISO 1750-1981	18181-70-9	Phosphorothioic acid, *O*-(2,5-dichloro-4-iodophenyl)*O*,*O*-dimethyl ester	-	SW	309700
Kaolin (= Kaolin Clay)	EPA	1332-58-7	Kaolin: A clay that is essentially kaolinite, a hydrated aluminum silicate.	-	-	100104
Lactic Acid[b]	EPA	50-21-5	Propanoic acid, 2-hydroxy-	-	-	128929
Lagenidium giganteum (Lagenidiaceae)	N4803, EPA	-	-	-	-	129084
Lambda-Cyhalothrin[c] (= Lambdacyhalothrin)	ISO 1750: 1999	91465-08-6	Cyclopropanecarboxylic acid, 3-[(1*Z*)-2-chloro-3,3,3-trifluoro-1-propen-1-yl]-2,2-dimethyl-, (*R*)-cyano(3-phenoxyphenyl)methyl ester, (1*S*,3*S*)-*rel*-	-	SN	128897
Lanolin	EPA	8006-54-0	Lanolin	-	-	31601
Larvicidal Oil (= Mineral Oil = Paraffin Oil = Petroleum Oils)[d]	WHOPES, EPA	8012-95-1 68920-06-9	Paraffin oils: Liquid hydrocarbons from petroleum; Hydrocarbons, C_{7-9}	-	SO	63503
Lauric Acid: see Dodecanoic acid						
Lauryl Sulfate	CAS	151-41-7	Sulfuric acid, monododecyl ester	-	-	-
L-Carvone	EPA	6485-40-1	2-Cyclohexen-1-one, 2-methyl-5-(1-methylethenyl)-, (5*R*)-	-	-	79500
Lead Arsenate	ISO 765	3687-31-8	Arsenic acid (H_3AsO_4), lead(2+) salt (2:3)	1617	-	-
Limonene	EPA	138-86-3	Cyclohexene, 1-methyl-4-(1-methylethenyl)-	-	-	79701

[a] Jodfenphos is recognized by ISO 1750; Iodofenphos by WHOPES.

[b] Lactic Acid has two stereoisomeric forms; Lactic Acid (CAS RN 50-21-5) and L-Lactic Acid (=2S-Lactic Acid, CAS RN 79-33-4) are both considered in this review.

[c] See Table A1 for stereochemical specification of pyrethroids.

[d] The specification of larvicidal mineral oils is extraordinarily inconsistent, in part because of differences in traditional names and reference identifiers, but also because these are virtually always mixtures of many different molecules refined from petroleum source materials of differing constitution. One broad distinction that is often made is between purely aliphatic oil mixtures and oils with aromatic constituents. For the purposes of this report, no further distinction is made.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Limonin	CAS	1180-71-8	[9]	-	-	-
Linalool	EPA	78-70-6	1,6-Octadien-3-ol, 3,7-dimethyl-	-	-	128838
Linalyl Acetate[10]	CAS	115-95-7	1,6-Octadien-3-ol, 3,7-dimethyl-, 3-acetate	-	-	-
Lindane (= Gamma-HCH = Gammexane)	ISO 1750: 1981	58-89-9	Cyclohexane, 1,2,3,4,5,6-hexachloro-,(1α,2α,3β,4α,5α,6β)-	2761	SO	9001
Linoleic Acid	EPA	60-33-3	9,12-Octadecadienoic acid (9*Z*,12*Z*)-	-	-	-
L-Lactic Acid	EPA	79-33-4	Propanoic acid, 2-hydroxy-, (2*S*)-	-	-	128929
Lysinibacillus sphaericus (= *Bacillus sphaericus*)[a] (Bacillaceae)	N1421	143447-72-7	*Lysinibacillus sphaericus*	-	-	119801
Lysinibacillus sphaericus (= *Bacillus sphaericus*) Serotype H5a5b Strain 2362 ATCC 1170	EPA	143447-72-7	*Lysinibacillus sphaericus*	-	-	119801
Magnesium Phosphide	GB 4839: 2009	12057-74-8	Magnesium phosphide (Mg_3P_2)	-	-	66504
Malathion	ISO 1750: 1981	121-75-5	Butanedioic acid, 2-[(dimethoxyphosphinothioyl)thio]-,1,4-diethyl ester	3082	SN	57701
Malic Acid	CAS	6915-15-7	Butanedioic acid, 2-hydroxy-	-	-	-
Menthofuran	CAS	494-90-6	Benzofuran, 4,5,6,7-tetrahydro-3,6-dimethyl-	-	-	-
Metaflumizone	ISO 1750: 2008	139968-49-3	Hydrazinecarboxamide, 2-[2-(4-cyanophenyl)-1-[3-(trifluoromethyl) phenyl]ethylidene]-*N*-[4-(trifluoromethoxy)phenyl]-	-	-	281250
Metarhizium anisopliae (Clavicipitaceae)[b]	N5530	67892-13-1	*Metarhizium anisopliae*	-	-	-
Metarhizium anisopliae Strain ESF1	EPA	67892-13-1	*Metarhizium anisopliae*	-	-	129056
Metarhizium anisopliae Strain F52 Spores	EPA	67892-13-1	*Metarhizium anisopliae*	-	-	29056
Methanoic Acid: see Formic Acid						
Methoprene (RS)	ISO 1750: 1983	40596-69-8	2,4-Dodecadienoic acid, 11-methoxy-3,7,11-trimethyl-, 1-methylethyl ester, (2*E*,4*E*)-	-	-	105401
Methoxychlor	ISO 1750: 1981	72-43-5	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-methoxy-	-	SW	34001
Methyl Bromide	ISO 765	74-83-9	Methane, bromo-	-	-	53201
Methyl Cinnamate	CAS	103-26-4	2-Propenoic acid, 3-phenyl-, methyl ester	-	-	-
Methylheptenone (= Sulcatone = Methyl Isohexenyl Ketone)	EPA	110-93-0	5-Hepten-2-one, 6-methyl-	-	-	127601
Methyl Isoeugenol[11]	CAS	93-16-3	Benzene, 1,2-dimethoxy-4-(1-propen-1-yl)-	-	-	-
Methyl Nonyl Ketone: see Undecan-2-one						
Methyl Salicylate[c, 12]	CAS	119-36-8	Benzoic acid, 2-hydroxy-, methyl ester	-	-	76601

[a] *Lysinibacillus sphaericus* (Meyer and Neide 1904) Ahmed et al. 2007. Syn. = *Bacillus sphaericus* Meyer and Neide 1904 (Approved Lists 1980), *Bacillus* sp. G10(2009) (NCBI Taxonomy Browser). EPA continues to identify this organism as *Bacillus sphaericus* (EPA OPP ChemicalSearch; PC Code 119801).

[b] *Metarhizium anisopliae* var. *anisopliae* (NCBI)

[c] Methyl Salicylate is a specific compound while Oil of Wintergreen is a plant extract, but because of the high percentage (98-99%) of methyl salicylate in high quality oil of wintergreen (*Gaultheria procumbens*, Ericaceae), the two identifiers are often used synonymously, especially in trade. The distinction between the chemical compound and the

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Metofluthrin[a]	ISO 1750: 2008	240494-70-6	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(1-propen-1-yl)-, [2,3,5,6-tetrafluoro-4-(methoxymethyl)phenyl]methyl ester	-	-	109709
MGK® 264: see N-Octyl Bicycloheptene Dicarboximide						
MGK® Repellent 11	EPA	126-15-8	4a(4*H*)-Dibenzofurancarboxaldehyde, 1,5a,6,9,9a,9b-hexahydro-	-	-	43302
MGK® Repellent 326: see Di-n-propyl Isocinchomeronate						
MGK® Repellent 874: see 2-Hydroxyethyl Octyl Sulfide						
Mineral Oil: see Larvicidal Oil						
Minoxidil	CAS	38304-91-5	2,4-Pyrimidinediamine, 6-(1-piperidinyl)-, 3-oxide	-	-	-
MMF: see POE Isooctadecanol						
Myristic Acid: see Tetradecanoic Acid						
Naled	ISO 1750: 1981	300-76-5	Phosphoric acid, 1,2-dibromo-2,2-dichloroethyl dimethyl ester	3018	-	34401
Nanosilver: see Silver Nanoparticles						
n-Butylacetanilide	EPA	91-49-6	Acetamide, *N*-butyl-*N*-phenyl-	-	-	401
n-Butyl Formate	CAS	592-84-7	Formic acid, butyl ester	-	-	-
Nematodes	N6231	-	-	-	-	-
Nepetalactone	CAS	490-10-8	Cyclopenta[*c*]pyran-1(4a*H*)-one, 5,6,7,7a-tetrahydro-4,7-dimethyl-	-	-	-
Niclosamide	ISO 1750: 1981	50-65-7	Benzamide, 5-chloro-*N*-(2-chloro-4-nitrophenyl)-2-hydroxy-	-	SN	217800
Niclosamide-Olamine (= Clinitralid)	WHOPES	1420-04-8	Benzamide, 5-chloro-*N*-(2-chloro-4-nitrophenyl)-2-hydroxy-, compd. with 2-aminoethanol (1:1)	-	SN	77401
N,N-Diethyl-meta-toluamide: see DEET						
N,N-Diethyl Phenylacetamide: see DEPA						
N-Octyl Bicycloheptene Dicarboximide (= MGK® 264)	WHO	113-48-4	4,7-Methano-1*H*-isoindole-1,3(2*H*)-dione, 2-(2-ethylhexyl)-3a,4,7,7a-tetrahydro-	-	-	57001
Nomilin	CAS	1063-77-0	[13]	-	-	-
Nonanal	CAS	124-19-6	Nonanal	-	-	-
Nonanoic Acid (= Pelargonic Acid)	EPA	112-05-0	Nonanoic acid	-	-	217500
Nootkatone	CAS	4674-50-4	2(3*H*)-Naphthalenone, 4,4a,5,6,7,8-hexahydro-4,4a-dimethyl-6-(1-methylethenyl)-, (4*R*,4a*S*,6*R*)-	-	-	-
Novaluron	ISO 1750: 1999	116714-46-6	Benzamide, *N*-[[[3-chloro-4-[1,1,2-trifluoro-2-(trifluoromethoxy)ethoxy] phenyl]amino]carbonyl]-2,6-difluoro-	-	SN	124002
Nucleopolyhedroviruses (= Nuclear Polyhedrosis viruses = NPV) (Baculoviridae)[b]	EPA	-	-	-	-	Varied

botanical oil is increasingly recognized in regulatory actions and documents. For example, the EPA RED for methyl salicylate clearly distinguishes between methyl salicylate and oil of wintergreen. However, PC Code 76601 is still used for both, as well as for birch bark oil, sweet birch oil, and *Betula lenta* oil. (see associated endnote and Oil – Plant, Wintergreen)

[a] See Table A1 for stereochemical specification of pyrethroids.

[b] The names Nucleopolyhedroviruses, Nuclear Polyhedrosis viruses, or NPV applies to multiple taxonomic groups within the family Baculoviridae (NCBI): Alphabaculovirus = N558016; Gammabaculovirus = N558018; and Deltabaculovirus = N558019 (which type includes *Culex nigripalpus* NPV = CuniNPV = N130556).

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Octadecanoic Acid (= Stearic Acid)	EPA	57-11-4	Octadecanoic acid	-	-	79082
Octanoic Acid (= Caprylic Acid)	EPA	124-07-2	Octanoic acid	-	-	128919
Octenal (= Aldehyde C8)	EPA	124-13-0	Octenal	-	-	128948
Oleic Acid[a]	EPA	112-80-1	9-Octadecenoic acid (9*Z*)-	-	-	31702
Orange Oil: see Plant Oil – Orange, Sweet and Tables A2 and A6						
Paecilomyces fumosoroseus: see *Isaria fumosorosea* (Cordycipitaceae)						
Palmitic Acid: see Hexadecanoic Acid						
Paraffin Oil: see Larvicidal Oil						
Paris Green (= Copper(II) Acetoarsenite)	ISO 765	12002-03-8	C.I. Pigment Green 21	1585	-	22601
PBO: see Piperonyl Butoxide						
P-Cymene	EPA	99-87-6	Benzene, 1-methyl-4-(1-methylethyl)-	-	-	122103
Pelargonic Acid: see Nonanoic Acid						
Pentanoic Acid (= Valeric Acid)	CAS	109-52-4	Pentanoic Acid	-	-	-
Permethrin[b]	ISO 1750: 1983	52645-53-1	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, (3-phenoxyphenyl)methyl ester	3352	SN	109701
Petroleum Oil: see Larvicidal Oil						
Phenothrin[c]	ISO 1750: 1983	26002-80-2	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, (3-phenoxyphenyl)methyl ester	-	-	69005
Phoxim	ISO 1750: 1981	14816-18-3	4,6-Dioxa-3-aza-5-phosphaoct-2-enenitrile, 5-ethoxy-2-phenyl-, 5-sulfide	-	SO	598800
Phrymarolin-I	CAS	38303-95-6	1*H*,3*H*-Furo[3,4-*c*]furan-3a(4*H*)-ol, dihydro-1-(6-methoxy-1,3-benzodioxol-5-yl)-4-[(6-methoxy-1,3-benzodioxol-5-yl)oxy]-, acetate, [1*S*-(1α,3aα,4α,6aα)]-	-	-	-
Picaridin (= Icaridin)	WHOPES	119515-38-7	1-Piperidinecarboxylic acid, 2-(2-hydroxyethyl)-, 1-methylpropyl ester	-	SN	70705
Pilocarpene	CAS	92-13-7	2(3*H*)-Furanone, 3-ethyldihydro-4-[(1-methyl-1*H*-imidazol-5-yl)methyl]-, (3*S*,4*R*)-	-	-	-
Pinene	EPA	1330-16-1	Bicyclo[3.1.1]heptane, 2,6,6-trimethyl-, didehydro deriv.	-	-	67001
Pinocamphone	EPA	547-60-4	Bicyclo[3.1.1]heptan-3-one, 2,6,6-trimethyl-, (1*R*,2*S*,5*S*)-*rel*-	-	-	-
Piperidine	CAS	110-89-4	Piperidine	-	-	-
Piperine	EPA	94-62-2	2,4-Pentadien-1-one, 5-(1,3-benzodioxol-5-yl)-1-(1-piperidinyl)-, (2*E*,4*E*)-	-	-	43501
Piperonyl Butoxide (= PBO)	ISO 765	51-03-6	1,3-Benzodioxole, 5-[[2-(2-butoxyethoxy)ethoxy]methyl]-6-propyl-	-	SN	67501
Pirimiphos-methyl	ISO 1750: 1981	29232-93-7	Phosphorothioic acid, *O*-[2-(diethylamino)-6-methyl-4-pyrimidinyl] *O*,*O*-dimethyl ester	-	SN	108102

[a] See discussion of Soap Salts.

[b] Permethin consists of four stereoisomers, and the ratio of these varies in permethrin products in trade; see Table A1 for comprehensive specification. Two of the isomers are trans- in the cyclopropane moiety and two cis; the ratio of trans- to cis- varies from 60:40 to 75:25 in products meeting WHOPES specificiations.

[c] The stereochemistry and specification of phenothrin is complex and inconsistently applied; see Table A1 for comprehensive specification. The RN listed for Phenothrin (CAS RN 26002-80-2) is used for racemic or unspecified stereochemistry, while 188023-86-1 is used for the racemic mixture of (1R) stereoisomers known as d-Phenothrin or Sumithrin. EPA registers both Phenothrin and d-Phenothrin/Sumithrin as PC Code 69005.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Plant – Cinnamon (*Cinnamomum verum = C. zeylanicum*, Lauraceae)[a]	ITIS	-	-	-	-	129066
Plant – Citronella, Ceylon (*Cymbopogon nardus,* Poaceae)	ITIS	89998-15-2	*C. nardus* extractives and their physically modified derivatives	-	-	21901
Plant – Citronella, Java (*Cymbopogon winterianus,* Poaceae)	ITIS	91771-61-8	*C. winterianus* extractives and their physically modified derivatives	-	-	21901
Plant – Clove (*Syzygium aromaticum*, Myrtaceae)	ITIS	-	-	-	-	128895
Plant – Garlic (*Allium sativum*, Amaryllidaceae)	ITIS	-	-	-	-	-
Plant – Mint (*Mentha* spp., Lamiaceae)	ITIS	multiple	No CAS RN for mint oils generally	-	-	-
Plant – Peppermint (*Mentha × piperita*, Lamiaceae)	ITIS	-	-	-	-	-
Plant – Rosemary (*Rosmarinus officinalis*, Lamiaceae)	ITIS	-	-	-	-	128893
Plant – Sesame (*Sesamum indicum = Sesamum orientale*, Pedaliaceae)	ITIS	-	-	-	-	128970
Plant – Thyme (*Thymus vulgaris or T. zygis*, Lamiaceae)	ITIS, GRIN	-	-	-	-	128894
Plant Oil – Alaska Yellow Cedar = (*Callitropsis nootkatensis*, Cupressaceae)	ITIS	1069136-34-0	Oils, *Callitropsis nootkatensis*	-	-	-
Plant Oil – Anise (*Pimpinella anisum*, Apiaceae) (= Aniseed Oil)	ITIS	8007-70-3	Essential oils, anise: *Pimpinella anisum*	-	-	4301
Plant Oil – Atlantic Cedar (*Cedrus atlantica*)[b]	GRIN	8023-85-6 92201-55-3	Oils, cedarwood, Atlas: *Cedrus atlantica* *Cedrus atlantica* extractives and their physically modified derivatives	-	-	-
Plant Oil – Balsam Fir (*Abies balsamea*, Pinaceae)	ITIS	85085-34-3	Fir, *Abies balsamea*, extractives and their physically modified derivatives.	-	-	-
Plant Oil – Balsam Torchwood (*Amyris balsamifera*, Rutaceae)[c]	ITIS	8015-65-4 90320-49-3	Oils, amyris: *Amyris balsamifera*. *Amyris balsamifera* extractives and their physically modified derivatives	-	-	-
Plant Oil – Barbados Nut (*Jatropha curcas*, Euphorbiaceae)	ITIS	-		-	-	-
Plant Oil –Basil, Holy (*Ocimum tenuiflorum = O. sanctum*, Lamiaceae)	ITIS	-	-	-	-	-

[a] This and the following plants are distinguished from their essential oils because the whole plant or plant parts have been formally recognized as pesticides by EPA.

[b] CAS RN's have been assigned for a number of chemically altered derivatives of this plant oil: 94333-98-9 (oxidized), 94333-97-8 (epoxidized), 94333-96-7 (acetate).

[c] CAS RN's have been assigned for a number of chemically altered derivatives of this plant oil: 94333-84-3 (hydrogenated), 83863-22-3 (acetylated), 1180557-52-1 (reaction products with potassium carbonate (1:1)).

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Plant Oil – Basil, Sweet (*Ocimum basilicum*, Lamiaceae)[a]	ITIS	8015-73-4	Oils, basil: *Ocimum basilicum*	-	-	-
Plant Oil – Bay Laurel = Sweet Bay (*Laurus nobilis*, Lauraceae)[b]	ITIS	8007-48-5	Oils, sweet bay: *Laurus nobilis*	-	-	-
Plant Oil – Beautyberry, American (*Callicarpa americana*, Lamiaceae)[c]	ITIS	-	-	-	-	-
Plant Oil – Beautyberry, Japanese (*Callicarpa japonica*, Lamiaceae)	ITIS	1061737-07-2	*Callicarpa japonica* extractives and their physically modified derivatives	-	-	-
Plant Oil – Bergamot (*Citrus × aurantium* ssp. *bergamia* = *C. bergamia,* Rutaceae)	ITIS	8007-75-8	Essential oils, bergamot: *Citrus bergamia*	-	-	129029
Plant Oil – Betel = Betel Pepper (*Piper betle*, Piperaceae)	ITIS	84775-81-5	Pepper (Piper), *P. betle*, extractives and their physically modified derivatives	-	-	-
Plant Oil – Billygoat Weed (*Ageratum conyzoides*, Asteraceae)	ITIS	85480-32-6	*Ageratum conyzoides* extractives and their physically modified derivatives	-	-	-
Plant Oil – Birch (*Betula lenta*, etc. Betulaceae) = Birch Bark Oil / Tar[d]	ITIS	85251-66-7	Birch, *Betula lenta*, extractives and their physically modified derivatives	-	-	-
Plant Oil – Black Currant (*Ribes nigrum*, Grossulariaceae) Bud	ITIS	97676-19-2 68606-81-5	Oils, currant, *Ribes nigrum* Currant, *Ribes nigrum*, extractives and physically modified derivatives	-	-	-
Plant Oil – Bugle = Bugleweed (*Ajuga spp.*, Lamiaceae)	ITIS	Various	See notes below	-	-	-
Plant Oil – Cajeput (*Melaleuca leucadendron or M. quinquenervia*, Myrtaceae)[e]	ITIS	8008-98-8 85480-37-1	Oils, cajuput: *Melaleuca leucadendron* *Melaleuca leucadendron* extractives and physically modified derivatives	-	-	-
Plant Oil – Camphor Laurel (*Cinnamomum camphora*, Lauraceae)[f]	ITIS	8022-78-4 92201-50-8	Oils, apopin: *Cinnamomum camphora* Camphor tree, extractives and their physically modified derivatives	-	-	-

[a] CAS RN 8015-73-4 is sometimes used for "basil oil" generally although it is defined specifically by CAS as the oil of this plant.

[b] "Laurel" refers to the family Lauraceae, the type genus *Laurus*, and the type species *L. nobilis*, and there is thus some potential for ambiguity on laurel oils and other derivatives; see Table A2. L*aurus nobilis* is generally known as bay laurel or sweet bay, and this leads to possible confusion with other plants called "bay." CAS RN values assigned for oils of these taxa are generally unambiguous regarding source species.

[c] The taxonomic status of this genus is debated, and some authorities place it in the family Verbenaceae (see Table A2).

[d] "Birch" refers to the family Betulaceae, the type genus *Betula*, and the species B. *lenta*, as well as many other Betula species with useful oils and tars, and there is substantial potential for ambiguity on birch oils and other derivatives; see Table A1. The CAS RN shown is apparently the only one that has been issued for any products of this taxa.

[e] The taxonomic status and common names for many species in the genus *Melaleuca* are controversial, and some sources treat the species listed here as conspecific while others differentiate them. See Table A2 for more discussion.

[f] "Camphor" refers both to a specific compound described independently in this Inventory, and to the tree from which it has historically been derived – the camphor laurel *Cinnamomum camphora*. This leads to potential ambiguity, especially as the chemical is now also extracted from other plants or synthesized from turpentine. In addition to the

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Plant Oil – Canola: see Plant Oil – Rape seed (*Brassica napus or B. rapa*, Brassicaceae)						
Plant Oil – Caraway (*Carum carvi*, Umbelliferae) Seed	ITIS	8000-42-8	Oils, caraway: *Carum carvi*	-	-	-
Plant Oil – Cardamom = (*Elettaria cardamomum*, Zingiberaceae)	ITIS	8000-66-6	Oils, cardamom: *Elettaria cardamomum*	-	-	-
Plant Oil – Castor = Castorbean (*Ricinus communis*, Euphorbiaceae)	ITIS	8001-79-4	Castor oil: *Ricinus communis*. Primarily glycerides of ricinoleic fatty acid.	-	-	31608
Plant Oil – Catnip = Catmint (*Nepeta cataria*, Lamiaceae)	ITIS	8023-84-5 84929-35-1	Oils, catnip: *Nepata cataria* *Nepeta cataria* extractives and their physically modified derivatives	-	-	-
Plant Oil – Catnip (*Nepeta cataria*, Lamiaceae), Hydrogenated	ITIS, EPA	952722-18-8	Oils, catnip, hydrogenated	-	-	4801
Plant Oil – Cedar, Deodar (*Cedrus deodara*, Pinaceae)	ITIS	-	-	-	-	-
Plant Oil – Cedarwood (*Juniperus virginiana*, etc., Cupressaceae)[a]	ITIS	8000-27-9 85085-41-2	Essential oils, cedarwood: *Cedrus atlantica* and *Juniperus virginiana* Juniper, *J. virginiana*, extractives and physically modified derivatives	-	-	40505
Plant Oil – Cedarwood (*Thuja plicata*, Cupressaceae)	ITIS	-	-	-	-	40505
Plant Oil – Celery (*Apium graveolens*, Apiaceae)	ITIS	-	-	-	-	-
Plant Oil – Chamomile (*Chamaemelum nobile = Anthemis nobilis*, Asteraceae)[b]	ITIS	8015-92-7 84649-86-5	Oils, chamomile: *Anthemis nobilis* *Anthemis nobilis* extractives and physically modified derivatives	-	-	128853
Plant Oil – Chamomile, German (*Matricaria chamomilla*, Asteraceae)	ITIS	8002-66-2	Oils, chamomile, German: *Matricaria chamomilla*	-	-	128853
Plant Oil – Chastetree (*Vitex negundo*, Lamiaceae)	ITIS	-	-	-	-	-
Plant Oil – *Chenopodium ambrosiodes* var. *ambrosiodes*: see Plant Oil – Epazote (*Dysphania ambrosioides*)						
Plant Oil – Cinnamon (*Cinnamomum verum = C. zeylanicum,* Lauraceae)[c]	ITIS	8015-91-6	Essential oils, cinnamon: *Cinnamomum zeylanicum*	-	-	-

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CAS RN reported above, derivatives of subspecies of *Cinnamomum camphora* have their own CAS RN's: 93685-43-9 (Extracts of *C. camphora nominale*); 92704-03-5 (*C. camphora formosana*); and 91745-89-0 (*C. camphora linalooliferum*) (en.wikipedia.org/wiki/Camphor, 3/12/12).

[a] Cedarwood Oil in the U.S. has been specified as extracts from sawdust or chips of wood from members of the Cupressaceae family, which includes true cedars, junipers, and cypresses (regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0258-0015). The taxonomic status of many members of this family is contested (GRIN, ITIS), which complicates specification of these oils; see Tables A2 and A4. Most cedarwood oil in the U.S. comes from Eastern Red Cedar = Virginia Cedar (*Juniperus virginiana*) and Western Red Cedar (*Thuja plicata*), but oils from many different trees called cedar have been used in trade, including the Atlas Cedar, *Cedrus atlantica = C. libani* subsp. *atlantica*: e.g. handmade-natural-soap.net/Natural-Bug-Repellent/Shoo-Fly-Natural-Bug-Repellent-Spray.html.

[b] EPA ChemicalSearch shows the source for oil of chamomile as either *Matricaria chamomilla* and/or *Anthemidis nobilis* (a typographical error).

[c] "Cinnamon" refers both to the genus *Cinnamomum* and the type species *C. verum = C. zeylanicum*, but there seems little potential for ambiguity on cinnamon oils and other derivatives; see Table A2.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Plant Oil – Citronella, Ceylon (*Cymbopogon nardus,* Poaceae)[a]	ITIS	8000-29-1 89998-15-2	Oils, citronella: *Cymbopogon nardus* or *C. winterianus*. *C. nardus* extractives and physically modified derivatives.	-	-	21901
Plant Oil – Citronella, Java (*Cymbopogon winterianus,* Poaceae)	ITIS	8000-29-1 91771-61-8	Oils, citronella: *Cymbopogon nardus* or *C. winterianus*.[14] *C. winterianus* extractives and physically modified derivatives	-	-	21901
Plant Oil – Citrus Oil / Citrus Extract (*Citrus* spp.; Rutaceae)[b]	ITIS	68608-34-4	Terpenes and Terpenoids, citrus-oil	-	-	-
Plant Oil – Clove (*Syzygium aromaticum*, Myrtaceae)[c]	ITIS	8000-34-8	Essential oils, clove: *Eugenia caryophyllata* or *Caryophyllus aromaticus*	-	-	220700
Plant Oil – Coconut (*Cocos nucifera*, Arecaceae)	ITIS	8001-31-8	Coconut oil: *Cocos nucifera*. Primarily glycerides of capric, lauric, myristic, oleic and palmitic fatty acids.	-	-	218700
Plant Oil – Corn = Maize (*Zea mays* var. *mays*, Poaceae)	ITIS	8001-30-7	Corn oil: *Zea mays*. Primarily glycerides of linoleic, oleic, palmitic and stearic fatty acids.	-	-	-
Plant Oil – Cotton (*Gossypium* spp., Malvaceae) (= Cottonseed Oil)	ITIS	8001-29-4	Cottonseed oil: *Gossypium* spp. Primarily glycerides of linoleic, oleic and palmitic fatty acids.	-	-	31602
Plant Oil – Cypress, Chinese Weeping (*Chamaecyparis funebris = Cupressus funebris*, Cupressaceae)	ITIS	1159574-01-2 85085-29-6	Oils, cypress, *Cupressus funebris* *Cupressus funebris* extractives and their physically modified derivatives	-	-	-
Plant Oil – Epazote (*Dysphania ambrosioides*, Amaranthaceae)	ITIS	89997-47-7	*Chenopodium ambrosioides* extractives and physically modified derivatives	-	-	599995
Plant Oil – Eucalyptus (*Eucalyptus* spp. & *Corymbia* spp., Myrtaceae)[d]	ITIS	8000-48-4	Essential oils, eucalyptus: *Eucalyptus* spp.	-	-	40503
Plant Oil – Fingerroot (*Boesenbergia rotunda*, Zingiberaceae)	ITIS	-	-	-	-	-
Plant Oil – Flax: see Plant Oil - Linseed = Flax (*Linum usitatissimum*, Linaceae)						

[a] Citronella oil is associated with two distinct plant species, *Cymbopogon nardus* = Ceylon or Sri Lanka citronella, and *Cymbopogon winterianus* = Java or Burma citronella (CAS SciFinder; en.wikipedia.org/wiki/Citronella-oil). The common name citronella is more commonly associated with the Ceylon type *C. nardus*.

[b] Oils of Citrus (NCBI 2706) are not consistently identified or specified, for a variety of reasons; see Tables A2 and A-6. Citrus taxa hybridize easily, often leading to complex taxonomic status; there is little consistency in the use of common and scientific names; some key constituents (especially D-Limonene) are extracted from a variety of source plants; and it is commonplace for plant oils and their dominant constituents to be used interchangeably. This CAS RN refers to "Terpenes and Terpenoids, citrus-oil." Citrus Oil is registered in the U.S. as Lemon Peel Oil (PC Code 40518), but NPIRS shows no registrations under this name or number. Specific citrus oils and many constituents are treated independently in this Inventory.

[c] CAS recognizes that various parts of the plant (e.g. bud, stem, leaf) have been listed as distinct source materials for the oil (CAS SciFinder); CAS RN's 8015-97-2 and 8015-98-3 are deleted numbers for Clove Oil.

[d] "Eucalptus" and "Eucalptus Oil" are not consistently defined, and Tables A2 and A5 describe taxonomic and chemical relationships between the source plants and their key constituents. In particular, the traditional genus *Eucalyptus* has been divided in recent years between *Eucalyptus* (L'Hér) and *Corymbia* (Corymbia K.D. Hill & L.A.S. Johnson 1995, NCBI), and many species traditionally known as Eucalyptus, including lemon eucalyptus, are now placed by taxonomists in *Corymbia* , though conventional names used in regulation or trade change more slowly. The primary source of eucalyptus oil in trade is the Blue Gum *Eucalyptus globulus*, and the major component of this oil is Eucalyptol. In addition to Oil of Lemon Eucalyptus, which is treated separately in this Inventory, CAS RN's have been issued for extracts and physically modified derivatives of several other *Corymbia* species, none of which are apparently used currently as PHP's.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Plant Oil – Garlic (*Allium sativum*, Amaryllidaceae)[a]	ITIS	8000-78-0	Essential oils, garlic: *Allium sativum*	-	-	128827
Plant Oil – Garlic Chives (*Allium tuberosum*, Amaryllidaceae)	ITIS	-		-	-	-
Plant Oil – Geranium, Rose (*Pelargonium graveolens*, Geraniaceae)[b]	ITIS	8000-46-2	Oils, geranium: *Pelargonium graveolens* or *P. radula*	-	-	597500
Plant Oil – Geranium, Rasp-leaf (*Pelargonium radens*, Geraniaceae)	ITIS	8000-46-2	Oils, geranium: *Pelargonium graveolens* or *P. radula*	-	-	597500
Plant Oil – Ginger (*Zingiber officinale*, Zingiberaceae)[c]	ITIS	8007-08-7 84696-15-1 68916-45-0	Oils, ginger: *Zingiber officinale* *Zingiber officinalis* extractives and physically modified derivatives Oils, ginger, terpene-free	-	-	-
Plant Oil – Ginger, Cassumunar (*Zingiber montanum*, Zingiberaceae)	ITIS	864662-46-4 68916-45-0	Oils, ginger: *Zingiber purpureum* Oils, ginger, terpene-free	-	-	-
Plant Oil – Jatropha: see Plant Oil – Barbados Nut (*Jatropha curcas*)						
Plant Oil – Jojoba (*Simmondsia chinensis*, Simmondsiaceae)	ITIS	61789-91-1	Jojoba oil: *Simmondsia californa*	-	-	67200
Plant Oil – Juniper (*Juniperus communis* etc., Cupressaceae) Berry	ITIS	73049-62-4	Oils, juniper, terpene-free	-	-	-
Plant Oil – Lavandin (*Lavandula × intermedia*, Lamiaceae)	ITIS	8022-15-9	Oils, lavandin: *Lavandula hybrida* = *Lavandula officinalis* + *Lavandula latifolia*	-	-	40500
Plant Oil – Lavender (*Lavandula angustifolia*, etc., Lamiaceae)	ITIS	8000-28-0	Essential oils, lavender: *Lavandula officinalis*	-	-	597600
Plant Oil – Lemon (*Citrus × limon = C. limonum*, Rutaceae)	ITIS	8008-56-8	Essential oils, lemon: *Citrus limonum*	-	-	-
Plant Oil – Lemon Eucalyptus (*Corymbia citriodora,* Myrtaceae)[d]	ITIS	129828-24-6	Oils, eucalyptus: *Eucalyptus citriodora*	-	-	40522
Plant Oil – Lemongrass (*Cymbopogon citratus* or *C. flexuosus,* Poaceae)[a]	ITIS	72869-82-0	Terpenes and Terpenoids, lemongrass-oil	-	-	40502

[a] CAS 8000-78-0 is alternatively listed as "garlic oil" or "garlic bulb oil".

[b] "Geranium" refers to the family Geraniaceae, the type genus *Pelargonium*, and the species *P. graveolens*, *P. radens = P. radula*, etc., and there is consequently significant potential for ambiguity on geranium oils and other derivatives; see Table A2. CAS specification of oils by the sources plants is good for this taxa.

[c] "Ginger" refers to the family Zingiberaceae, the type genus *Zingiber*, and the type species *Z. officinalis*, and there is consequently potential for ambiguity on ginger oils and other derivatives; see Table A2. CAS RN values for ginger oils are generally unambiguous regarding source species; in addition to those in the table, CAS RN values have also been assigned for oleoresins of *Z. officinalis* (8002-60-6) and extractives and physically modified derivatives of *Z. zerumbet* (91770-92-2) and *Z. amaricans* (91770-91-1).

[d] CAS RN's have been assigned for several refined products from this oil. Refining turn the leaves' high citronellal load (up to 80%) into cis- and trans- isomers of PMD, a process which occurs naturally as the eucalyptus leaves age (en.wikipedia.org/ wiki/Lemon-eucalyptus). The raw oil of this plant is not registered in the U.S., but PC Code 11550 refers variously to the acid-modified oil, to "*Eucalyptus citriodora* crystal", or specifically to PMD; see Tables A2 and A5 for the relationships between these materials.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Plant Oil – Lignum-vitae (*Guaiacum* spp., Zygophyllaceae)	ITIS	9000-29-7	Resins, guaiacum: *Guaiacum* spp.	-	-	-
Plant Oil – Lime, Thai = Kaffir (*Citrus hystrix*, Rutaceae)	ITIS	929194-65-0 91771-50-5	Oils, *Citrus hystrix* *Citrus hystrix* extractives and their physically modified derivatives	-	-	-
Plant Oil – Linseed = Flax (*Linum usitatissimum*, Linaceae)	ITIS	8001-26-1	Linseed oil: *Linum usitatissimum*. Primarily glycerides of linoleic, linolenic and oleic fatty acids.	-	-	31603
Plant Oil – Lopseed (*Phryma leptostachya*, Phrymaceae)	ITIS	-	-	-	-	-
Plant Oil – Marigold, French (*Tagetes erecta = T. patula,* Asteraceae)	ITIS	-	-	-	-	176602
Plant Oil – Marjoram (*Origanum majorana,* Lamiaceae)[b]	ITIS	8015-01-8	Oils, marjoram, sweet: *Origanum majorana*	-	-	-
Plant Oil – May Chang = Litsea (*Litsea cubeba*, Lauraceae)	ITIS	68855-99-2 90063-59-5	Oils, *Litsea cubeba* *Litsea cubeba* extractives and their physically modified derivatives	-	-	-
Plant Oil – Mint (*Mentha* spp., Lamiaceae)[c]	ITIS	multiple	No CAS RN for mint oils generally	-	-	128800
Plant Oil – Mint, Field or Wild = Cornmint (*Mentha arvensis*, Lamiaceae)	ITIS	68608-35-5	Terpenes and Terpenoids, mint, *Mentha arvensis piperascens*-oil	-	-	179700
Plant Oil – Mugwort = Common Wormwood (*Artemisia vulgaris*, Asteraceae)	ITIS	68991-20-8 68916-13-2	Oils, *Artemisia vulgaris* Oils, *Artemisia vulgaris*, terpene-free	-	-	-
Plant Oil – Mustard (Black) (*Brassica nigra*, Brassicaceae)[d]	ITIS	8007-40-7	Fats and Glyceridic oils, mustard: *Brassica nigra*	-	-	-
Plant Oil – Neem (*Azadirachta indica*, Meliaceae)	ITIS	8002-65-1	Fats and Glyceridic oils, margosa: *Azadirachta indica*. Primarily glycerides of linoleic, oleic, palmitic and stearic fatty acids.	-	-	25006
Plant Oil – Niaouli (*Melaleuca*	ITIS	8014-68-4	Oils, niaouli: *Melaleuca viridiflora*	-	-	-

[a] "Lemongrass" refers both to the genus *Cymbopogon* and type species *C. citratus*, and there is consequently substantial potential for ambiguity on lemongrass oils and other derivatives; see Table A2. The genus *Cymbopogon* contains about 55 species of tall perennial grasses native to warm temperate and tropical regions of the Old World and Oceania, including *C. nardus* and *C. winterianus*, the sources for citronella; oils from the citronellas are not considerered "lemongrass oil". Lemongrass oil in "natural" insect repellents is sometimes derived from *C. flexuosus*: e.g. herbariasoap.com/products-by-ingredient/essential-oils/lemongrass-soaps/.

[b] Oil of Summer savory (*Satureja hortensis*) is sometimes sold as "marjoram oil" (liveandfeel.com/medicinalplants/marjoram.html).

[c] Both Mint and Mint Oil are recognized by EPA and some other regulatory authorities as pesticides, but the specification and characterization of these materials is ambiguous. The PLANTS database identifies 49 named species or subspecies in the genus *Mentha* L. (see Table A2), and several of these have been used as sources of PHP oils, including wild mint (*M. arvensis* L.), spearmint (*M. spicata* L.), and the hybrid known as peppermint (*M.* × *piperita* L. (pro sp.) [*aquatic* × *spicata*]). Pennyroyal (*M. pulegium* L.) is also in this genus, but is not considered a source of "mint oil", and is treated separately in this Inventory. EPA is in the process of clarifying the status of mint oils in its 25(b) list, but this report has not yet been published.

[d] "Mustard" refers to the family Brassicaceae, the type genus *Brassica*, and the species B. *nigra*, as well as many other Brassica species with useful oils, and there is substantial potential for ambiguity on mustard oils and other derivatives; see Table A2. CAS specification of source material is generally good with this taxa.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
viridiflora, Myrtaceae)						
Plant Oil – Nutmeg (*Myristica fragrans*, Myristicaceae)[a]	ITIS	8008-45-5 8007-12-3 84082-68-8	Oils, nutmeg: *Myristica fragrans* Fats and Glyceridic oils, nutmeg butter: *Myristica fragrans* *Myristica fragrans* extractives and their physically modified derivatives	-	-	-
Plant Oil – Olive (*Olea europaea*, Oleaceae)	ITIS	8001-25-0	Olive oil: *Olea europaea*. Primarily glycerides of linoleic, oleic and palmitic fatty acids.	-	-	31610
Plant Oil – Orange, Bitter (*Citrus × aurantium*, Rutaceae)[b]	ITIS	8014-17-3 92346-90-2	Essential oils, sour orange: *Citrus vulgaris* *Citrus medica vulgaris* extractives and physically modified derivatives	-	-	-
Plant Oil – Orange, Mandarin = Tangerine (*Citrus reticulata*, Rutaceae)[c]	ITIS	8016-85-1 90063-83-5	Oils, tangerine: *Citrus reticulata* Mandarin orange, tangerine (*Citrus reticulata* var. *tangerine*), extractives and their physically modified derivatives	-	-	-
Plant Oil – Orange, Sour (*Citrus × aurantium* ssp. *amara = C. × aurantium* ssp. *aurantium*, Rutaceae)	ITIS	68916-04-1	Oils, orange, sour: *Citrus aurantium, var. amara*	-	-	-
Plant Oil – Orange, Sweet (*Citrus × sinensis = C. sinensis*, Rutaceae)[d]	ITIS	8008-57-9 308064-82-6 8028-48-6	Oils, orange, sweet (*Citrus aurantium*, dulces) Essential oils, orange, sweet (*Citrus sinensis*) Orange, sweet (*Citrus sinensis*) extractives and their physically modified derivatives	-	-	-
Plant Oil – Oregano (*Origanum vulgare,* Lamiaceae)[e]	ITIS	862374-92-3	Essential oils, oregano	-	-	-
Plant Oil – Osage Orange (*Maclura pomifera*, Moraceae)	ITIS	-	-	-	-	-
Plant Oil – Paracress (*Spilanthes acmella*, Asteraceae)	ITIS	90131-24-1	*Spilanthes acmella* extractives and their physically modified derivatives	-	-	-
Plant Oil – Patchouli (*Pogostemon cablin*, Lamiaceae)	ITIS	8014-09-3	Oils, patchouli: *Pogostemon cablin* (*Pogostemon patchouli*)	-	-	-
Plant Oil – Peanut (*Arachis hypogaea*,	ITIS	8002-03-7	Peanut oil: *Arachis hypogaea*. Primarily the glycerides of arachidic,	-	-	-

[a] "Nutmeg" refers both to the genus *Myristica* and the type species *M. fragrans*, and there is thus some potential for ambiguity on nutmeg oils and other derivatives; see Table A1. The potential for confusion seems slight, as almost all nutmeg products in trade are derived from *M. fragrans.*

[b] Subtypes include Sour Orange (subsp. *amara*) and Bergamot (subsp. *bergamia*), although this taxonomy has been contested; see Tables A2 and A6. All types of sour/bitter orange have been used in botanical insect repellents (e.g. songcroftnaturals.com/ body/herbal-insect-repellent/). Efficacy may be due to the presence of limonene (springerlink.com/content/q731x5p17q23537w/) or linalool or linalyl acetate (mdpi.com/1420-3049/14/2/839) or other constituents.

[c] In addition to the CAS RN's reported in the table, numbers have been registered for derivatives of this oil: 68608-38-8 (Terpenes and Terpenoids, tangerine-oil) and 68607-01-2 (Oils, tangerine, terpene-free).

[d] Orange Oil and Oil of Orange have been defined differently at times. Orange Oil in trade typically refers to extracts from this species, cold-pressed by centrifugation associated with orange juice preparation. Orange oil is typically >90% d-limonene, and the two terms are sometimes used interchangeably (see Tables A2 and A6). Essentially pure d-limonene can is commercially distilled from orange oil. CAS RN's have been assigned for other sweet orange oil derivatives, including 68647-72-3 (Terpenes and Terpenoids, sweet orange-oil), 68917-06-6 (Oils, orange, sweet, de-oiled), and 68917-57-7 (Terpenes and Terpenoids, mixed sour and sweet orange-oil).

[e] Oregano oil is registered in Australia as Oreganum aetheroleum (oregano etheric oils obtained by steam distillation of the leaves and flowers of the plant *O. vulgare* ssp. *hirtum*).

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Fabaceae)			behenic, lignoceric, linoleic, oleic, palmitic and stearic fatty acids.			
Plant Oil – Pennyroyal, American False (*Hedeoma pulegioides*, Lamiaceae)	ITIS	8007-44-1	Oils, pennyroyal, *Hedeoma pulegioides*	-	-	40509
Plant Oil – Pennyroyal, European (*Mentha pulegium*, Lamiaceae)	ITIS	8013-99-8	Oils, pennyroyal, *Mentha pulegium*	-	-	-
Plant Oil – Pepper, Black (*Piper nigrum;* Piperaceae)[a]	ITIS	8006-82-4	Oils, black pepper: *Piper nigrum*	-	-	669
Plant Oil – Peppermint (*Mentha × piperita*, Lamiaceae)	ITIS	8006-90-4	Essential oils, peppermint: *Mentha piperita*	-	-	128800 500740
Plant Oil – Pillpod Sandmat (*Euphorbia hirta*, Euphorbiaceae)	ITIS	84625-37-6	*Euphorbia hirta* extractives and their physically modified derivatives	-	-	-
Plant Oil – Pine (*Pinus* spp., Pinaceae)[b]	ITIS	8002-09-3	Essential oils, pine. Composed primarily of isomeric tertiary and secondary cyclic terpene alcohols.	-	-	67002
Plant Oil – Pine, Scots (*Pinus sylvestris*, Pinaceae)	ITIS	-	-	-	-	-
Plant Oil – Pine (*Pinus* spp., Pinaceae) = Pine Tar Oil	ITIS, EPA	91995-59-4	Distillates, wood-tar. Composed primarily of phenols, fatty acids, ester, ketones and alcohols.	-	-	67205
Plant Oil – Prickly-ash (*Zanthoxylum spp.*, Rutaceae)	ITIS	-		-	-	-
Plant Oil – Pyrethrum (*Tanacetum cinerariifolium = Chrysanthemum cinerariifolium or T. coccineum = C. coccineum,* Asteraceae)[c]	WHOPES; GRIN, ITIS	8003-34-7	Pyrethrins. A complex substance which may be obtained by extraction of chrysanthemum flowers or may be made synthetically. Composed primarily of four esters of chrysanthemumcarboxylic acid (mono and di). They are pyrethrin I and II and cinerin I and II.	-	SO	69000 69002
Plant Oil – Rape (*Brassica napus* or *B. rapa*, Brassicaceae) (= Canola Oil)[d]	ITIS	120962-03-0 8002-13-9	Canola oil: *Brassica napus* and *B. campestris* Rape oil: *B. napus*. Primarily the glycerides of erucic, linoleic and oleic	-	-	-

[a] "Pepper" refers to the family Piperaceae, the type genus *Piper*, the species *P. nigrum*, and a wide range of extracts and derivatives; there is consequently substantial potential for ambiguity on pepper oils and other derivatives; see Table A2. CAS RN values for pepper derivatives are generally unambiguous regarding source species. *Piper nigrum* is the source of the spices known as black pepper, white pepper, and green pepper. The fruit of *P. nigrum* (known as peppercorns when dried) and the powdered pepper derived from grinding them, may be described simply as pepper, or as black pepper (cooked and dried unripe fruit), green pepper (dried unripe fruit), or white pepper (dried ripe seeds). White Pepper is U.S. 25(b) FIFRA-exempt, but the other pepper derivatives are not.

[b] See Tables A2 and A4 for detailed description of taxonomic relationships within the conifers used to produce PHP's, and for discussion of relationships between and specification of their key constituents.

[c] The primary source of pyrethrins is from extracts of *Tanacetum cinerariifolium = Chrysanthemum cinerariifolium*, but the related species *T. coccineum = C. coccineum* was an historically important source material as well. Pyrethrum is an extract of the seed heads of these plants, and it contains about 2% pyrethrins – the insectically active fraction. See Tables A2 and A3 for detailed description of taxonomic relationships within the plants used to produce pyrethrins, and for discussion of relationships between and specification of their key constituents.

[d] Rape and Rape Mustard refer to the plant species *Brassica napus* and *B. rapa*, and the oil from their seeds is known as rape seed oil or canola oil. There are many CAS RN's assigned for chemically modified forms and derivatives of canola oil, extending beyond the scope of this document (see CAS SciFinder).

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
			fatty acids.			
Plant Oil – Rosemary (*Rosmarinus officinalis*, Lamiaceae)	ITIS	8000-25-7	Essential oils, rosemary: *Rosmarinum officinalis*	-	-	597700
Plant Oil – Sabadilla (*Schoenocaulon officinale*, Melanthiaceae)	GRIN	84604-18-2	*Schoenocaulon officinale* extractives and their physically modified derivatives	-	-	-
Plant – Sesame (*Sesamum indicum* = *Sesamum orientale*, Pedaliaceae)	ITIS	8008-74-0	Fats and Glyceridic oils, sesame: *Sesamum indicum*. Primarily the glycerides of linoleic, oleic, palmetic and stearic fatty acids.	-	-	72401
Plant Oil – Sichuan Pepper = Timur (*Zanthoxylum armatum*, Rutaceae)[15]	NCBI	-	-	-	-	-
Plant Oil – Soybean / Soya (*Glycine max*, Fabaceae)	ITIS	8001-22-7	Soybean oil: *Soja hispida*. Primarily the glycerides of linoleic, oleic, palmitic and stearic fatty acids.	-	-	31605
Plant Oil – Soybean / Soya (*Glycine max*, Fabaceae), Epoxylated	ITIS	-	-	-	-	-
Plant Oil – Spearmint (*Mentha spicata or M. × gracilis = M. cardiaca,* Lamiaceae)	ITIS	8008-79-5 868742-18-1	Oils, spearmint: *Mentha spicata* and occasionally *Mentha cardiaca* Essential oils, spearmint	-	-	217400
Plant Oil – Stinking Roger (*Tagetes minuta*, Asteraceae)	ITIS	-	-	-	-	-
Plant Oil – Summer Savory (*Satureja hortensis,* Lamiaceae)	ITIS	8016-68-0 84775-98-4	Oils, savory, summer: *Satureja hortensis* Savory, *Satureja hortensis*, extractives and their physically modified derivatives			-
Plant Oil – Sunflower (*Helianthus annuus*, Asteraceae)	ITIS	8001-21-6	Sunflower oil: *Helianthus annuus.* Primarily the glycerides of linoleic and oleic fatty acids.	-	-	-
Plant Oil – Sweet Bay: see Plant Oil – Bay Laurel (*Laurus nobilis*, Lauraceae)						
Plant Oil – Tansy (*Tanacetum vulgare*, Asteraceae)	ITIS	8016-87-3	Oils, tansy: *Tanacetium vulgare*	-	-	-
Plant Oil – Tea Tree (*Leptospermum petersonii*, *Melaleuca alternifolia* etc., Myrtaceae)[a]	ITIS, etc.	85085-43-4 308064-79-1 68647-73-4 85085-48-9	*Leptospermum petersonii* extractives and their physically modified derivatives (tea tree extracts) Essential oils, *Melaleuca* (tea tree oil) Essential oils, *Melaleuca alternifolia* (tea tree oil) *Melaleuca alternifolia* extractives and their physically modified derivatives (tea tree extracts)	-	-	28853
Plant Oil – Thyme (*Thymus vulgaris or T. zygis*, Lamiaceae)[b]	ITIS, GRIN	8007-46-3	Essential oils, thyme: *Thymus vulgaris* or *Thymus zygis*	-	-	597800

[a] The source material for "tea tree" oil is inconsistent. "Tea tree" can refer to the genera *Leptospermum* and *Melaleuca*, to the species *L. petersonii* and *M. alternifolia*, or, less commonly, to other species in these genera; see Table A2.

[b] Thyme oil is commonly associated with *Thymus vulgaris*, but some thyme oil incorporated in "natural" insect repellents is from the related plant *T. zygis*. e.g. herbariasoap.com/products-by-ingredient/essential-oils/thyme-soaps/. CAS RN 8007-46-3 is the essential oil of either *T. vulgaris* or *T. zygis* (CAS).

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Plant Oil – Tropical Whiteweed: see Plant Oil – Billygoat Weed (Ageratum conyzoides, Asteraceae)						
Plant Oil – Turmeric (*Curcuma longa*, Zingiberaceae)	ITIS	8024-37-1	Oils, curcuma: *Curcuma longa*	-	-	-
Plant Oil – Turmuric, Wild (*Curcuma aromatica*, Zingiberaceae)	ITIS	94349-73-2	*Curcuma aromatica* extractives and their physically modified derivatives	-	-	-
Plant Oil – Vetiver (*Chrysopogon zizanioides*, Poaceae)	ITIS	8016-96-4 84238-29-9	Essential oils, vetiver: *Vetiveria zizanoides* *Vetiveria zizanioides* extractives and physically modified derivatives	-	-	-
Plant Oil – Violet (*Viola odorata*, Violaceae)[a]	ITIS	8024-07-5	Violet oil	-	-	-
Plant Oil – Wild Bergamot (*Monarda fistulosa*, Lamiaceae)	ITIS	97952-61-9	*Monarda fistulosa* extractives and their physically modified derivatives	-	-	-
Plant Oil – Wintergreen (*Gaultheria procumbens*, Ericaceae)	ITIS	90045-28-6	*Gaultheria procumbens* extractives and their physically modified derivatives	-	-	-
Plant Oil – Wormwood = Absinth (*Artemisia absinthium*, Asteraceae)	ITIS	8008-93-3	Oils, wormwood: *Artemisia absinthium*	-	-	-
Plant Oil – Ylang Ylang (*Cananga odorata*, Annonaceae)	ITIS	68989-25-3	Terpenes and Terpenoids, ylang-ylang-oil	-	-	-
PMD (= p-Menthane-3,8-diol = Quwenling)[b]	EPA	3564-98-5 42822-86-6	Cyclohexanemethanol, 2-hydroxy-α,α,4-trimethyl-, (1*R*,2*R*,4*R*)-*rel*- Cyclohexanemethanol, 2-hydroxy-α,α,4-trimethyl-	-	-	11550
POE Isooctadecanol (= MMF)	EPA	52292-17-8	Poly(oxy-1,2-ethanediyl), α-isooctadecyl-ω-hydroxy-	-	-	124601
Polyvinylpyrrolidone (= PVP)	EPA	9003-39-8	2-Pyrrolidinone, 1-ethenyl-, homopolymer	-	-	79033
Potassium Laurate[c]	EPA	10124-65-9	Dodecanoic acid, potassium salt (1:1)	-	-	79021
Potassium Silicate	CAS	1312-76-1	Silicic acid, potassium salt	-	-	72606
Potassium Sorbate	CAS	24634-61-5	2,4-Hexadienoic acid, potassium salt (1:1), (2*E*,4*E*)-	-	-	-
Prallethrin[d]	ISO 1750: 2008	23031-36-9	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, 2-methyl-4-oxo-3-(2-propyn-1-yl)-2-cyclopenten-1-yl ester	3352	SN	128722
Prodigiosin	CAS	82-89-3	2,2'-Bi-1*H*-pyrrole, 4-methoxy-5-[(5-methyl-4-pentyl-2*H*-pyrrol-2-ylidene) methyl]-	-	-	-

[a] "Violet" refers to the family Violaceae, the type genus Viola, the species V. odorata, and a number of extracts and derivatives; there is thus substantial potential for ambiguity on violet oils and other derivatives; see Table A2. CAS does not specify the source material for plant oils with this name.

[b] PMD has three chiral carbons, but only two configurations are commonly reported – unspecified and the enantiomeric pair (1R,2R,4R)-rel = (1α,2β,4β).

CAS Name	Stereochemistry	CAS RN
Cyclohexanemethanol, 2-hydroxy-α,α,4-trimethyl-,(1R,2R,4R)-rel-	(1R,2R,4R)-rel = (1α,2β,4β)	3564-98-5
Cyclohexanemethanol, 2-hydroxy-α,α,4-trimethyl-	unspecified	42822-86-6

[c] See also Soap Salts.

[d] See Table A1 for stereochemical specification of pyrethroids.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Propanoic Acid (= Propionic Acid)	EPA	79-09-4	Propanoic acid	-	-	77702
Propargite	ISO 1750: 1981	2312-35-8	Sulfurous acid, 2-[4-(1,1-dimethylethyl)phenoxy]cyclohexyl 2-propyn-1-yl ester	-	-	97601
Propoxur	ISO 1750: 1981	114-26-1	Phenol, 2-(1-methylethoxy)-, 1-(*N*-methylcarbamate)	2757	SN	47802
Propylene Glycol Monolaurate	EPA	27194-74-7	Dodecanoic acid, monoester with 1,2-propanediol	-	-	11288
Pulegone	CAS	89-82-7	Cyclohexanone, 5-methyl-2-(1-methylethylidene)-, (5*R*)-	-	-	-
Pynamin Forte: see d-Allethrin						
Pyrethrin I	ISO 765	121-21-1	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, (1*S*)-2-methyl-4-oxo-3-(2*Z*)-2,4-pentadien-1-yl-2-cyclopenten-1-yl ester, (1*R*,3*R*)-	-	-	69008
Pyrethrin II	ISO 765	121-29-9	Cyclopropanecarboxylic acid, 3-[(1*E*)-3-methoxy-2-methyl-3-oxo-1-propen-1-yl]-2,2-dimethyl-, (1*S*)-2-methyl-4-oxo-3-(2*Z*)-2,4-pentadien-1-yl-2-cyclopenten-1-yl ester, (1*R*,3*R*)-	-	-	69006
Pyrethrins[a]	ISO 765	8003-34-7	Pyrethrins	-	SO	69001
Pyrethrum: See Plant Oils – Pyrethrum						
Pyrethrum Marc[b, 16]		-	-	-	-	69007
Pyridaben	ISO 1750: 1999	96489-71-3	3(2*H*)-Pyridazinone, 4-chloro-2-(1,1-dimethylethyl)-5-[[[4-(1,1-dimethylethyl)phenyl]methyl]thio]-	-	-	129105
Pyridostigmine Bromide	CAS	101-26-8	Pyridinium, 3-[[(dimethylamino)carbonyl]oxy]-1-methyl-, bromide (1:1)	-	-	227702
Pyrimidifen	ISO 1750: 1999	105779-78-0	4-Pyrimidinamine, 5-chloro-*N*-[2-[4-(2-ethoxyethyl)-2,3-dimethylphenoxy] ethyl]-6-ethyl-	-	-	-
Pyriproxyfen	ISO 1750: 1999	95737-68-1	Pyridine, 2-[1-methyl-2-(4-phenoxyphenoxy)ethoxy]-	-	SN	129032
Quwenling: see PMD						
R-(-)-1-Octen-3-ol	EPA	3687-48-7	1-Octen-3-ol, (3*R*)-	-	-	69038
Resmethrin[c]	ISO 1750: 1981	10453-86-8	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, [5-(phenylmethyl)-3-furanyl]methyl ester	-	-	97801
RIDL (**R**elease of **I**nsects carrying a **D**ominant **L**ethal) genes	Literature[d]	-	-	-	-	-
RNAi = RNA Interference	Literature[e]	-	-	-	-	-
Rotenone (extracts of *Lonchocarpus*	ISO 765	83-79-4	[1]Benzopyrano[3,4-*b*]furo[2,3-*h*][1]benzopyran-6(6a*H*)-one, 1,2,12,12a-	2588	-	71003

[a] The extract of the pyrethrum plant is known as pyrethrum and has CAS RN 8003-34-7. The insecticidal fraction of this material is known as the pyrethrins, each of which has a distinct RN. The molecule known as Pyrethrin I is the most abundant, but there is also Pyrethrin II, Cinerin I and II, and Jasmolin I and II.

[b] Pyrethrum Marc is the material left over after the pyrethrins are removed from pyrethrum extract. It is known by EPA as "Pyrethrins and Pyrethroids, manufg. Residues", but Pyrethrum Marc is a common conventional name in science and trade (e.g. http://www.ncbi.nlm.nih.gov/pubmed/9719824, http://www.alibaba.com/showroom/pyrethrum-marc.html).

[c] See Table A1 for stereochemical specification of pyrethroids.

[d] E.g. http://www.oxitec.com/ridl-science/; http://www.msmbb.org.my/apjmbb/html173/173b.pdf; http://en.wikipedia.org/wiki/Sterile_insect_technique

[e] E.g. http://www.rnaiweb.com/; http://www.macalester.edu/~montgomery/rnai.html; http://en.wikipedia.org/wiki/RNA_interference

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
utilis, *Derris* spp., *Tephrosia* spp.)			tetrahydro-8,9-dimethoxy-2-(1-methylethenyl)-, (2*R*,6a*S*,12a*S*)-			
Rutgers 612: see Ethohexadiol						
Ryanodine	EPA	15662-33-6	[a]	-	-	71502
S 220	CAS	-	Methanone, (1S)-3-cyclohexen-1-yl[2-methyl-1-piperidinyl]-			
Sabinene	CAS	3387-41-5	Bicyclo[3.1.0]hexane, 4-methylene-1-(1-methylethyl)-	-	-	-
Saponins	EPA	8047-15-2	Saponins	-	-	97004
S-Bioallethrin[b] (= Esbiol)	WHOPES	28434-00-6	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, (1*S*)-2-methyl-4-oxo-3-(2-propen-1-yl)-2-cyclopenten-1-yl ester, (1*R*,3*R*)-	-	SN	4004
S-Biothrin: see Esbiothrin						
Serratia entomophila (Enterobacteriaceae)[c]	N42906	-	-	-	-	
Serratia proteamaculans (Enterobacteriaceae)[d]	N28151	-	-	-	-	
S-Fenvalerate: see Esfenvalerate						
S-Hydroprene	EPA	65733-18-8	2,4-Dodecadienoic acid, 3,7,11-trimethyl-, ethyl ester, (2*E*,4*E*,7*S*)-	-	-	128966
Silica Gel	EPA	7631-86-9	Silica	-	-	72605
Silicon Dioxide (Diatomaceous Earth)	EPA	63231-67-4	Silica gel	-	-	72602
Silicon Dioxide Nanoparticles	CAS	7631-86-9	Silica	-	-	72605
Silver Nanoparticles (= Nanosilver)	EPA	7440-22-4	Silver	-	-	72599
S-Methoprene	EPA	65733-16-6	2,4-Dodecadienoic acid, 11-methoxy-3,7,11-trimethyl-, 1-methylethyl ester, (2*E*,4*E*,7*S*)-	-	-	105402
Soap: see Soap Salts – Sodium Salts of Fatty Acids						
Soap Salts – Ammonium Salts of Fatty Acids[17]	EPA	84776-33-0	Fatty acids, C_{8-18} and C_{18}-unsatd., ammonium salts	-	-	31801[e]
Soap Salts – Potassium Salts of Fatty Acids	EPA	67701-09-1	Fatty acids, C_{8-18} and C_{18}-unsatd., potassium salts	-	-	79021
Soap Salts – Sodium Salts of Fatty	EPA	61789-31-9	Fatty acids, coco, sodium salts	-	-	79009

[a] 1*H*-Pyrrole-2-carboxylic acid, (3*S*,4*R*,4a*R*,6*S*,6a*S*,7*S*,8*R*,8a*S*,8b*R*,9*S*,9a*S*)-dodecahydro-4,6,7,8a,8b,9a-hexahydroxy-3,6a,9-trimethyl-7-(1-methylethyl)-6,9-methanobenzo[1,2]pentaleno[1,6-*bc*]furan-8-yl ester

[b] See Table A1 for stereochemical specification of pyrethroids.

[c] *Serratia entomophila* Grimont et al. 1988 (NCBI).

[d] *Serratia proteamaculans* (Paine and Stansfield 1919) Grimont et al. 1978 (NCBI). Syn. = *Pseudomonas proteamaculan* Paine and Stansfield 1919, *Xantomonas proteamaculans* (Paine and Stansfield 1919) Burkholder 1948, and *Erwinia proteamaculans* (Paine and Stansfield 1919) Dye 1966 (NCBI).

[e] Soap salts, or salts of fatty acids, are a complex group to characterize because virtually any fatty acid can form salts with a range of cations – most commonly, but not exclusively, Na^+, K^+, and NH_4^+. EPA often groups these materials by their anion, but treats some specific examples, such as potassium laurate, individually; other regulators vary in their treatment of this group and its individual constituents. Many soap salts have insecticidal activity, and some are discussed here alone or in groups with similar attributes, but a full review of individual materials is beyond the scope of this report.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Acids						
Sodium Chloride	EPA	7647-14-5	Sodium chloride (NaCl)	-	-	13905
Sodium Lauryl Sulfate	EPA	151-21-3	Sulfuric acid monododecyl ester sodium salt (1:1)	-	-	79011
Sodium Metasilicate	EPA	6834-92-0	Silicic acid (H_2SiO_3), sodium salt (1:2)	-	-	72604
Spathulenol	CAS	6750-60-3	1*H*-Cycloprop[*e*]azulen-7-ol, decahydro-1,1,7-trimethyl-4-methylene-, (1a*R*,4a*R*,7*S*,7a*R*,7b*R*)-	-	-	-
Spinetoram	ISO 1750: 2008	935545-74-7	Spinetoram	-	-	-
Spinosad	ISO 1750: 2001	168316-95-8	Spinosad	-	SN	110003
Spinosyn A	CAS	131929-60-7	[18]	-	-	-
Spinosyn D	CAS	131929-63-0	[19]	-	-	-
SS 220[a] (= AI3-37220)	CAS	298207-27-9	Methanone, (1*S*)-3-cyclohexen-1-yl[(2*S*)-2-methyl-1-piperidinyl]-	-	-	-
Stearic Acid: see Octadecanoic Acid						
Steinernema riobravis (Steinernematidae)	N52067	-	-	-	-	-
Sulfoxaflor	ISO: provisional	946578-00-3	Cyanamide, *N*-[methyloxido[1-[6-(trifluoromethyl)-3-pyridinyl]ethyl]-λ^4-sulfanylidene]-	-	-	5210
Sulfoxide	WHO	120-62-7	1,3-Benzodioxole, 5-[2-(octylsulfinyl)propyl]-	-	-	57101
Sulfur (= Sulphur)	ISO 765	7704-34-9	Sulfur	1350	-	77501
Sulfuryl Fluoride	GB 4839: 2009	2699-79-8	Sulfuryl fluoride	-	-	78003
Sumithrin: see d-Phenothrin						
SYN 131-1[b]	n/a	n/a	n/a	-	-	n/a
Tartaric Acid[c]	CAS	87-69-4	Butanedioic acid, 2,3-dihydroxy- (2*R*,3*R*)-	-	-	-
Tasmanone	CAS	22595-52-4	4-Cyclohexene-1,3-dione, 5-methoxy-4,6,6-trimethyl-2-(2-methyl-1-oxopropyl)-	-	-	-
Tau-Fluvalinate	ISO 1750: 1999	102851-06-9	D-Valine, *N*-[2-chloro-4-(trifluoromethyl)phenyl]-, cyano(3-phenoxyphenyl) methyl ester	-	-	109302
Tebufenpyrad	ISO 1750: 1999	119168-77-3	1*H*-Pyrazole-5-carboxamide, 4-chloro-*N*-[[4-(1,1-dimethylethyl)phenyl]	-	-	90102

[a] SS 220 is a particular (1S, 2S) stereoisomer of a molecule with four possible forms. The CAS RN given applies to the fully specified molecule. Other sources incorrectly have attributed other CAS numbers which are either obsolete, apply to unspecified stereochemistry, or to other stereoisomers (CAS SciFinder, 6/29/12):

CAS Name	Common Name	Stereochemistry	CAS RN
Methanone, 3-cyclohexen-1-yl(2-methyl-1-piperidinyl)-		Unspecified	69462-43-7 (obsolete = 77251-47-9, 201465-63-6)
Methanone, (1S)-3-cyclohexen-1-yl[(2S)-2-methyl-1-piperidinyl]-	SS 220	(1S,2S)	298207-27-9
Methanone, (1S)-3-cyclohexen-1-yl[(2R)-2-methyl-1-piperidinyl]-		(1S,2R)	298207-31-5
Methanone, (1S)-3-cyclohexen-1-yl[2-methyl-1-piperidinyl]-	S 220	(1S, 2RS)	-

[b] SYN 131-1 is the code name used by its developer for a molecule distinct from others in this list that is under development (July 2012) is a USDA ARS laboratory.

[c] Tartaric Acid has two chiral carbons and hence multiple stereoisomers, but the natural product, referred to by the CAS RN provided, has the (2*R*,3*R*)- or L-(+)configuration.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
			methyl]-3-ethyl-1-methyl-			
Tefluthrin[a]	ISO 1750: 2008	79538-32-2	Cyclopropanecarboxylic acid, 3-[(1*Z*)-2-chloro-3,3,3-trifluoro-1-propen-1-yl]-2,2-dimethyl-, (2,3,5,6-tetrafluoro-4-methylphenyl)methyl ester, (1*R*,3*R*)-*rel*-	3349	-	128912
Temephos	ISO 1750: 1981	3383-96-8	Phosphorothioic acid, $O^{p},O^{p'}$-(thiodi-4,1-phenylene)$O^{p},O^{p},O^{p'},O^{p'}$-tetramethyl ester	P8	SN	59001
Terpineol	CAS	8000-41-7	Terpineol	-	-	-
Tetradecanoic Acid (= Myristic Acid)	CAS	544-63-8	Tetradecanoic acid	-	-	-
Tetramethrin[b]	ISO 1750: 1981	7696-12-0	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, (1,3,4,5,6,7-hexahydro-1,3-dioxo-2*H*-isoindol-2-yl)methyl ester	-	-	69003
Thiamethoxam	ISO 1750: 2001	153719-23-4	4*H*-1,3,5-Oxadiazin-4-imine, 3-[(2-chloro-5-thiazolyl)methyl]tetrahydro-5-methyl-*N*-nitro-	-	-	60109
Thujic Acid	CAS	499-89-8	1,3,6-Cycloheptatriene-1-carboxylic acid, 5,5-dimethyl-	-	-	-
Thujone	CAS	546-80-5	Bicyclo[3.1.0]hexan-3-one, 4-methyl-1-(1-methylethyl)-, (1*S*,4*R*,5*R*)-	-	-	-
Thymol	EPA	89-83-8	Phenol, 5-methyl-2-(1-methylethyl)-	-	-	80402
Tralomethrin[a]	ISO 1750: 2008	66841-25-6	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(1,2,2,2-tetrabromoethyl)-, cyano(3-phenoxyphenyl)methyl ester	3349	-	121501
Trans-Allethrin[a]	CAS	482370-76-3	Cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propen-1-yl)-, 2-methyl-4-oxo-3-(2-propen-1-yl)-2-cyclopenten-1-yl ester, (1*R*,3*R*)-*rel*-	-	-	-
Trans-Cinnamaldyhyde	EPA	14371-10-9	2-Propenal, 3-phenyl-, (2*E*)-	-	-	40516
Transfluthrin[a]	ISO 1750: 1999	118712-89-3	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, (2,3,5,6-tetrafluorophenyl)methyl ester, (1*R*,3*S*)-	-	SN	-
Transpermethrin[a]	ISO 1750: 1983	61949-77-7	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, (3-phenoxyphenyl)methyl ester, (1*R*,3*S*)-*rel*-	-	-	-
Trichlorfon	ISO 1750: 1981	52-68-6	Phosphonic acid, *P*-(2,2,2-trichloro-1-hydroxyethyl)-, dimethyl ester	P27	SW	57901
Triethylene Glycol	EPA	112-27-6	Ethanol, 2,2'-[1,2-ethanediylbis(oxy)]bis-	-	-	83501
Trifluralin	ISO 1750: 1981	1582-09-8	Benzenamine, 2,6-dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)-	-	-	36101
Trilinolein	CAS	537-40-6	9,12-Octadecadienoic acid (9*Z*,12*Z*)-, 1,1',1''-(1,2,3-propanetriyl) ester	-	-	-
Triolein	CAS	122-32-7	9-Octadecenoic acid (9*Z*)-, 1,1',1''-(1,2,3-propanetriyl) ester	-	-	-
Tripalmitin	CAS	555-44-2	Hexadecanoic acid, 1,1',1''-(1,2,3-propanetriyl) ester	-	-	-
Tristearin	CAS	555-43-1	Octadecanoic acid, 1,1',1''-(1,2,3-propanetriyl) ester	-	-	-
Undecan-2-one (= Methyl Nonyl Ketone = 2-Undecanone = IBI 246)	WHO, EPA	112-12-9	2-Undecanone	-	-	44102
Undecanoic Acid (= Hendecanoic Acid)	CAS	112-37-8	Undecanoic acid	-	-	-
Vanillin	CAS	121-33-5	Benzaldehyde, 4-hydroxy-3-methoxy-	-	-	115801

[a] See Table A1 for stereochemical specification of pyrethroids.

[b] See Table A1 for stereochemical specification of pyrethroids.

Active Ingredient Name	Authority[a]	CAS RN[b]	Chemical Name / Specification (CAS)	UN[c]	WHO[d]	EPA[e]
Verbenol	CAS	473-67-6	Bicyclo[3.1.1]hept-3-en-2-ol, 4,6,6-trimethyl-	-	-	128926
Verbenone	CAS	80-57-9	Bicyclo[3.1.1]hept-3-en-2-one, 4,6,6-trimethyl-	-	-	-
(Z)-4-Decenal (= cis-4-Decenal)	CAS	21662-09-9	4-Decenal, (4*Z*)-	-	-	-
(Z)-9-Tricosene (= cis-9-Tricosene = Muscalure)	EPA	27519-02-4	9-Tricosene, (9*Z*)-	-	-	103201
Zeta-Cypermethrin[a]	ISO 1750: 1999	52315-07-8	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, cyano(3-phenoxyphenyl)methyl ester	3352	-	129064
Zinc Oxide Nanoparticles	CAS	1314-13-2	Zinc Oxide	-	-	88502

Table A1. Stereochemistry of Pyrethroids

The multiple stereocenters in the pyrethroids, always seen in the acid moiety and frequently in the alcohol as well, means that chemical specification of these materials is complex and prone to inaccuracy or imprecision. For some materials, this has not been a problem, as only one standard isomer mix is commonly used, but for many of the pyrethroids, multiple combinations and/or ratios of stereoisomers are possible, and careful description is critical to predicting biological activity, both to target and non-target organisms.

The **Allethrin** molecule has three stereocenters, resulting in eight specific stereoisomers and many possible isomer mixtures. Note that the molecules described here as Allethrin are all forms of the original Allethrin I, and differ chemically from Allethrin II, which has not been commercially developed.

CAS RN	Chemical Specification	Naming Convention & Authority
584-79-2	Allethrin with unspecified or racemic stereochemistry	Allethrin (ISO 1750) = unspecified isomers or racemic
231937-89-6	(1R) = d- stereoisomers; racemic or unspecified mixtures	d-Allethrin (WHO, AFNOR) (= Pynamin Forte; EPA) is about 80% (1R) isomers and 20% (1S) isomers, with a 4:4:1:1 ratio of (1R,3R)(S), (1R,3R)(R), (1R,3S)(R), and (1R,3S)(S)
482370-76-3	(1R,3R)-rel = trans-enantiomeric pair	"Trans-allethrin" is not and ISO recognized name, but is used occasionally in the literature.
260359-57-7	(1R,3R) = d-(trans) stereoisomers; racemic or unspecified	Used for Bioallethrin (=d-trans-Allethrin), which has a 1:1 ratio of (1R,3R)(S) and (1R,3R)(R) isomers, and also for Esbiothrin (EPA), which has a 3:1 ratio of these isomers. In some specifications, Esbiothrin contains >93% m/m total isomers of which >72% is S-d-trans-allethrin, the remainder being essentially the R-d-trans isomer, with <3% cis-isomers.
28434-00-6	(1R,3R)(S) stereoisomer	S-Bioallethrin (WHO, AFNOR) (=Esbiol); >96% this isomer
42534-61-2	Enantiomeric pair (1R,3R)(S) & (1S,3S)(R); racemic or unspecified	Used imprecisely to refer to one or more of the pesticides listed above

The stereochemistry of **cyhalothrin** is moderately complex, but usage seems to be more consistent than with many other pyrethorids. Unlike most pyrethroids, for cyhalothrin the CAS RN and common name do not apply to a mixture of all possible stereoisomers, but only to the cis- configurations.

CAS RN	Chemical Specification	Naming Convention & Authority
68085-85-6	The name Cyhalothrin and CAS RN apply to racemic or unspecified mixtures of the 4 cis- stereoisomers of the molecule	Cyhalothrin (ISO 1750) = unspecified isomers or racemic
91465-08-6	Enantiomeric pair (1R,3R)(S) & (1S,3S)(R); racemic or unspecified; thus lambda-cyhalothrin is gamma-cyhalothrin and its enantiomeric pair	Lambda-cyhalothrin (ISO 1750 & WHO)
76703-62-3	(1R,3R)(S)	Gamma-cyhalothrin (ISO 1750)

The stereochemistry and specification of **cyfluthrin** is complex, but there is only one CAS RN (68359-37-5) currently assigned for all stereoisomer mixtures. While some individual stereoisomers have their own RN's, the number listed is used for racemic or unspecified stereochemistry and also for the mixture of stereoisomers known as Beta-cyfluthrin. CAS RN 83855-46-3 and 85782-82-7 are obsolete.

Permethin, with two stereocenters, consists of four stereoisomers, and the ratio of these varies in permethrin products in trade. Two of the isomers are trans- in the cyclopropane moiety and two cis; the ratio of trans- to cis- varies from 60:40 to 75:25 in products meeting WHOPES specificiations.

CAS RN	Stereochemistry	CAS Name	Common Name
52645-53-1	Unspecified	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, (3-phenoxyphenyl)methyl ester	Permethrin (ISO)
51877-74-8	(1R,3S)	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, (3-phenoxyphenyl)methyl ester, (1R,3S)-	Biopermethrin (ISO)
54774-45-7	(1R,3R)	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, (3-phenoxyphenyl)methyl ester, (1R,3R)-	1R-cis-Permethrin
54774-47-9	(1S,3R)	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, (3-phenoxyphenyl)methyl ester, (1S,3R)-	1S-trans-Permethrin
54774-46-8	(1S,3S)	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, (3-phenoxyphenyl)methyl ester, (1S,3S)-	1S-cis-Permethrin
61949-77-7	(1R,3S)-rel	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, (3-phenoxyphenyl)methyl ester, (1R,3S)-rel-	Transpermethrin (ISO)
61949-76-6	(1R,3R)-rel	Cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, (3-phenoxyphenyl)methyl ester, (1R,3R)-rel-	Cispermethrin

Cypermethrin has three stereocenters, resulting in eight specific stereoisomers and many possible isomer mixtures.

CAS RN	Chemical Specification	Naming Convention & Authority
52315-07-8	Cypermethrin with unspecified or racemic stereochemistry	Cypermethrin (ISO 1750 & WHOPES) = mixture of all stereoisomers in equal parts
67375-30-8	Enantiomeric pair (1R,3R)(S) + (1S,3S)(R); racemic or unspecified	Alpha-Cypermethrin (ISO 1750 & WHOPES) = (1R,3R)(S)-rel racemate
1224510-29-5	(1R,3RS)(S)-rel stereoisomers = (1R,3R)(S) + (1R,3S)(S) + (1S,3S)(R) + (1S,3R)(R)	Beta-Cypermethrin (ISO 1750) = 40% Alpha + 60% Theta = 2:2:3:3 ratio of (1R,3R)(S) + (1S,3S)(R)+ (1R,3S)(S) + (1S,3R)(R)
71697-59-1	Enantiomeric pair (1R,3S)(S) + (1S,3R)(R); racemic or unspecified	Theta-Cypermethrin (ISO 1750) = (1R,3S)(S)-rel racemate
1315501-18-8	(1RS,3RS;1RS,3SR)(S)-abs stereoisomers = (1R,3R)(S) + (1R,3S)(S) + (1S,3R)(S) + (1S,3S)(S)	Zeta-Cypermethrin (ISO 1750) = 45-55% of [1:1 mixture of (1R,3R)(S)+(1S,3S)(S)] and 45-55% of [1:1 mixture of (1R,3S)(S)+(1S,3R)(S)]
-	(1R,3S)(RS) = (1R,3S)(R) + (1R,3S)(S)	q-Cypermethrin = 1:1 mixture of (1R,3S) stereoisomers
66841-24-5	(1R,3S)(R)	d-trans-Beta-Cypermethrin = essentially pure stereoisomer
65731-84-2	(1R,3R)(S)	ISO 1750 uses this number for Beta-Cypermethrin, but CAS uses it for this stereoisomer alone (CAS)

The stereochemistry and specification of **phenothrin** is complex and inconsistently applied. The number listed for Phenothrin (CAS RN 26002-80-2) is used for racemic or unspecified stereochemistry, while 188023-86-1 is used for the racemic mixture of (1R) stereoisomers known as d-Phenothrin or Sumithrin. 53528-32-8 and 73170-79-3 are cancelled CAS Registry Numbers for phenothrin. EPA registers both Phenothrin and d-Phenothrin/Sumithrin as PC Code 69005.

Cyphenothrin has three chiral carbons, and hence eight possible specific stereoisomers, some of which have unique CAS RN's. However, only one CAS RN (39515-40-7) has been assigned to date for all the possible stereoisomer mixtures. Thus, this RN refers to racemic or unspecified stereochemistry and also for the mixtures of stereoisomers known as d-cyphenothrin, d-trans-cyphenothrin, and d-d-trans-cyphenothrin. The specific stereoisomer d-d-trans-cyphenothrin does not have a unique RN.

Deltamethrin, Transfluthrin, Metofluthrin, and most other pyrethroids have not apparently been as challenging, as typically only one set of stereoisomers dominates trade. Nontheless, it is important to evaluate research results to ensure that the materials used conforms to what is commercially available, if the research conclusions will be relevant to commercial products.

Table A2. Accepted[a] Taxonomic Relationships & Names of Plants Identified as Source Material for PHP's

amily	Genus	Species	Common	CAS Name	NCBI	GRIN	ITIS
ANGIOSPERMAE (Flowering Plants)							
Class Magnoliopsida							
SUPERORDER ASTERANAE							
Order Apiales							
Apiaceae	*Apium*	*Apium graveolens*[b]	Celery		4045	300034	182184
Apiaceae	*Pimpinella*	*Pimpinella anisum*[c]	Anise	*Pimpinella anisum*	271192	28395	29822
Umbelliferae	*Carum*	*Carum carvi*[d]	Caraway	*Carum carvi*	48032	9245	29610
Order Asterales							
Asteraceae[e]	*Artemisia*	*Artemisia* spp.[f]					35431
Asteraceae	*Artemisia*	*Artemisia vulgaris*[g]	Mugwort = Common Wormwood	*Artemisia vulgaris*	4220	4190	35505
Asteraceae	*Artemisia*	*Artemisia absinthium*[h]	Absinth Wormwood	*Artemisia absinthium*	72332	4274	35445
Asteraceae	*Tagetes*	*Tagetes* spp.	Marigolds				38482
Asteraceae	*Tagetes*	*Tagetes erecta* = *T. patula*[i]	French Marigold		55843	36202	38488
Asteraceae	*Tagetes*	*Tagetes minuta*[j]	Stinking Roger		169607	36201	38487
Asteraceae	*Ageratum*	*Ageratum conyzoides*[k]	Billygoat Weed	*Ageratum conyzoides*	68299	103793	36481

[a] The over-arching taxonomic structure, as well as names for taxa, has been adopted from the Integrated Taxonomic Information System (ITIS), as of July 2012. Wherever possible, names have been compared with those of the USDA PLANTS, ARS GRIN, and NCBI databases, and with Wikipedia, and differences in usage are noted.

[b] *Apium graveolens* L. (ITIS & NCBI). Syn. = wild celery (GRIN). Subtypes and synonyms include *Apium graveolens* var. *dulce* (wild celery = stalk celery), *A. graveolens* var. *rapaceum* (celeriac = celery-root = root celery = turnip-root celery = knob celery), *A. graveolens* var. *graveolens* (wild celery), and *A. graveolens* var. *secalinum* (smallage = Chinese celery = cutting celery = leaf celery = soup celery) (GRIN, ITIS).

[c] *Pimpinella anisum* L. (ITIS & NCBI). Syn. = Anise Burnet Saxifrage, Sweet Cumin (GRIN, NCBI)

[d] *Carum carvi* L. (ITIS & NCBI). Syn. = *C. velenovskyi* Rohlena (PLANTS), carum (GRIN), wild caraway (ITIS).

[e] The specification of oils from plants in the Asteraceae (= Compositae) is relatively straight-forward. Several genera in this family, including in particular Artemisia spp., are characterized by extracts with significant insecticidal or insect repellent activity.

[f] *Artemisia* L. (ITIS).

[g] *Artemisia vulgaris* L. (ITIS & NCBI). Syn. = *A. selengensis* Turcz. ex Besser, *A. tilesii* Ledeb. var. aleutica (Hultén) S.L. Welsh, *A. unalaskensis* Rydb., *A. unalaskensis* Rydb. var. aleutica Hultén, and many subtypes (PLANTS); *A. vulgaris* var. *coarctata* Forselles ex Besser, felonherb, green-ginger (GRIN), hierba de San Juan, Artemisia (ITIS).

[h] *Artemisia absinthium* L. (ITIS & NCBI). Syn. = absinthium, absinthe, absinth wormwood (GRIN).

[i] *Tagetes erecta* L. (ITIS). Syn. = *T. patula* L. (NCBI); *T. lunulata* (NCBI); *T. corymbosa* Sweet, *T. remotiflora* Kunze, *T. signata* Bartling, *T. tenuifolia* Millsp. (PLANTS).

[j] *Tagetes minuta* L. (ITIS & PLANTS). Syn. = *T. bonariensis* Pers., *T. glandulifera* Schrank, *T. glandulosa* Schrank ex Link, *T. porophylla* Vell., muster John Henry, wild marigold (PLANTS); Aztec marigold, dwarf marigold, khakibush, Mexican marigold, southern marigold (GRIN); marigold, stinkweed (ITIS).

[k] *Ageratum conyzoides* L. (NCBI). Syn. = tropical whiteweed, billygoat plant, bluebonnet , bluetop, goatweed, whiteweed (GRIN).

amily	Genus	Species	Common	CAS Name	NCBI	GRIN	ITIS
Asteraceae	*Chamaemelum*	*Chamaemelum nobile = Anthemis nobilis*[a]	Chamomile	*Anthemis nobilis*	99037	104133	501396
Asteraceae	*Helianthus*	*Helianthus annuus*[b]	Sunflower	*Helianthus annuus*	4232	27923	36616
Asteraceae	*Matricaria*	*Matricaria chamomilla*[c]	German Chamomile	*Matricaria chamomilla*	98504	104435	780435
Asteraceae	*Spilanthes*	*Spilanthes acmella*[d]	Paracress	*Spilanthes acmella*		35254	505915
Asteraceae	*Tanacetum*	*Tanacetum cinerariifolium = Chrysanthemum cinerariifolium*[e]	Pyrethrum	Pyrethrins		104580	522332
Asteraceae	*Tanacetum*	*Tanacetum coccineum = Chrysanthemum coccineum*[f]	Pyrethrum	Pyrethrins			780529
Asteraceae	*Tanacetum*	*Tanacetum vulgare*[g]	Tansy	*Tanacetium vulgare*	128002	80037	36328
Order Ericales							
Ericaceae	*Gaultheria*	*Gaultheria procumbens*[h]	Wintergreen	*Gaultheria procumbens*	157519	360	23657
Order Lamiales							
Lamiaceae[i]	*Ajuga*	*Ajuga spp.*[j]	Bugle = Bugleweed		38595		32451

[a] *Chamaemelum nobile* (L.) All (ITIS) = *Anthemis nobilis* (NCBI). Syn. = *Anthemis nobilis* L. (CAS, GRIN), *Ormenis nobilis* (L.) J. Gay ex Coss. & Germ, English chamomile, Roman chamomile, Russian chamomile, common chamomile, corn chamomile, English garden chamomile, noble chamomile, sweet chamomile (GRIN).

[b] *Helianthus annuus* L. (ITIS & NCBI). Syn. = common sunflower (NCBI); *H. aridus* Rydb., *H. lenticularis* Douglas ex Lindl. (PLANTS); *H. jaegeri* Heiser, *H. annuus subsp. jaegeri* (Heiser) Heiser, etc. (GRIN).

[c] *Matricaria chamomilla* L. (ITIS & NCBI). Syn. = *Chamomilla chamomilla* L. (GRIN), *C. chamomilla* (L.) Rydb., *C. recutita* (L.) Rauschert, *M. chamomilla* L. 1755 & 1763, non 1753; *M. chamomilla* L. var. *coronate* (J. Gay) Coss. & Germ., *M. suaveolens* L. (PLANTS). NCBI shows German Chamomile as the subtype *M. chamomilla* var. *recutita* (L.) Fiori, which it treats as a synonym for *M. recutita* L.

[d] *Spilanthes acmella* (L.) L. (ITSI & GRIN). Syn. = *Blainvillea acmella* (L.) Philipson, non *Spilanthes acmella* auct. pl. (= *Acmella paniculata* (Wall. ex DC.) R. K. Jansen) (GRIN); para cress (ITIS); *Acmella oleracea*, *Spilanthes oleracea*, toothache plant (en.wikipedia.org/wiki/Acmella-oleracea). The extract is commonly referred to as Spilanthes Extract (Wikipedia).

[e] *Tanacetum cinerariifolium* (Trevir.) Sch. Bip. (GRIN) is increasingly the taxonomic standard in Asteracea authorities (Jose Panero et al, pers. comm.), but *Chrysanthemum cinerariifolium* (Trevir.) Vis. is recognized by ITIS and PLANTS as the accepted version. Syn. = *Pyrethrum cinerariifolium* Trevir. (ITIS); *Chrysanthemum cinerariaefolium* (EPA 2005), Dalmatian chrysanthemum, pyrethrum daisy, Dalmatian pyrethrum, Dalmatian insect flower, Dalmatian pellitory, big daisy [en.wikipedia.org/wiki/Pyrethrum].

[f] *Tanacetum coccineum* (Willd.) Grierson (ITIS); Syn. = *Chrysanthemum coccineum* Willd., *C. roseum* Adams, pyrethrum daisy (ITIS); painted daisy, Persian insect flower, Persian chrysanthemum, Persian pellitory, Caucasian insect powder plant, red pyrethrum (Wikipedia).

[g] *Tanacetum vulgare* L. (ITIS & NCBI). Syn. = *T. boreale* Fisch. ex DC., *T. vulgare* var. *boreale* (Fisch. ex DC.) Trautv. & C.A.Mey (NCBI); *Chrysanthemum vulgare* (L.) Bernh., *T. vulgare* L. var. *crispum* DC., common tansy (PLANTS); golden-buttons (GRIN); garden tansy (ITIS).

[h] *Gaultheria procumbens* L. (ITIS & NCBI), teaberry, checkerberry (NCBI); eastern teaberry (PLANTS); creeping wintergreen, mountain-tea (GRIN); boxberry, American wintergreen (en.wikipedia.org/wiki/Gaultheria-procumbens).

[i] The specification of mint oils and their constituents is complex and inconsistently applied, in part because "mint" refers botanically both to a genus and to a broader plant family (Lamiaceae = Labiatae). The mint family is known synonymously as both Lamiaceae and Labiatae, and there is no uniform preference given by taxonomists; this Inventory uses Lamiaceae throughout, which is consistent with both NCBI (4136) and ITIS (TSN 32251).

[j] *Ajuga* L. (ITIS) is a diverse genus, broadly known as bugle (ITIS, PLANTS); bugleweed, carpet bugle, and ground pine (hen.wikipedia.org/wiki/Ajuga). The Common Bugle is *A. reptans* and CAS RN's have been assigned for the extractives and physically modified derivatives of that species (CAS RN 90320-26-6), and for *A. australis* (1174174-96-9), *A. bracteosa* (93347-97-8), *A. chamaepytis* (90320-24-4), *A. iva* (90320-25-5), and *A. turkestanica* (329360-59-0).

amily	Genus	Species	Common	CAS Name	NCBI	GRIN	ITIS
Lamiaceae	*Hedeoma*	*Hedeoma pulegioides*[a]	American False Pennyroyal	*Hedeoma pulegioides*		316705	32520
Lamiaceae	*Lavandula*	*Lavandula* spp.	Lavender				500370
Lamiaceae	*Lavandula*	*Lavandula angustifolia*[b]	Lavender	*Lavandula officinalis*	39329	21677	503344
Lamiaceae	*Lavandula*	*Lavandula × intermedia*[c]	Lavandin	*L. hybrida = L. officinalis + L. latifolia*	1196215	400265	506022
Lamiaceae	*Mentha*	*Mentha* spp.	Mint		21819		32264
Lamiaceae	*Mentha*	*Mentha arvensis*[d]	Field Mint (Wild Mint) = Cornmint	*Mentha arvensis piperascens*	292239	24069	565302
Lamiaceae	*Mentha*	*Mentha × piperita*[e]	Peppermint	*Mentha piperita*	34256	24078	32275
Lamiaceae	*Mentha*	*Mentha pulegium*[f]	Pennyroyal, European	*Mentha pulegium*	294739	24079	32270
Lamiaceae	*Mentha*	*Mentha spicata*[g]	Spearmint	*Mentha spicata*	29719	24082	32272
Lamiaceae	*Mentha*	*Mentha × gracilis = M. cardiaca*[h]	Spearmint, Scotch	*Mentha cardiaca*	241069		503751
Lamiaceae	*Monarda*	*Monarda fistulosa*[i]	Wild Bergamot	*Monarda fistulosa*	39344	24536	565311
Lamiaceae	*Nepeta*	*Nepeta cataria*[j]	Catnip (= Catmint)	*Nepata cataria*	39347	25165	32623
Lamiaceae	*Ocimum*	*Ocimum* spp.	Basil				32626
Lamiaceae	*Ocimum*	*Ocimum tenuiflorum = O. sanctum*[a]	Basil, Holy		204149	25491	507863

[a] *Hedeoma pulegioides* (L.) Pers. (ITIS & PLANTS). Syn. = *Cunila pulegioides* L., *Melissa pulegioides* (L.) L., *Ziziphora pulegioides* (L.) Desf. (PLANTS); American pennyroyal (GRIN).

[b] *Lavandula angustifolia* Mill. (ITIS & NCBI). Syn. = *L. officinalis* Chaix ex Vill. (NCBI); *L. officinalis* Chaix, *L. spica* L., *L. vera* DC., English lavender (PLANTS & ITIS); *L. angustifolia* subsp. *angustifolia*, common lavender, garden lavender (GRIN). CAS shows lavender oil from this species, but the commercial product is apparently derived from other species or hybrids in the genus. Some taxonomists believe that garden varieties are hybrids between true lavender *L. angustifolia* and spike lavender (*L. latifolia*).

[c] *Lavandula × intermedia* Emeric ex Loisel. (ITIS & NCBI). Syn. = *L. hybrida = L. officinalis + L. latifolia* (CAS); bastard lavender, broadleaf barren lavender, Dutch lavender, hybrid lavender (GRIN); *L. hortensis* (essentialoils.co.za/essential-oils/lavandin.htm).

[d] *Mentha arvensis* L. (ITIS & NCBI). Syn. = *M. austriaca* Jacq., *M. gentilis* L. (GRIN); cornmint (EPA). Many subtypes and common names; the subtype noted by CAS is not recognized by PLANTS, GRIN, NCBI, or ITIS.

[e] *Mentha × piperita* L. (ITIS & PLANTS). Syn. = *M. × piperita* L. (pro sp.) [*aquatic × spicata*] (PLANTS), Curly Mint, Black Peppermint, White Peppermint, etc. (GRIN); *M. piperita*, *M. x piperita* var. *officinalis* f. *rubescens*, *M. aquatica* x *M. spicata* (NCBI).

[f] *Mentha pulegium* L. (ITIS & NCBI). Syn. = *M. micrantha* (Benth.) Des.-Shost. ≡ *M. pulegium* var. *micrantha*, *Pulegium vulgare* Mill., pennyroyal (NCBI); peppermint (ITIS).

[g] *Mentha spicata* L. (ITIS & PLANTS 7/11/13). Syn. = *M. viridis* (L.) L., *M. crispa* var. *crispata* f. *reticulata* (NCBI); *M. longifolia* auct. non (L.) Huds., *M. longifolia* (L.) Huds. var. *mollissima* (Borkh.) Rouy, *M. sylvestris* L., *M. spicata* L. var. *spicata*, *M. spicata* L. var. *longifolia* L., *M. longifolia* (L.) Huds. var. *undulata* (Willd.) Fiori (PLANTS); *M. cordifolia* Lej. & Courtois auct., spear mint, bush mint (ITIS).

[h] *Mentha × gracilis* Sole (pro. sp.) (ITIS). This plant is cited by CAS (as *Mentha cardiaca*) as an occasional source of "spearmint oil" in trade. Syn. = *M. cardiaca* J. Gerard ex Baker, *M. X muelleriana* auct. non F.W. Schultz, *M. gentilis* auct. non L., *M. X gentilis* var. *cardiaca* (J. Gerard ex Baker) B. Boivin (pro nm.) (ITIS); *M. gracilis*, *M. x cardiaca* J.Gerard ex Baker, *M. x gentilis* auct., *M. x gracilis* Sole, *M. arvensis x M. spicata*, ginger mint, red mint (NCBI); gingermint (ITIS).

[i] *Monarda fistulosa* L. (ITIS & GRIN). Syn. = *Monarda menthifolia* Graham [≡ *Monarda fistulosa* var. *menthifolia*], horse-mint, beebalm, purple beebalm, wild bergamot beebalm (GRIN).

[j] *Nepeta cataria* L. (ITIS & NCBI). Syn. = catwort, field balm (ITIS)

amily	Genus	Species	Common	CAS Name	NCBI	GRIN	ITIS
Lamiaceae	*Ocimum*	*Ocimum basilicum*[b]	Basil, Sweet	*Ocimum basilicum*	39350	25478	32627
Lamiaceae	*Origanum*	*Origanum* spp.	Oregano				32630
Lamiaceae	*Origanum*	*Origanum vulgare*[c]	Oregano		39352	25913	32632
Lamiaceae	*Origanum*	*Origanum majorana*[d]	Sweet Marjoram	*Origanum majorana*	268884	25912	32631
Lamiaceae	*Pogostemon*	*Pogostemon cablin*[e]	Patchouli	*Pogostemon cablin* (*P. patchouli*)	28511	29154	506020
Lamiaceae	*Rosmarinus*	*Rosmarinus officinalis*[f]	Rosemary	*Rosmarinum officinalis*	39367	32207	32677
Lamiaceae	*Satureja*	*Satureja hortensis*[g]	Summer Savory	*Satureja hortensis*	49987	33176	32308
Lamiaceae	*Thymus*	*Thymus* spp.	Thyme				32820
Lamiaceae	*Thymus*	*Thymus vulgaris*[h]	Garden Thyme	*Thymus vulgaris*		36631	505501
Lamiaceae	*Thymus*	*Thymus zygis*[i]	Spanish Thyme	*Thymus zygis*		36632	
Lamiaceae	*Vitex*	*Vitex negundo*[j]	Chastetree		361442	41831	32222
Lamiaceae	*Callicarpa*[k]	*Callicarpa* spp.	Beautyberries				32143
Lamiaceae	*Callicarpa*	*Callicarpa americana*[l]	Beautyberry, American		204211	8516	32144
Lamiaceae	*Callicarpa*	*Callicarpa japonica*[m]	Beautyberry, Japanese	*Callicarpa japonica*	105891	300094	506860
Oleaceae	*Olea*	*Olea europaea*[n]	Olive	*Olea europaea*	4146	25555	32990
Pedaliaceae	*Sesamum*	*Sesamum indicum = S. orientale*[o]	Sesame	*Sesamum indicum*		318056	34431

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[a] *Ocimum tenuiflorum* L., *O. sanctum* L. (ITIS & GRIN). Syn. = non *O. tenuiflorum* Burm.f. (NCBI); brush-leaf-tea, sacred basil, tulsi (GRIN).

[b] *Ocimum basilicum* L. (ITIS & NCBI). Syn. = basil (NCBI).

[c] *Origanum vulgare* L. (ITIS & NCBI). Syn. = *O. heracleoticum* Rchb., nom. illeg. (NCBI); Algerian oregano (*O. vulgare* subsp. *glandulosum*), European oregano (*O. vulgare* subsp. *vulgare*), Greek oregano (*O. vulgare* subsp. *hirtum*), oregano (*O. vulgare* subsp. *vulgare*), pot marjoram (*O. vulgare* subsp. *vulgare*), Russian oregano (*O. vulgare* subsp. *gracile*), wild marjoram, wintersweet.

[d] *Origanum majorana* L. (ITIS & NCBI). Syn. = *O. dubium* Boiss., *Majorana hortensis* Moench (NCBI); *M. majorana* (L.) Karst. (PLANTS & ITIS); pot marjoram (GRIN). There is inconsistency in the use of the name marjoram (en.wikipedia.org/wiki/Marjoram); in particular, oil of Summer savory (*Satureja hortensis*) is sometimes sold as "marjoram oil" (liveandfeel.com/medicinalplants/marjoram.html).

[e] *Pogostemon cablin* (Blanco) Benth. (ITIS & NCBI). Syn. = *P. patchouly* Pellet. (NCBI); *P. patchouli* (CAS SciFinder); patchouli-plant, patchouli (GRIN).

[f] *Rosmarinus officinalis* L. (ITIS & NCBI).

[g] *Satureja hortensis* L. (ITIS & NCBI). Syn. = savory (GRIN).

[h] *Thymus vulgaris* L. (ITIS & GRIN). Syn. = common thyme, English thyme (GRIN).

[i] *Thymus zygis* L. (GRIN). Syn. = sauce thyme, white thyme (GRIN).

[j] *Vitex negundo* L. (ITIS & NCBI). Syn. = Chinese chastetree, five-leaf chastetree (GRIN), negundo chastetree (ITIS); Indian privet; five-leaved chaste tree (Wikipedia).

[k] The taxonomic status of this genus is debated, and some authorities place it in the family Verbenaceae (see ars-grin.gov/cgi-bin/npgs/html/taxon.pl?8516 for discussion).

[l] *Callicarpa americana* L. (ITIS & NCBI). Syn. = *Callicarpa americana* var. *lactea* F.J. Müll. (ITIS); beautyberry, French mulberry (GRIN).

[m] *Callicarpa japonica* Thunb. (ITIS & NCBI). Syn. = Japanese callicarpa (PLANTS & ITIS).

[n] *Olea europaea* L. (ITIS & NCBI). Syn. = *O. sativa* Hoffmanns. & Link (NCBI). Many subordinate types.

[o] Both *Sesamum indicum* L. (e.g. ITIS) and *S. orientale* L. (e.g. PLANTS and GRIN) are common names, used synonymously for this plant. CAS 90106-86-8 is a deleted RN.

amily	Genus	Species	Common	CAS Name	NCBI	GRIN	ITIS
Phrymaceae	*Phryma*	*Phryma leptostachya*[a]	Lopseed		41401		504348
SUPERORDER CARYOPHYLLANAE							
Order Caryophyllales							
Amaranthaceae	*Dysphania*	*Dysphania ambrosioides*[b]	Epazote	*Chenopodium ambrosioides*	330163	446530	822812
Simmondsiaceae	*Simmondsia*	*Simmondsia chinensis*[c]	Jojoba	*Simmondsia californica*	3999	105075	28030
SUPERORDER LILIANAE (MONOCOTS)							
Order Aspargales							
Arecaceae	*Cocos*	*Cocos nucifera*[d]	Coconut	*Cocos nucifera*	13894	11043	42451
Order Aspargales							
Amaryllidaceae	*Allium*	*Allium sativum*[e]	Garlic	*Allium sativum*	4682		42652
Amaryllidaceae	*Allium*	*Allium tuberosum*[f]	Garlic Chives		4683	2409	506484
Order Liliales							
Melanthiaceae	*Schoenocaulon*	*Schoenocaulon officinale*[g]	Sabadilla	*Schoenocaulon officinale*	294315	33260	
Order Poales							
Poaceae	*Chrysopogon*	*Chrysopogon zizanioides*[h]	Vetiver	*Vetiveria zizanoides*	167337	80369	782799
Poaceae	*Cymbopogon*	*Cymbopogon citratus*[i]	Lemongrass	Lemongrass	66014	12797	41613
Poaceae	*Cymbopogon*	*Cymbopogon flexuosus*[j]	East Indian Lemongrass	Lemongrass			506666
Poaceae	*Cymbopogon*	*Cymbopogon nardus*[k]	Citronella, Ceylon	*Cymbopogon nardus*	79840	12810	41615

[a] *Phryma leptostachya* L. (ITIS). Syn. = American lopseed (ITIS).

[b] *Dysphania ambrosioides* (L.) Mosyakin & Clemants (ITIS & NCBI). Syn. = *Chenopodium ambrosioides* L., American wormseed, Jerusalem-tea (NCBI); *C. ambrosioides* L. (basionym), Mexican-tea, Spanish-tea, wormseed (GRIN); Jesuit's tea, Paico, Herba Sancti Mariæ (Wikipedia).

[c] *Simmondsia chinensis* (Link) C.K.Schneid. (ITIS & NCBI). Syn. = *S. californica* Nutt., goatnut (NCBI); *Buxus chinensis* Link (PLANTS; ITIS).

[d] *Cocos nucifera* L. (ITIS). Syn. = coconut palm (NCBI); copra (Wikipedia).

[e] *Allium sativum* L. (ITIS). Syn. = cultivated garlic (ITIS &NCBI).

[f] *Allium tuberosum* Rottler ex Spreng. (ITIS & NCBI). Syn. = *A. uliginosum* D.Don, non Ledeb., non Kanitz (NCBI); *A. clarkei* Hook. f., Chinese chives, Oriental garlic, Chinese leek (GRIN).

[g] *Schoenocaulon officinale* (Schltdl. & Cham.) A. Gray ex Benth. (GRIN)

[h] *Chrysopogon zizanioides* (L.) Roberty (ITIS). Syn. = *Vetiveria zizanioides* (L.) Nash (NCBI); vetivergrass, khus-khus, cuscus grass (NCBI); *Anatherum zizanioides* (L.) Hitchc. & Chase, *Phalaris zizanioides* L. (PLANTS). CAS RN's for chemically modified extracts of this plant include 91082-76-7 (hydrogenated), 84082-84-8 (acetylated), 84650-35-1 (hydrogenated & acetylated), 101896-31-5 (borated), and 95009-70-4 (reaction products with acetic acid and formaldehyde).

[i] *Cymbopogon citratus* (DC.) Stapf (ITIS & NCBI). Syn. = *C. citratus* (DC. ex Nees) Stapf, *Andropogon citratus* DC. ex Nees (PLANTS); West Indian lemongrass, citronelle (GRIN); *A. cerifer* Hack., *A. citriodorum* hort. ex Desf., *A. roxburghii* Nees ex Steud., *A. nardus* ssp. *ceriferus* (Hack.) Hack., *C. nardus* subvar. *citratus* (DC.) Roberty (ITIS). While the type species for lemongrass is *C. citratus*, the name lemongrass has also been applied to all species of the genus *Cymbopogon*, which contains about 55 species of tall perennial grasses native to warm temperate and tropical regions of the Old World and Oceania, including *C. nardus* and *C. winterianus*, the sources for citronella.

[j] *Cymbopogon flexuosus* (Nees ex Steud.) Will.Watson (ITIS). Syn. = *Andropogon flexuosus* Nees ex Steudel (ITIS).

[k] *Cymbopogon nardus* (L.) Rendle (ITIS & GRIN). Syn. = *Andropogon nardus* L. (PLANTS); citronella grass (ITIS).

amily	Genus	Species	Common	CAS Name	NCBI	GRIN	ITIS
Poaceae	*Cymbopogon*	*Cymbopogon winterianus*[a]	Citronella, Java	*Cymbopogon winterianus*		103628	782979
Poaceae	*Zea*	*Zea mays* var. *mays*[b]	Corn = Maize	*Zea mays*	381124	311987	524870
Order Zingiberales							
Zingiberaceae	*Boesenbergia*	*Boesenbergia rotunda*[c]	Fingerroot		97729	100983	506504
Zingiberaceae	*Curcuma*	*Curcuma longa*[d]	Turmeric	*Curcuma longa*	136217	12676	42394
Zingiberaceae	*Curcuma*	*Curcuma aromatic*[e]	Turmeric, Wild	*Curcuma aromatica*	136209	400160	506512
Zingiberaceae	*Elettaria*	*Elettaria cardamomum*[f]	Cardamom	*Elettaria cardamomum*	105181	300197	506505
Zingiberaceae	*Zingiber*	*Zingiber* spp.	Ginger				42400
Zingiberaceae	*Zingiber*	*Zingiber officinale*[g]	Ginger	*Zingiber officinale*	94328	42254	42402
Zingiberaceae	*Zingiber*	*Zingiber montanum*[h]	Cassumunar Ginger	*Zingiber purpureum*	336856	413101	817992
Zingiberaceae	*Zingiber*	*Zingiber zerumbet*[i]	Bitter Ginger				42403
SUPERORDER MAGNOLIANAE							
Order Laurales							
Lauraceae	*Cinnamomum*	*Cinnamomum camphora*[j]	Camphor Laurel	*Cinnamomum camphora*	13429	10578	18175
Lauraceae	*Cinnamomum*	*Cinnamomum verum= C. zeylanicum*[k]	Cinnamon	*Cinnamomum zeylanicum*	128608	310501	501529
Lauraceae	*Laurus*	*Laurus nobilis*[l]	Bay Laurel = Sweet Bay	*Laurus nobilis*	85223	21664	503343
Lauraceae	*Litsea*	*Litsea cubeba*[m]	May Chang = Litsea	*Litsea cubeba*	155299	400267	506204

[a] *Cymbopogon winterianus* Jowitt ex Bor (ITIS). Syn. = Burma citronella, cymbopogon grass (PLANTS & GRIN).

[b] *Zea mays* var. *mays* L. (ITIS & NCBI). Syn. = *Zea mays* L. ssp. *mays* (GRIN).

[c] *Boesenbergia rotunda* (L.) Mansf. (ITIS & NCBI). Syn. = *B. pandurata* (Roxb.) Schltr., *Curcuma rotunda* L. (basionym), *Gastrochilus panduratus* (Roxb.) Ridl., *Kaempferia pandurata* Roxb., Chinese-keys (GRIN); rotund boesenbergia (PLANTS).

[d] *Curcuma longa* L. (ITIS & NCBI). Syn. = *C. domestica* Valeton (NCBI); common turmeric (PLANTS); Indian-saffron (GRIN).

[e] *Curcuma aromatica* Salisb. (ITIS & NCBI). Syn. = curcuma (PLANTS); yellow zedoary (GRIN); aromatic turmeric, Jangli Haldi (en.wikipedia.org/wiki/ Curcuma-aromatica).

[f] *Elettaria cardamomum* (L.) Maton (ITIS & NCBI). Syn. = *Amomum cardamomum* L. (ITIS); Subordinate types = Ceylon cardamom, greater oblong cardamom, long cardamom, wild cardamom (*E. cardamomum* var. *major*); Chester cardamom, Malabar cardamom, Mysore cardamom, small cardamom (*E. cardamomum* var. *cardamomum*)

[g] *Zingiber officinale* Roscoe (ITIS & GRIN). Syn. = *Amomum zingiber* L., (GRIN); *Z. zingiber* (L.) H. Karst., garden ginger (ITIS & PLANTS).

[h] *Zingiber montanum* (J. Koenig) Link ex A. Dietr. (ITIS & PLANTS). Syn. = *Z. cassumunar* Roxb., *Z. purpureum* Roscoe (PLANTS); *Z. montanum* (J.Koenig ex Retz.) Theilade (NCBI), Bengal ginger, cassumar ginger (GRIN).

[i] *Zingiber zerumbet* (L.) Sm. (ITIS).

[j] *Cinnamomum camphora* (L.) J.Presl (ITIS & NCBI). Syn. = *Camphora camphora* (L.) Karst., *Laurus camphora* L., camphortree, camphor laurel, camphor tree (PLANTS); Japanese camphor, Japanese camphortree (GRIN); apopin (CAS).

[k] *Cinnamomum verum* J.Presl, 1825 (ITIS & NCBI). Syn. = *C. zeylanicum* Blume, 1826 (NCBI); *C. zeylanicum* Garcin ex Blume (PLANTS); Ceylon Cinnamon (GRIN).

[l] *Laurus nobilis* L. (ITIS & GRIN). Syn. = bay, laurel, bay-leaf laurel, Grecian laurel (GRIN, NCBI); sweet bay, bay tree, true laurel, laurel tree, Daphne (Wikipedia). Worldwide, many other kinds of plants in diverse families are also called "bay" or "laurel," generally due to similarity of foliage or aroma to *Laurus nobilis*, and the full name is used for the wholly distinct California bay laurel (*Umbellularia californica*, Lauraceae).

[m] *Litsea cubeba* (Lour.) Pers. (ITIS & NCBI). Syn. = mountain-pepper, sambal (NCBI); pheasant-pepper (GRIN).

amily	Genus	Species	Common	CAS Name	NCBI	GRIN	ITIS
Order Magnoliales							
Annonaceae	*Cananga*	*Cananga odorata*[a]	Ylang Ylang	ylang-ylang	13393		181839
Myristicaceae	*Myristica*	*Myristica fragrans*[b]	Nutmeg	*Myristica fragrans*	51089	24855	18125
Order Piperales							
Piperaceae	*Piper*	*Piper betle*[c]	Betel = Betel Pepper	*Piper betle*	13217	28574	895503
Piperaceae	*Piper*	*Piper nigrum*[d]	Black Pepper	*Piper nigrum*	13216	28589	18310
SUPERORDER ROSANAE							
Order Brassicales							
Brassicaceae	*Brassica*	*Brassica spp.*[e]	*Brassica* spp.				23054
Brassicaceae	*Brassica*	*Brassica nigra*[f]	Black Mustard	*Brassica nigra*	3710	7666	23061
Brassicaceae	*Brassica*	*Brassica napus*[g]	Rape	*Brassica napus*	3708	7661	23060
Brassicaceae	*Brassica*	*Brassica rapa*[h]	Rape Mustard	*Brassica campestris*			23063
Order Fabales							
Fabaceae	*Arachis*	*Arachis hypogaea*[i]	Peanut	*Arachis hypogaea*	3818	3785	26463
Fabaceae	*Glycine*	*Glycine max*[j]	Soy = Soya	*Soja hispida*	3847	17711	26716
Order Fagales							
Betulaceae	*Betula*	*Betula spp.*[k]	Birch				19478
Betulaceae	*Betula*	*Betula lenta*[l]	Sweet Birch	*Betula lenta*		7107	19487
Order Geraniales							
Geraniaceae	*Pelargonium*	*Pelargonium* spp.[m]	Geranium				29154

[a] *Cananga odorata* (Lam.) Hook.f. & Thomson (ITIS & NCBI). Syn. = ilang-ilang (NCBI).

[b] *Myristica officinalis* L. f. (ITIS & PLANTS & GRIN). Syn. = *M. fragrans* Houtt. (NCBI & ITIS); mace (NCBI). Other plants in the genus *Myristica* are known as nutmeg trees (en.wikipedia.org/wiki/Nutmeg), but this is the primary source of spice nutmeg, nutmeg oil, and similar extracts.

[c] *Piper betle* L. (ITIS & NCBI). Syn. = *P. rubroglandulosum* Chaveer. & Mokkamul (NCBI); betel pepper, betelvine (GRIN).

[d] *Piper nigrum* L. (ITIS & NCBI). Syn. = *P. lampong* (NCBI), pepper, white pepper (GRIN).

[e] *Brassica* L. (ITIS).

[f] *B. nigra* (L.) W. D.J.Koch (NCBI & ITIS). Syn. = *B. sinapoides* Rothm. ≡ *Sinapis nigra* L. (basionym) (GRIN); shortpod mustard (ITIS).

[g] *Brassica napus* L. (ITIS & NCBI). Syn. = oilseed rape (NCBI). The oil, but not the plant, is known as Canola (Wikipedia etc.).

[h] *Brassica rapa* L. (ITIS). Syn. = *B. campestris* L. (ITIS & CAS), etc.

[i] *Arachis hypogaea* L. (ITIS & NCBI). Syn. = ground-nut (NCBI).

[j] *Glycine max* (L.) Merr. (ITIS & PLANTS). Syn. = *Dolichos soja* L., *Glycine gracilis* Skvortzov, *G. hispida* (Moench) Maxim., *G. soja* (L.) Merr., nom. illeg., non, *G. soja* Siebold & Zucc., *G. ussuriensis* Regel & Maack, *Phaseolus max* L., *Soja hispida* Moench, *Soja max* (L.) Piper (PLANTS), soya-bean (GRIN).

[k] *Betula* L. (ITIS).

[l] *Betula lenta* L. (ITIS)

[m] *Pelargonium* L'Hér. ex Aiton (ITIS).

amily	Genus	Species	Common	CAS Name	NCBI	GRIN	ITIS
Geraniaceae	*Pelargonium*	*Pelargonium graveolens*[a]	Rose Geranium	*Pelargonium graveolens*	73200	317549	29157
Geraniaceae	*Pelargonium*	*Pelargonium radens*[b]	Rasp-leaf Geranium	*Pelargonium radula*	122257	414287	895177
Order Malpighiales							
Euphorbiaceae	*Euphorbia*	*Euphorbia hirta*[c]	Pillpod Sandmat	*Euphorbia hirta*	318062	400049	28081
Euphorbiaceae	*Jatropha*	*Jatropha curcas*[d]	Barbados Nut		180498	20692	28335
Euphorbiaceae	*Ricinus*	*Ricinus communis*[e]	Castor = Castorbean	*Ricinus communis*	3988	31896	28393
Linaceae	*Linum*	*Linum usitatissimum*[f]	Flax	*Linum usitatissimum*	4006	22361	29226
Violaceae	*Viola*	*Viola odorata*[g]	Violet	Violet	97441	41733	22122
Order Malvales							
Malvaceae	*Gossypium*	*Gossypium spp.*[h]	Cotton	*Gossypium* spp.	3633		21709
Order Myrtales							
Myrtaceae	*Corymbia*	*Corymbia* spp.[i]	Eucalyptus		87658		834875
Myrtaceae[j]	*Corymbia*	*Corymbia citriodora*[k]	Lemon Eucalyptus	*Eucalyptus citriodora*	34329	404658	834901
Myrtaceae	*Eucalyptus*	*Eucalyptus* spp.[l]	Eucalyptus = Gum	*Eucalyptus* spp.	3932		27187
Myrtaceae	*Eucalyptus*	*Eucalyptus globulus*[m]	Blue Gum				28197
Myrtaceae	*Leptospermum*	*Leptospermum petersonii*[n]	Common Tea Tree	*Leptospermum petersonii*			834972

[a] *Pelargonium graveolens* L'Hér. (ITIS). Syn. = *P. graveolens* L'Hér. ex Aiton (PLANTS); rose-scent geranium (GRIN); rose geranium (NCBI); sweet scented geranium (ITIS & PLANTS).

[b] *Pelargonium radens* H.E. Moore (ITIS & PLANTS). Syn. = *P. radula* (Cav.) L'Her, rasp-leaf pelargonium (PLANTS); mutifid-leaf pelargonium (GRIN).

[c] *Euphorbia hirta* L. (ITIS & NCBI) = *Chamaesyce hirta* (L.) Millsp. (GRIN). Syn. = *E. pilulifera* auct. non L. (ITIS); garden spurge, asthma-plant (NCBI); tawa-tawa (Wikipedia).

[d] *Jatropha curcas* L. (ITIS). Syn. = bubblebush (GRIN); *Curcas curcas* (L.) Britton & Millsp., physic nut (ITIS).

[e] *Ricinus communis* L. (ITIS & NCBI). Syn. = *R. sanguineus* hort. ex Groenl. (NCBI); castor bean, castor-bean-plant, castor-oil-plant, palma-christi (GRIN)

[f] *Linum usitatissimum* L. (ITIS & NCBI). Syn. = *L. usitatissimum* var. *usitatissimum* L. (ITIS); *L. humile* Mill, *L. usitatissimum* L. var. *humile* (Mill.) Pers., common flax (PLANTS).

[g] *Viola odorata* L. (ITIS & NCBI). Syn. = sweet violet, common violet, English violet, florist's violet, garden violet (GRIN).

[h] The genus *Gossypium* L. (ITIS & NCBI) has many named species, and cottonseed oil can come from a variety of these, although the most common sources are *G. hirsutum* and *G. herbaceum* (http://en.wikipedia.org/wiki/Cottonseed-oil).

[i] *Corymbia* K.D. Hill & L.A.S. Johnson (ITIS).

[j] The specification of plants within the Myrtaceae and their associated oils has been inconsistent, and, in particular, characterization of eucalyptus oils is not uniform. This is largely because the traditional genus *Eucalyptus* (L'Hér) has been divided in recent years between *Eucalyptus* and *Corymbia*, and many plant species and plant oils traditionally known as Eucalyptus, including lemon eucalyptus, are now placed in the latter genus by taxonomists.

[k] *Corymbia citriodora* (Hook.) K.D.Hill & L.A.S. Johnson (ITIS & NCBI). Syn. = *Eucalyptus citriodora* Hook. (GRIN); *E. maculata citriodora* (lessmosquito.com/incognito/what-is-incognito-mosquito-repellent), citron-scent gum, lemon-scent gum, spotted gum, lemonscented gum (GRIN).

[l] *Eucalyptus* L'Hér. (ITIS).

[m] *Eucalyptus globulus* Labill. (ITIS).

[n] *Leptospermum petersonii* F.M. Bailey (ITIS). Syn. = *L. flavescens* Sm. (ITIS).

amily	Genus	Species	Common	CAS Name	NCBI	GRIN	ITIS
Myrtaceae	*Melaleuca*	*Melaleuca* spp.[a]	Tea Tree				27227
Myrtaceae	*Melaleuca*	*Melaleuca alternifolia*[b]	Tea Tree	*Melaleuca alternifolia*	164405	402629	
Myrtaceae	*Melaleuca*	*Melaleuca leucadendron*[c]	Cajeput	*Melaleuca leucadendron*			506176
Myrtaceae	*Melaleuca*	*Melaleuca quinquenervia*[d]	Cajeput, Naiouli		164942	105723	27228
Myrtaceae	*Melaleuca*	*Melaleuca viridiflora*[e]	Niaouli	*Melaleuca viridiflora*	106062	23906	835802
Myrtaceae	*Syzygium*	*Syzygium aromaticum*[f]	Clove	*Eugenia caryophyllata*, *Caryophyllus aromaticus*	219868	50069	506167
Order Rosales							
Moraceae	*Maclura*	*Maclura pomifera*[g]	Osage Orange		3496	23061	19102
Order Sapindales							
Meliaceae	*Azadirachta*	*Azadirachta indica*[h]	Neem	*Azadirachta indica*	124943	6161	290127
Rutaceae	*Citrus*[i]	*Citrus* spp.	Citrus	citrus			28882
Rutaceae	*Citrus*	*Citrus × aurantium*[j]	Bitter Orange	*Citrus vulgaris*, *C. medica vulgaris*	43166	10684	825215
Rutaceae	*Citrus*	*Citrus × aurantium* ssp. *amara = C. × aurantium* ssp. *aurantium*[k]	Sour Orange	*Citrus aurantium, var. amara*			524858

[a] The characterization of plants in the genus *Melaleuca* L. (ITIS) is unsettled, with significant inconsistencies in both scientific and common names.

[b] *Melaleuca alternifolia* (Maiden & Betche) Cheel (GRIN). Syn. = narrow-leaf paperbark, narrow-leaf teatree (GRIN). ITIS does not recognize this taxon.

[c] *Melaleuca leucadendra* (L.) L. (ITIS). The USDA PLANTS database treats this species as synonymous with M. *quinquenervia*, but ITIS distinguishes them.

[d] *Melaleuca quinquenervia* (Cav.) S.T.Blake (ITIS & NCBI). Syn. = *Metrosideros quinquenervia* Cav. (basionym), belbowrie, broadleaf paperbark, broadleaf teatree, coastal teatree, five-vein paperbark, melaleuca, paperbark teatree, punktree (GRIN); bottlebrush tree, niaouli (ITIS).

[e] *Melaleuca viridiflora* Sol. ex Gaertn. (ITIS & NCBI). Syn. = niaouli-tree (PLANTS), broadleaf paperbark, broadleaf teatree, coarse-leaf paperbark, green-flower paperbark, paperbark teatree, paperbark-tree, swamp paperbark, swamp teatree, white teatree (GRIN). Oil of Niaouli is used inconsistently – while CAS assigns RN 8014-68-4 to Niaouli Oil (oil of *M. viridiflora*), Amer and Mehlhorn (2006) and Wikipedia (en.wikipedia.org/wiki/Niaouli) note Niaouli as a common name for *M. quinquenervia*. Both *M. viridiflora* and *M. quinquenervia* are called Broad-leaved paperbark (Wikipedia) and are used in ethnobotany by native Australians.

[f] *Syzygium aromaticum* (L.) Merr. & L.M.Perry (ITIS). Syn. = *Caryophyllus aromaticus* L., *Eugenia caryophyllata* Thunb., *Eugenia caryophyllus* (Spreng.) Bullock & S. Harrison (ITIS & PLANTS); cloves. *Eugenia aromatica* (L.) Baill. is reported as a synonym by NCBI but as a distinct species (= *S. aqueum* (Burm. f.) Alston) by ITIS.

[g] *Maclura pomifera* (Raf.) C.K.Schneid. (ITIS & NCBI). Syn. = *Ioxylon pomiferum* Raf., orth. var., *Toxylon pomiferum* Raf. (NCBI); *Ioxylon pomiferum* Raf. (basionym), bow-wood, hedge apple (GRIN).

[h] *Azadirachta indica* A.Juss. (ITIS & NCBI). Syn. = *Melia azadirachta* L. (NCBI); *Antelaea azadirachta* (L.) Adelb. (PLANTS), neem tree, margosa, Indian-lilac (NCBI); nimtree, sadao India (*A. indica* var. *indica*), sweet neem or Thai neem (*A. indica* var. *siamensis*) (GRIN).

[i] *Citrus* L. (ITIS). The specification of citrus oils and their constituents is complex and inconsistently applied, in part because citrus plants hybridize easily, making taxonomic relationships somewhat ambiguous, and, in part, because of the variations in common usage seen in many other plant families

[j] *Citrus* × *aurantium* L. (pro. sp.) (ITIS). Syn. = *Citrus* × *aurantium* L. (pro sp.) [*maxima* × *reticulata*] (PLANTS); *C. aurantium* L., Seville orange, sour orange (NCBI), bigarade (Wikipedia); Subtypes are generally thought to include Sour Orange (subsp. *amara*), Bergamot (subsp. *bergamia*) (NCBI); and *C.* × *aurantium* L. ssp. *aurantium* = *C. vulgaris* (PLANTS), although this taxonomy has been contested.

[k] *Citrus x aurantium* ssp. *amara* (Wikipedia); Syn. = Neroli; *Citrus* × *aurantium* ssp. *aurantium* (ITIS) is apparently synonymous.

amily	Genus	Species	Common	CAS Name	NCBI	GRIN	ITIS
Rutaceae	*Citrus*	*Citrus × aurantium* ssp. *bergamia = C. bergamia*[a]	Bergamot	*Citrus bergamia*		102901	524859
Rutaceae	*Citrus*	*Citrus × limon = C. limonum*[b]	Lemon	*Citrus limonum*	2708		825214
Rutaceae	*Citrus*	*Citrus hystrix*[c]	Thai Lime	*Citrus hystrix*			825206
Rutaceae	*Citrus*	*Citrus reticulata*[d]	Mandarin Orange = Tangerine	*Citrus reticulate = C. reticulata* var. *tangerine*	85571	10778	28888
Rutaceae	*Citrus*	*Citrus × sinensis = C. sinensis*[e]	Sweet Orange	*Citrus sinensis= C. aurantium, dulces*	2711	10782	825213
Rutaceae	*Zanthoxylum*	*Zanthoxylum* spp.[f]	Prickly-ash		67937		28849
Rutaceae	*Zanthoxylum*	*Zanthoxylum armatum*[g]	Sichuan Pepper = Timur		67938		
Rutaceae	*Amyris*	*Amyris balsamifera*[h]	Balsam Torchwood	*Amyris balsamifera*		102846	28874
Order Zygophyllales							
Zygophyllaceae	*Guaiacum*	*Guaiacum* spp.[i]	Lignum-vitae	*Guaiacum* spp.	45188		29039
SUPERORDER SAXIFRAGANAE							
Order Saxifragales							
Grossulariaceae	*Ribes*	*Ribes nigrum*[j]	Black Currant	*Ribes nigrum*	78511	31845	24488

[a] *Citrus* × *aurantium* L. ssp. *bergamia* (Risso & Poit.) Wight & Arn. ex Engl. (ITIS & GRIN & PLANTS). Syn.: Although bergamot is now widely recognized as a subspecies of *Citrus* × *aurantium* , use of *Citrus bergamia* Risso & Poit. is still common (CAS, etc.). Other synonyms are Bergamot Orange (PLANTS) and *C. aurantium* ssp. *bergamia* (Risso & Poit.) Wight & Arn. ex Engl. (ITIS).

[b] *Citrus* × *limon* (L.) Burm. f. (pro. sp.) (ITIS). Syn. = *C. limonum* Risso (NCBI), *C. limon* (L.) Burm.f. (NCBI).

[c] *Citrus hystrix* DC. (ITIS & GRIN). Syn. = *C.* × *hystrix* (Wikipedia); Mauritius papeda, Kaffir lime (GRIN); Leech lime (Wikipedia).

[d] *Citrus reticulata* Blanco (ITIS & NCBI). Syn. = *C. poonensis* hort. ex Tanaka, *C. chachiensis* hort. (NCBI); *C. nobilis* Andrews (PLANTS & GRIN); mandarin, culate mandarin, mandarine orange, Swatow orange (GRIN); *C. reticulata ssp. unshiu* (Marcow.) D. Rivera, Obón, S. Ríos, Selma, F. Méndez, Verde & F. Cano (ITIS).

[e] *Citrus* × *sinensis* (L.) Osbeck (ITIS). Syn. = *C. sinensis* (L.) Osbeck, Valencia orange, navel orange (NCBI); *C.* × *sinensis* (L.) Osbeck (pro sp.) [*maxima* × *reticulata*], *C. aurantium* L. var. *sinensis* L. (PLANTS); *C. aurantium* Sweet Orange Group, blood orange (GRIN).

[f] *Zanthoxylum* L. (ITIS & NCBI) is a genus of about 250 species of deciduous and evergreen trees and shrubs in the Rutaceae (citrus or rue) family, which are found in warm temperate and subtropical areas worldwide (en.wikipedia.org/wiki/Zanthoxylum). The fruit of several species is used to make a spice known as Sichuan pepper, including, in particular, *Z. armatum* (timur), which is treated independently in this Inventory. Syn. = *Xanthoxylum*, *Xanthoxylon* (NCBI), pricklyash (ITIS). In addition to *Z. armatum*, a number of other species in this genus have reputed PHP potential, including Makhwaen = *Z. limonella* Alston (Debboun et al., 2007).

[g] *Zanthoxylum armatum* DC. (NCBI). Syn. = winged prickly-ash (NCBI); Szechuan Pepper (Wikipedia).

[h] *Amyris balsamifera* L. (ITIS & GRIN). Syn. = Balsam amyris, candlewood, poison-ash, West Indian rosewood, and West Indian sandalwood (GRIN).

[i] *Guaiacum* L. (ITIS & NBCI). Identification and specification of this product is highly inconsistent between sources. Syn. = *Guajacum* spp. (NBCI); Gaiac, Guaiac Wood (Wikipedia); *Bulnesia sarmientoi* (cites.org/common/com/PC/19/E19i-09.pdf); CAS SciFinder.

[j] *Ribes nigrum* L. (ITIS & NBCI). Syn. = European Black Currant (NCBI); Blackcurrant (PLANTS), *Ribes cyathiforme* Pojark. [= *Ribes nigrum* var. *sibiricum*], *Ribes nigrum* f. *chlorocarpum* (Späth) Rehder, and *Ribes nigrum* var. *chlorocarpum* Späth (ITIS). Blackcurrant bud oil, in particular, is registered as a pesticide in Europe.

amily	Genus	Species	Common	CAS Name	NCBI	GRIN	ITIS
Gymnospermae (Gymnosperms)							
Class Pinopsida (Conifers)							
Order Cupressales							
Cupressaceae	*Callitropsis*	*Callitropsis nootkatensis*[a]	Alaska Yellow Cedar	*Callitropsis nootkatensis*	85954	12663	822596
Cupressaceae	*Chamaecyparis*	*Chamaecyparis funebris = Cupressus funebris*[b]	Chinese Weeping Cypress	*Cupressus funebris*	74301	12649	822574
Cupressaceae	*Juniperus*	*Juniperus* spp.	Juniper, Cedar				
Cupressaceae	*Juniperus*	*Juniperus virginiana*[c]	Juniper, Cedar	*Juniperus virginiana*		20878	18048
Cupressaceae	*Juniperus*	*Juniperus communis*[d]	Juniper	juniper	58039	20821	194820
Cupressaceae	*Thuja*	*Thuja plicata*[e]	Western Red Cedar				18044
Order Pinales (Pines)							
Pinaceae	*Pinus*	*Pinus* spp.	Hard Pines			139271	18035
Pinaceae	*Pinus*	*Pinus sylvestris*[f]	Scots Pine		3349	28552	183389
Pinaceae	*Abies*	*Abies* spp.	Fir Trees				18031
Pinaceae	*Abies*	*Abies balsamea*[g]	Balsam Fir	*Abies balsamea*	90345	635	18032
Pinaceae	*Cedrus*	*Cedrus* spp.[h]	Cedar		3321		183405
Pinaceae	*Cedrus*	*Cedrus atlantica*[a]	Atlantic Cedar	*Cedrus atlantica*	123597		

[a] *Callitropsis nootkatensis* (D. Don) D.P. Little (ITIS). Syn. = *C. nootkatensis* (D. Don) Oerst. ex D.P. Little (PLANTS); = *Xanthocyparis nootkatensis* (D.Don) Farjon & D.K. Harder (PLANTS); *Chamaecyparis nootkatensis*, Alaska cedar, Alaskan yellow cedar, Nootka Cypress, yellow cypress, yellow-cedar (GRIN).

[b] *Chamaecyparis funebris* (Endl.) Franco (ITIS). Syn. = *Cupressus funebris* Endl. (NCBI); mourning cypress, Chinese weeping chamaecyparis (GRIN). Chemically modified derivatives include CAS RN 90990-04-8 (extracts using acetate) and 124046-17-9 (Terpenes and Terpenoids, cypress, *Cupressus funebris*-oil, hydroxy, acetates).

[c] Cedarwood Oil in the U.S. has been specified as extracts from sawdust or chips of wood from members of the Cupressaceae family, which includes true cedars, junipers, and cypresses (regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0258-0015). The taxonomic status of many members of this family is contested (GRIN, ITIS), which complicates specification of these oils. Most cedarwood oil in the U.S. comes from Eastern Red Cedar or Virginia Cedar (*Juniperus virginiana* L.; Ashe's Juniper = Mexican Juniper (*J. ashei* J. Buchholz = *J. ashei* J. Buchholz var. *ovate* R.P. Adams = *J. occidentalis* Hook. var. *conjungens* Engelm. = *J. occidentalis* Hook. var. *texana* Vasey = *J. sabinoides* sensu Sarg., non Nees (PLANTS); = *J. mexicana* (GRIN 20807, ITIS 194812); and Western Red Cedar (*Thuja plicata* Donn ex D. Don; = western arborvitae; GRIN36593, ITIS 18044), but oils from many different trees called cedar have been used in trade, including the Atlas Cedar, *Cedrus libani* subsp. *atlantica* = *C. atlantica*: e.g. handmade-natural-soap.net/Natural-Bug-Repellent/Shoo-Fly-Natural-Bug-Repellent-Spray.html.

[d] *Juniperus communis* L. (ITIS & NCBI). Syn. = common juniper (NCBI). There are numerous subtypes and varieties (ITIS).

[e] *Thuja plicata* Donn ex D. Don (ITIS). Syn. = western redcedar (ITIS).

[f] *Pinus sylvestris* L. (ITIS & NCBI). Syn. = Scotch pine (NCBI); *P. densiflora f. sylvestriformis* Taken. ≡ *P. sylvestris var. sylvestriformis*, *P. hamate* (Steven) Sosn. ≡ *P. sylvestris* var. *hamate* = *P. nigra* f. *pygmaea* (Carrière) Rehder = *P. sylvestris* f. *nana* (Carrière) Lipa = *P. sylvestris* var. *rigensis* Loudon (GRIN).

[g] *Abies balsamea* (L.) Mill. (ITIS & NCBI). Syn. = balsam, Canada balsam, eastern fir, fir balsam (GRIN); *A. balsamifera* Michx. (NCBI). The taxonomy of this plant is complicated by at least two named subspecies – *A. balsamea* var. *balsamea* (L.) Mill. (also known as balsam fir), and *A. balsamea* var. *phanerolepis* Fernald (PLANTS; ITIS). CAS RN 85085-34-3 is defined as "Extractives and their physically modified derivatives such as tinctures, concretes, absolutes, essential oils, oleoresins, terpenes, terpene-free fractions, distillates, residues, etc., obtained from *Abies balsamea*, Pinaceae."

[h] *Cedrus* Trew (ITIS).

amily	Genus	Species	Common	CAS Name	NCBI	GRIN	ITIS
Pinaceae	*Cedrus*	*Cedrus deodara*[b]	Deodar Cedar		3322	9692	183408
Pinaceae	*Cedrus*	*Cedrus libani*[c]	Cedar of Lebanon		93692	9695	183406

[a] *Cedrus atlantica* (Endl.) G.Manetti ex Carriere (NCBI). Not treated by ITIS. Treated as a subset of *C. libani* by some taxonomists, but as a separate species more generally (en.wikipedia.org/wiki/Cedrus_libani, accessed 7/17/12).

[b] *Cedrus deodara* (Roxb. ex D.Don) G.Don (ITIS & NCBI). Syn. = *C. deodara f. aurea* (J. Nelson) Rehder, *Pinus deodara* Roxb. ex D. Don (basionym), Deodar, Himalayan Cedar (GRIN).

[c] *Cedrus libani* A. Rich. (ITIS).

Table A3. Pyrethrum and Pyrethins: Characterization and Key Constituents and Derivatives

The specification of the Chrysanthemum extracts known as pyrethrum, and their constituents and derivaties, is complex, but is reasonably consistently defined.

While the pyrethrins as pyrethrum extract are registered PHP's in virtually all jurisdictions, the individual constituents are rarely, if ever, extracted or synthesized as unique pesticide constituents. However, many of them have unique identifiers in some jurisdictions, allowing description and specification of differing mixtures. Therefore, they are formally recognized in the U.S. with PC Codes issued, but they are not "registered" in the sense that technical materials are not now registered for manufacturing use, and end-use products based on these materials are not available on the market.

Material	CAS RN	EPA PC Code	NIH PubChem ID	U.S. Registered Products
Pyrethrum Flowers	8003-34-7	69000	2457	0
Pyrethrum	8003-34-7	69000		
Pyrethrins	8003-34-7	69001	2458	3614 (594 active)
Pyrethrin Coils		69004	2461	0
Pyrethrum Marc = Pyrethrum Powder other than Pyrethrins	8003-34-7	69002	2459	2 (0 active)
Pyrethrin I	121-21-1	69008	2465	0
Pyrethrin II	121-29-9	69006	2463	0
Cinerin I	25402-06-6	69009	2466	0
Cinerin II	121-20-0	69010	2467	0
Jasmolin I	4466-14-2	69011	2468	0
Jasmolin II	1172-63-0	69012	2469	0

Table A4. Pine (Pinaceae) Oils: Characterization and Key Constituents and Derivatives

The specification of pine oils and their constituents, especially the pinene molecules and terpineols, is complex and inconsistently applied. Alpha- and beta-pinene have the same carbon structure as pinane (CAS RN 473-55-2) but differ in the location of a double bond. Alpha- and beta-pinene each have two stereocenters (C1 and C5) but only two possible stereoisomers. Unfortunately, (+)-alpha-pinene (1R,5R) is sometimes conflated with alpha-pinene (racemate of 1R,5R and 1S,5S), so that the regulatory status of stereoisomers of this molecule can be uncertain. For example, in the EPA ChemicalSearch database, Alpha-(+)-Pinene is shown as an EPA-registered pesticide compound (PC Code 067004), but the CAS RN associated with this material, 80-56-8, is actually the identifier for racemic Alpha-Pinene. It is potentially even less clear what specifically is registered in other jurisdictions, but a full treatment of this group is not possible here. The specification and regulatory status of the terpineols is also complex. EPA used PC Code 067003 for alpha-terpineol prior to 6/21/77 and then switched to 224400, but no products have been registered under this PC Code. EPA uses CAS RN 138-87-4 for unspecified terpineols, but CAS uses this RN specifically for β-Terpineol = Cyclohexanol, 1-methyl-4-(1-methylethenyl)-.

Material	CAS RN (PC Code)	CAS
Pine Oil = Plant Oil – Pine (*Pinus* spp., Pinaceae)	8002-09-3 (67002)	CAS = Essential oils, pine. A complex combination of terpenes produced by the high temperature distillation of oil of turpentine residues or by the catalytic hydration of pinenes. Composed primarily of isomeric tertiary and secondary cyclic terpene alcohols.
Plant Oil – Pine, Scots		Not particulary regulated, but some evidence of efficacy in the literature.
Plant Oil – Pine (*Pinus* spp., Pinaceae) = Pine Tar Oil	91995-59-4 (67205)	CAS = Distillates, wood-tar. A complex combination of organic compounds obtained by the vacuum distillation of wood tar. Composed primarily of phenols, fatty acids, ester, ketones and alcohols.
Terpineol	8000-41-7 (67005)	
α-Terpineol = Alpha-Terpineol	98-55-5 (224400)	
β-Terpineol / Terpineols (unspec.) (EPA)	138-87-4 (67003)	
4-Terpineol	562-74-3	
Pinene	1330-16-1 (67001)	
Alpha-Pinene = (±)-Alpha-Pinene	80-56-8	
d-Pinene = (+)-Alpha-Pinene = (1R)-α-Pinene	7785-70-8 (67004)	
(-)-Alpha-Pinene	7785-26-4	
Beta-Pinene = (±)-Beta-Pinene	127-91-3 (224300)	
(+)-Beta-Pinene	19902-08-0	
(-)-Beta-Pinene	18172-67-3	

Part B: Regulatory Status of Public Health Pesticides and Potential PHP's

Regulation of the manufacture, trade, and use of pesticides is primarily the responsibility of national governments and, at times, subsidiary authorities such as state governments within the U.S.A. However, pesticide availability and usage are also heavily influenced by international actions, including the adoption of conventions by multiple national governments; the issuance of formal specifications, recommendations, evaluations, and other documents by the WHO and other accepted international authorities; and by the funding decisions of major donors, who largely defer to the recommendations of these authorities.

This table summarizes the current regulatory status of all PHP materials evaluated in the Inventory, including both recognized and potential vector control chemicals, covering both national and international authorities. An exhaustive review of country-level pesticide registration or other approvals is beyond the scope of this document, as accurate, current lists of approved materials could not be located for many locations. However, a current (Mar-July 2012) review of on-line regulatory databases from many of the major national regulatory entities allows a representative view, as it includes jurisdictions covering most pesticide use globally. With the addition of global conventions (Stockholm and Rotterdam) and publications from WHO and its subsidiary the World Health Organization Pesticide Evaluation Scheme (WHOPES), these data sources cover, at least indirectly, the vast bulk of vector control pesticides sold and used throughout the world, as those countries not directly represented here in the national data frequently rely on WHOPES and the other standards presented here.

Evaluation and characterization of pesticide risk by WHO has evolved over time and multiple classification systems are currently recognized. "The WHO Recommended Classification of Pesticides by Hazard" (2009) recognizes not only the long-standing scheme of Ia = "Extremely Hazardous", Ib = "Highly Hazardous", II = "Moderately Hazardous", and III = "Slightly Hazardous"; but also uses the U classification for "Technical grade active ingredients of pesticides unlikely to present acute hazard in normal use," and "The Globally Harmonized System of Classification and Labelling of Chemicals" (GHS), which assigns categories GHS 1-5, with 1 the highest ("fatal") and 5 the lowest ("may be harmful") categories of risk.

Other widely accepted international terms include O = obsolete; FUM = gaseous or volatile fumigants; PIC = Prior Informed Consent materials listed under the Rotterdam Convention; and POP = Persistent Organic Pollutants listed under the Stockholm Convention (WHO 2009). Note that the "O" category is a reflection of business practice perhaps more than an evaluation on the potential utility or hazard of specific materials; the term is elaborated in Table 6 of the WHO Recommended Classification of Pesticides by Hazard (WHO 2009):

> "ACTIVE INGREDIENTS BELIEVED TO BE OBSOLETE OR DISCONTINUED FOR USE AS PESTICIDES: Ingredients discontinued have been identified from the previous edition of this classification, from the Pesticide Manual (Pesticide Manual, 1991, 1994; 1997, 2003), and in some cases from the manufacturer. It is difficult, in some cases, to be sure whether or not all commercial activity in a substance has ceased; some of these materials are known to be still in use for non-agricultural purposes."

WHOPES is not formally a pesticide regulatory agency, but provides a multitude of reports on vector control products / PHP's that are widely recognized and respected. WHOPES publications on PHP's are presented in depth later in the Inventory (Table D), and are summarized in this Table B as follows: E = Products under evaluation; ER = Evaluation Report; R = Recommended products; SN = Specifications published under new procedure; SO = Specifications published under old procedure; W = Specifications withdrawn (citations follow Table D).

National regulatory programs employ different systems for reflecting approvals or rejections of pesticide active ingredients, but for the programs reviewed here, the following convention closely reflects current regulatory status in the nations reviewed. Please note that there may be inaccuracies in the documents relied on here, errors in transcription, or changes in status since these data were collected. Therefore, this table cannot be relied on for a legal or definitive indication of regulatory status.

The following conventions are used for national regulatory status in Table B: - = Not currently registered and no evidence of registration in the recent past; # = Identification code issued but no technical material or end-use products registered; A = Active registration; AR = Active registration for restricted uses; AV = registered for use against vectors; E = Exempt from registration; T = Technical or manufacturing use material only has been registered / approved; P = Pending submittal for registration; C = Cancelled for all uses; CB = Banned; F = Failed registration (submitted but not approved); VC = Vector control uses cancelled but some other uses stil approved.

Table B. Regulatory Status of Recognized or Potential Public Health Pesticides in Major Jurisdictions, July 2012

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
(+)-Citronellol	1117-61-9	-	-	-	-	-	-	-	-	-	-
(-)-Citronellol	7540-51-4	-	-	-	-	-	-	-	-	-	-
(-)-Isolongifolenone	26839-52-1	-	-	-	-	-	-	-	-	-	-
1,3,3-trimethylcyclohex-1-ene-4-carboxaldehyde	1726-47-2	-	-	-	-	-	-	-	-	-	-
1-Octen-3-ol[20]	3391-86-4	-	-	-	AV	A	-	-	-	-	-
2-Butyl-2-ethyl-1,3-propanediol	115-84-4	-	-	-	C	-	-	-	-	-	-
2-Hydroxyethyl Octyl Sulfide (= MGK® Repellent 874)	3547-33-9	U, GHS 5	-	-	C	-	-	-	-	-	-
2-Phenethyl Propionate	122-70-3	-	-	-	AV	-	-	-	-	-	-
4-Terpineol	562-74-3	-	-	-	-	-	-	-	-	-	-
Abamectin (= Avermectin B1)	65195-56-4	-	-	-	A	A	A	A	A	-	A
Acepromazine	61-00-7	-	-	-	-	-	-	-	-	-	-
Acequinocyl	57960-19-7	-	-	-	A	-	A	-	P	-	-
Acetaminophen	103-90-2	-	-	-	A[21]	-	-	-	-	-	-
Acetamiprid	135410-20-7	-	-	-	A	A	A	A	A	A	A
Acetic Acid (= Ethanoic Acid, Vinegar)	64-19-7	-	-	-	A	-	A	-	A	-	-
Aedes aegypti male pheromone	-	-	-	-	-	-	-	-	-	-	-
AI-35765 (= CHR 11)	52736-58-0	-	-	-	-	-	-	-	-	-	-
Allethrin	584-79-2	II, GHS 4	-	-	C	-	-	A	A	A	-
Allethrin II	497-92-7	-	-	-	-	-	-	-	-	-	-

[a] See explanatory notes in text for WHO and Globally Harmonized System (GHS) hazard codes.

[b] Other key international codes include O = obsolete; FUM = fumigants; PIC = Prior Informed Consent materials; and POP = Persistent Organic Pollutants (see text for details).

[c] E = Products under evaluation; ER = Evaluation Report; R = Recommended products; SN = Specifications published under new procedure; SO = Specifications published under old procedure; W = Specifications withdrawn.

[d] National Regulatory Status: A = Active registration; - = Not currently registered; # = Identification code issued but no registered technical materials or end-use products; AR = Active registration for restricted uses; AV = registered for use against vectors; C = Cancelled for all uses; CB = Banned; E = Exempt from registration; F = Failed registration (submitted but not approved); P = Pending submittal for registration; T = Technical or manufacturing only; VC = Vector control uses cancelled.

[e] Pesticides registered in the USA are listed at epa.gov/pesticides/chemicalsearch; more data is in product-specific EPA documents, some of which are identified in this inventory, some of which are linked to the chemicalsearch site, and others have links from the general EPA pesticides website, epa.gov/pesticides.

[f] Pesticides registered in Australia are listed at apvma.gov.au/products/constituents/docs/approved_actives_a-z_02-07-2012.pdf.

[g] Pesticides registered in Canada are listed at pr-rp.hc-sc.gc.ca/pi-ip/index-eng.php

[h] Pesticides registered in China (PRC) are listed at chinapesticide.gov.cn/service/aspx/e2.aspx

[i] Pesticides registered in the European Union are listed at ec.europa.eu/sanco-pesticides/public/index.cfm?event=activesubstance.selection

[j] Insecticides registered in India are listed at cibrc.nic.in/ (List dated May 16, 2012)

[k] Pesticides registered in South Africa are listed at nda.agric.za/doaDev/sideMenu/ActNo36-1947/AR/AR%20Lists.htm (List undated)

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
Allyl Isothiocyanate	57-06-7	-	-	-	A	-	-	-	-	-	-
Alpha-Cypermethrin	67375-30-8	II, GHS 3	-	SN, R, E	P	A	-	-	A	A	A
α-Humulene (= Alpha-Humulene, α-Caryophyllene)	6753-98-6	-	-	-	-	-	-	-	-	-	-
α-Ionone (= Alpha-Ionone)	127-41-3	-	-	-	A	-	-	-	-	-	-
α-Pinene (= Alpha-Pinene)	80-56-8	-	-	-	#	A[22]	-	-	-	-	-
α-Terpineol (= Alpha-Terpineol)	98-55-5	-	-	-	#	-	-	-	-	-	-
α-Thujone (= Alpha-Thujone)	546-80-5	-	-	-	-	-	-	-	-	-	-
Aluminum Phosphide	20859-73-8	Fum	-	-	A, VC	A	A	-	-	AR	A
Amitraz	33089-61-1	II, GHS 4	-	-	AV	A	A	A	A	-	A
Ammonia	7664-41-7	-	-	-	A	-	?	-	-	-	-
Ammonium Bicarbonate	1066-33-7	-	-	-	AV	-	-	-	-	-	-
Ammonium Fluorosilicate	16919-19-0	-	-	-	C	-	-	-	-	-	-
Anethole	104-46-1	-	-	-	C	-	-	-	-	-	-
Arsenenic Acid	10102-53-1	-	-	-	C	-	-	-	-	-	-
Arsenic Acid	7778-39-4	-	-	-	A	A	-	-	-	-	-
Arsenous Acid	13464-58-9	-	-	-	-	-	-	-	-	-	-
Atrazine	1912-24-9	III, GHS 4	-	-	AV	A	A	A	A	A	-
Avermectin	73989-17-0	-	-	-	#	-	-	-	-	-	-
Azadirachtin (= Azadirachtin A)	11141-17-6	-	-	-	AV	T	P	A	A	A	-
Azadirachtin B	95507-03-2	-	-	-	#	-	-	-	-	-	-
Azadirachtin H	134788-15-1	-	-	-	-	-	-	-	-	-	-
Azocyclotin	41083-11-8	II, GHS 3	-	-	#	-	-	A	-	-	-
Bacillus thuringiensis subsp. *israelensis* (Bti) , serotype H-14	68038-71-1	III, GHS 5	-	-	AV	A	A	-	-	A	A
Bti strain AM65-52	68038-71-1	III, GHS 5	-	SN, R, E	AV	-	-	-	A	-	-
Bti Strain BK, ATCC number 35646	68038-71-1	III, GHS 5	-	-	#	-	-	-	-	-	-
Bti strain BMP 144	68038-71-1	III, GHS 5	-	-	AV	-	-	-	-	-	-
Bti strain EG2215	68038-71-1	III, GHS 5	-	-	T	-	-	-	-	-	-
Bti Strain IPS-78	68038-71-1	III, GHS 5	-	-	-	-	-	-	-	-	-
Bti strain SA3A	68038-71-1	III, GHS 5	-	-	AV	-	-	-	-	-	-
Beauveria amorpha	-	-	-	-	-	-	-	-	-	-	-
Beauveria bassiana	63428-82-0	-	-	-	A	A	A	-	A	A	A
Beauveria brongniartii	67891-89-8	-	-	-	-	-	-	-	A	-	-
Beauveria velata	-	-	-	-	-	-	-	-	-	-	-
Beauveria vermiconia	-	-	-	-	-	-	-	-	-	-	-
Beauvericin	26048-05-5	-	-	-	-	-	-	-	-	-	-
Bendiocarb	22781-23-3	II, GHS 3	-	SN, R	C	A	A	-	A	A	-
Benzyl Benzoate	120-51-4	-	-	-	A,VC	A	A	-	-	-	-
β-Alanine (= B-Alanine, 3-Aminopropanoic Acid)	107-95-9	-	-	-	-	-	-	-	-	-	-
Betabaculovirus (= *Granulovirus* = Granulosis virus = GV)	-	-	-	-	A	-	-	-	A[23]	-	-
β-Caryophyllene (= Beta-Caryophyllene)	87-44-5	-	-	-	-	-	-	-	-	-	-

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
Beta-Cyfluthrin	68359-37-5	Ib, GHS 2	-	-	AV	A	P	A	A	A	A
Beta-Cypermethrin	1224510-29-5	-	-	-	-	A	-	-	A	-	A
β-Ionone (= Beta-Ionone)	79-77-6	-	-	-	-	-	-	-	-	-	-
β-Pinene (= Beta-Pinene)	127-91-3	-	-	-	#	-	-	-	-	-	-
β -Terpineol (= Beta-Terpineol)	138-87-4	-	-	-	C	-	-	-	-	-	-
β-Thujone (= Beta-Thujone)	471-15-8	-	-	-	-	-	-	-	-	-	-
BHT (= Butylated Hydroxytoluene)	128-37-0	-	-	-	C	-	-	-	-	-	-
Bifenthrin	82657-04-3	II, GHS 3	-	SN, R	AV	A	A	-	A	A	A
Bioallethrin (= d-trans-Allethrin)	260359-57-7	II, GHS 4	-	SN	AV	A	A	A	A	A	A
Bioresmethrin	28434-01-7	U, GHS 5	-	-	C	A	-	A	A	-	-
Bistrifluron	201593-84-2	-	-	-	-	-	-	-	-	-	-
Borax	1303-96-4	III, GHS 5	-	-	A	-	A	-	-	-	A
Boric Acid	10043-35-3	-	-	-	AV	-	A	A	A	-	-
Bovidic Acid	765956-30-7	-	-	-	-	-	-	-	-	-	-
Brodifacoum[a]	56073-10-0	Ia, GHS 1	-	SO	A	A	A	A	A	-	A
Buprofezin	69327-76-0	III, GHS 5	-	-	A	A	-	A	A	A	A
Butane	106-97-8	-	-	-	-	-	-	-	-	-	-
Butanoic Acid (= Butyric Acid)	107-92-6	-	-	-	-	C[b]	-	-	-	-	-
Butopyronoxyl (= Indalone)	532-34-3	O	-	-	#	-	-	-	-	-	-
Butoxy Poly Propylene Glycol (= BPG)	9003-13-8	-	-	-	AV	-	A	-	-	-	-
Calcium Arsenate	7778-44-1	Ib, GHS 2	-	-	C	-	-	-	-	F	-
Callicarpenal	161105-12-0	-	-	-	-	-	-	-	-	-	-
Camphor	76-22-2	-	-	-	C	C[b]	-	A	-	-	-
Carbaryl	63-25-2	II, GHS 3	-	-	AV	A	A	A	A	A	A
Carbon Dioxide	124-38-9	-	-	-	AV	A	A	-	A	-	A
Carboxylic Acids, C1-C3	Various	-	-	-	A	-	-	-	-	-	-
Carvacrol	499-75-2	-	-	-	#	-	-	A	-	-	-
Carveol	99-48-9		-	-	-	-	-	-	-	-	-
Carvone	6485-40-1		-	-	AV	-	-	-	A	-	-
Chlorantraniliprole	500008-45-7	U, GHS 5	-	-	A	A	A	A	P	A	-
Chlordane	57-74-9	II, GHS 4	POP PIC	-	C	-	-	-	A	CB	-
Chlorfenapyr	122453-73-0	II, GHS 4	-	E	A	A	P	-	A	A	A
Chlorfluazuron	71422-67-8	U, GHS 5	-	-	A	A	-	A	-	-	-
Chloropicrin	76-06-2	FUM	-	-	AV	-	A	A	A	-	-

[a] Brodifacoum is a rodenticide, and is included in this and other tables because it is the only rodenticide with WHOPES Specifications published. Given the significance of WHOPES in this arena, we comprehensively list WHOPES recognized products here, even though we do not list other rodenticides registered in the U.S. or other jurisdictions.

[b] Listed as registered within the last year, but not in latest available list. No details have been found on whether this reflects a formal cancellation or a withdrawal of registration for business or other reasons.

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
Chlorphoxim	14816-20-7	O	-	-	-	-	-	-	-	-	-
Chlorpyrifos	2912-88-2	II, GHS 3	-	SN	AV	A	A	A	A	AV	A
Chlorpyrifos-methyl	5598-13-0	III, GHS 5	-	-	A	A	-	A	A	C[a]	A
Chromafenozide	143807-66-3	-	-	-	-	C[a]	-	-	P	-	-
Chromobacterium subtsugae	-	-	-	-	A	-	A	-	-	-	-
Chrysoperla carnea	-	-	-	-	-	-	-	-	-	-	-
Cinerin I	25402-06-6	-	-	-	#	-	-	-	-	-	-
Cinerin II	121-20-0	-	-	-	#	-	-	-	-	-	-
Cinnamaldehyde	104-55-2	-	-	-	A	-	-	-	-	-	-
Citral	5392-40-5	-	-	-	A	-	-	-	-	-	-
Citric Acid	77-92-9		-	-	A, E	-	A	-	-	-	-
Citronellal	106-23-0	-	-	-	-	-	-	-	-	-	-
Citronellol	106-22-9	-	-	-	A	-	-	-	A	-	-
Citronellyl Acetate	150-84-5	-	-	-	-	-	-	-	-	-	-
Coelomomyces spp.	-	-	-	-	-	-	-	-	-	-	-
Conidiobolus coronatus	-	-	-	-	-	-	-	-	-	-	-
Copper Nanoparticles	7440-50-8	-	-	-	-	-	-	-	-	-	-
Corn Gluten Meal	66071-96-3	-	-	-	A, E	-	A	-	-	-	-
Coumaphos	56-72-4	Ib, GHS 2	-	-	AV	-	A	-	A	-	-
Cryolite (= Trisodium Hexafluoroaluminate)	15096-52-3	U, GHS 5	-	-	A	-	-	-	A	-	-
Culicinomyces spp.	-	-	-	-	-	-	-	-	-	-	-
Culex nigripalpus NPV (= CuniNPV)	-	-	-	-	-	-	-	-	-	-	-
Cyantraniliprole	736994-63-1	-	-	-	-	-	A	-	P	-	-
Cyflumetofen	400882-07-7	-	-	-	#	-	A	-	P	-	-
Cyfluthrin	68359-37-5	Ib, GHS 2	-	SN, R	AV	A	A	A	A	A	-
Cyhalothrin	68085-85-8	II, GHS 3	-	-	#	-	-	A	-	-	-
Cypermethrin	52315-07-8	II, GHS 3	-	-	AV	A	A	A	A	A	A
Cyphenothrin	39515-40-7	II, GHS 4	-	-	AV	A	A	-	-	A	-
d-Allethrin (= Pynamin Forte)	584-79-2	-	-	SN	AV	A	A	A	-	-	A
d-α-Pinene (= d-Pinene, (+)-Alpha-Pinene)	7785-70-8	-	-	-	-	-	-	-	-	-	-
DDT	50-29-3	II, GHS 3	POP PIC	SO, R	C	-	-	-	A	AVR	-
d-d, trans-Cyphenothrin	39515-40-7	II, GHS 4	-	SN, R	-	-	-	A	-	-	-
Decanoic Acid (= Capric Acid)	334-48-5	-	-	-	A	-	-	-	-	-	-
DEET (= N,N-Diethyl-meta-toluamide)	134-62-3	III, GHS 4	-	W	AV	A	A	A	AV	-	-
Dehydrolinalool	29171-20-8	-	-	-	-	-	-	-	-	-	-
Deltamethrin	52918-63-5	II, GHS 3	-	SO, R, E	AV	A	A	A	A	A	A

[a] Listed as registered within the last year, but not in latest available list. No details have been found on whether this reflects a formal cancellation or a withdrawal of registration for business or other reasons.

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
DEPA (= N,N-Diethyl Phenylacetamide)	2431-96-1	-	-	-	-	-	-	-	-	-	-
Diafenthiuron	80060-09-9	III, GHS 5	-	-	#	A	-	A	-	C[a]	-
Diazinon	333-41-5	II, GHS 4	-	SO	AV	A	A	A	A	AVR	A
Dibutyl Phthalate (= DBP)	84-74-2	O	-	-	C	C[a]	-	-	-	-	-
Dichlorvos (= DDVP)	62-73-7	Ib, GHS 3	-	SO	AV	A	A	A	A	A	A
Dicofol	115-32-2	II, GHS 4	-	-	C	A[24]	-	A	-	A	A
Dieldrin	60-57-1	O	POP PIC	-	C	-	-	-	A	C	-
Diflubenzuron	35367-38-5	III, GHS 5	-	SN, R	AV	A	A	A	A	AV	-
Dihydro-5-heptyl-2(3H)-furanone (= Gamma-Undeccalactone)	104-67-6	-	-	-	AV[25]	-	-	-	-	-	-
Dihydro-5-pentyl-2(3H)-furanone (= Gamma-Nonalactone)	104-61-0	-	-	-	AV	-	-	-	-	-	-
Dimethoate	60-51-5	II, GHS 3	-	SN	A	A	A	A	A	A	A
Dimethyl Phthalate (= DMP)	131-11-3	U, GHS 5	-	-	C	-	-	-	-	-	-
Dinotefuran	165252-70-0	-	-	-	AV	-	P	-	A	A	-
Di-n-propyl Isocinchomeronate (= MGK® Repellent 326)	136-45-8	-	-	-	AV	A	-	-	-	-	-
Dioctyl Phthalate (= DEHP)	117-81-7	-	-	-	#	-	-	-	-	-	-
Dipropylene Glycol	110-98-5	-	-	-	C	-	-	-	-	-	-
D-Limonene	5989-27-5	-	-	-	A	-	-	-	-	-	-
DMC (= Dimethyl Carbate)	5826-73-3	-	-	-	#	-	-	-	-	-	-
DNOC	534-52-1	Ib, GHS 2	PIC	-	C	-	-	-	-	-	-
Dodecanoic Acid (= Lauric Acid)	143-07-7	-	-	-	#	-	-	-	A	-	-
d-Phenothrin (= Sumithrin)	188023-86-1	-	-	SN	AV	A	A	A	-	-	A
Dried Blood / Blood Meal	68911-49-9	-	-	-	C/E	-	A	-	A	-	-
d-Verbenone	18309-32-5	-	-	-	-	-	A[26]	-	-	-	-
Egg Solids	-	-	-	-	A, E	-	-	-	-	-	-
Elemol	639-99-6	-	-	-	-	-	-	-	-	-	-
(E)-N-cyclohexyl-N-ethyl-2-hexenamide	1263262-56-1	-	-	-	-	-	-	-	-	-	-
Endosulfan	115-29-7	II, GHS 3	-	SO	AC[27]	-	A	A	A	AC[28]	A
Engyodontium album (= *Beauveria alba*)	-	-	-	-	-	-	-	-	-	-	-
Esbiothrin	584-79-2 etc.	II, GHS 4	-	SN	A,V?	A	-	A	-	-	-
Esfenvalerate	66230-04-4	II, GHS 3	-	-	AV	A	-	A	A	-	A
Ethohexadiol (= Rutgers 612)	94-96-2	O	-	-	C	-	-	-	-	-	-
Etofenprox	80844-07-1	U, GHS 5	-	SN, R	AV	-	A	A	A	A	-
Etoxazole	153233-91-1	-	-	-	A	A	-	A	A	-	A
Eucalyptol (=1,8-Cineole)	470-82-6	-	-	-	-	A	-	A	-	-	-
Eugenol	97-53-0	-	-	-	AE,V?	A	-	A	A	-	-
Fatty Acids: C7 – C20	67254-79-9	-	-	-	A	-	A[29]	-	A	-	-

[a] Listed as registered within the last year, but not in latest available list. No details have been found on whether this reflects a formal cancellation or a withdrawal of registration for business or other reasons.

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
Fatty Acids, Long Chain (LCFA = C14-C22)	67254-79-9	-	-	-	-	-	A	-	A[30]	-	-
Fatty Acids, Medium Chain (MCFA = C6-C12)	67254-79-9	-	-	-	A	-	A	-	A	-	-
Fatty Acids, Short Chain (SCFA = C4-C5)	67254-79-9	-	-	-	A	-	A	-	A	-	-
Fatty Acids, Very Long Chain (VLCFA = C24+)	67254-79-9	-	-	-	-	-	A	-	-	-	-
Fenazaquin	120928-09-8	-	-	-	A	-	-	A	A	A	A
Fenitrothion	122-14-5	II, GHS 4	-	SN, R	A	A	-	A	A	AVR	A
Fenoxycarb	72490-01-8	U, GHS 5	-	-	A	A	-	A	A	-	A
Fenpropathrin	39515-41-8	II, GHS 3	-	-	A	-	-	A	A	A	A
Fenthion	55-38-9	II, GHS 3	-	SN, R	C	A	-	A	A	AVR	A
Fipronil	120068-37-3	II, GHS 3	-	-	AV	A	-	A	A	A	A
Fish Oil (= Cod Liver Oil)	8016-13-5	-	-	-	A	A	-	-	-	-	-
Flufenoxuron	101463-69-8	III, GHS 5	-	-	-	A	-	A	-	A	A
Formic Acid (= Methanoic Acid)	64-18-6	-	-	-	A	C[a]	-	-	-	-	-
Gamma-Cyhalothrin	76703-62-3	-	-	-	AV	A	-	-	A	-	A
Geraniol	106-24-1	-	-	-	AE,V?	-	-	-	A	-	-
Geranyl Acetate	105-87-3	-	-	-	-	-	-	-	-	-	-
Geranylacetone	3796-70-1	-	-	-	-	-	-	-	-	-	-
Haedoxane A	-	-	-	-	-	-	-	-	-	-	-
Haedoxane E	-	-	-	-	-	-	-	-	-	-	-
HBTX	23509-17-3	-	-	-	-	-	-	-	-	-	-
HCH (= 1,2,3,4,5,6-Hexachlorocyclohexane)[31]	608-73-1	II, GHS 3	PIC	-	C	-	-	-	-	-	-
Heptanoic Acid	111-14-8	-	-	-	-	C[32]	-	-	-	-	-
Hexadecanoic Acid (= Palmitic Acid)	57-10-3	-	-	-	-	-	-	-	-	-	-
Hexahydro-1-(1-oxohexyl)-1H-azepine	18494-57-0	-	-	-	-	-	-	-	-	-	-
Hexanal	66-25-1	-	-	-	#	-	-	-	-	-	-
Hexanoic Acid (= Caproic Acid)	142-62-1	-	-	-	#	-	-	-	-	-	-
Humulene Epoxide II	19888-34-7	-	-	-	-	-	-	-	-	-	-
Hydramethylnon	67485-29-4	II, GHS 4	-	-	A	A	A	A	-	-	A
Imidacloprid	105827-78-9	II, GHS 4	-	-	AV	A	A	A	A	A	A
Imiprothrin	72963-72-5	-	-	-	AV	T	A	A	-	A	-
Indole	120-72-9	-	-	-	A	C[a]	-	-	-	-	-
Indoxacarb	173584-44-6	II, GHS 3	-	-	A	A	-	A	A	A	A
Intermedeol	6168-59-8	-	-	-	-	-	-	-	-	-	-
IR3535 (= Ethyl Butylacetylaminopropionate)	52304-36-6	U, GHS 5	-	SN	AV	C[a]	-	-	AV	-	-
Isaria fumosorosea Apopka Strain 97	-	-	-	-	A	-	-	-	A	-	-
Isaria fumosorosea Strain FE 9901	-	-	-	-	P[33]	-	A	-	P	-	-

[a] Listed as registered within the last year, but not in latest available list. No details have been found on whether this reflects a formal cancellation or a withdrawal of registration for business or other reasons.

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
Isaria fumosorosea Lilacinus Strain 251	-	-	-	-	A	-	-	-	A	-	A
Isoeugenol	97-54-1	-	-	-	-	A	-	-	-	-	-
Isopropyl Alcohol	67-63-0	-	-	-	AV	-	A	-	-	-	-
Isopulegol	59905-53-2	-	-	-	-	-	-	-	-	-	-
Ivermectin	70288-86-7	-	-	-	-	X	-	A	-	-	-
Jasmolin I	4466-14-2	-	-	-	#	-	-	-	-	-	-
Jasmolin II	1172-63-0	-	-	-	#	-	-	-	-	-	-
Jodfenphos (= Iodofenphos)	18181-70-9	O	-	W	#	-	-	-	A	-	-
Kaolin	1332-58-7	-	-	-	A	-	A	-	A	-	-
Lactic Acid	50-21-5	-	-	-	AV	A	A	-	A	-	-
Lagenidium giganteum	-	-	-	-	C	-	-	-	-	-	-
Lambda-Cyhalothrin	91465-08-6	II, GHS 3	-	SN, R, E	AV	A	A	A	A	A	A
Lanolin	8006-54-0	-	-	-	#	-	-	-	-	-	-
Larvicidal Oil	8012-95-1	-	-	SO	AV	AC[a]	A	A	A	-	A
Lauryl Sulfate	151-41-7	-	-	-	E	-	-	-	-	-	-
L-Carvone	6485-40-1	-	-	-	AV	-	-	-	A	-	-
Lead Arsenate	3687-31-8	Ib, GHS 2	-	-	C	-	-	-	-	F	-
Limonene	138-86-3	-	-	-	AV	-	-	-	-	-	-
Limonin	1180-71-8	-	-	-	-	-	-	-	-	-	-
Linalool	78-70-6	-	-	-	AV	-	-	-	-	-	-
Lindane (= BHC, Gamma-HCH, Gammexane)	58-89-9	II, GHS 3	POP PIC	SO	C	-	-	-	A	AC[34]	-
Linoleic Acid	60-33-3	-	-	-	-	-	-	-	-	-	-
L-Lactic Acid	79-33-4	-	-	-	AV	-	A	-	-	-	-
Lysinibacillus sphaericus	143447-72-7	-	-	-	AV	-	A	-	A	A	-
Lysinibacillus sphaericus Serotype H5a5b Strain 2362 ATCC 1170	143447-72-7	-	-	-	AV	A	-	-	-	-	-
Magnesium Phosphide	12057-74-8	FUM	-	-	A, VC	A	A	-	A	A	A
Malathion	121-75-5	III, GHS 5	-	SN, R, E	AV	-	A	A	A	AV	-
Malic Acid	6915-15-7	-	-	-	E	A	-	-	-	-	-
Menthofuran	494-90-6	-	-	-	-	-	-	-	-	-	-
Metaflumizone	139968-49-3	-	-	-	A	-	-	A	A	A	-
Metarhizium anisopliae Strain ESF1	67892-13-1	-	-	-	A	-	A	-	A	A[35]	A[36]
Metarhizium anisopliae Strain F52 Spores	67892-13-1	-	-	-	AV	-	A	-	A	A	A
Methoprene (RS)	40596-69-8	U, GHS 5	-	ER	AV	A	-	-	A	-	-
Methoxychlor	72-43-5	U, GHS 5	-	W	C	-	-	-	A	-	-
Methyl Bromide	74-83-9	FUM	-	-	A	A	A	A	-	AR	A
Methyl Cinnamate	103-26-4	-	-	-	-	-	-	-	-	-	-
Methylheptenone (= Sulcatone)	110-93-0	-	-	-	#	-	-	-	-	-	-

[a] Larvicidal oils have recently been registered in Australia, but are not on latest list. It is unclear if they have been canceled or if they are registered under another name.

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
Methyl Isoeugenol	93-16-3	-	-	-	-	-	-	-	-	-	-
Methyl Salicylate	119-36-8	-	-	-	A	-	A	-	-	-	-
Metofluthrin	240494-70-6	-	-	-	AV	A	A	A	-	-	-
MGK® Repellent 11	126-15-8	-	-	-	C	-	-	-	-	-	-
Minoxidil	38304-91-5	-	-	-	-	-	-	-	-	-	-
Naled	300-76-5	II, GHS 4	-	-	AV	A	A	A	A	-	-
n-Butylacetanilide	91-49-6	-	-	-	C	-	-	-	-	-	-
n-Butyl Formate	592-84-7	-	-	-	-	-	-	-	-	-	-
Nematodes	-	-	-	-	-	-	-	-	-	-	-
Nepetalactone	490-10-8	-	-	-	-	-	-	-	-	-	-
Niclosamide	50-65-7	U, GHS 5	-	SN	A	-	A	A	-	-	-
Niclosamide-Olamine	1420-04-8	-	-	SN	-	-	-	A	-	-	-
N-Octyl Bicycloheptene Dicarboximide (= MGK® 264)	113-48-4	III, GHS 5	-	-	AV	A	A	-	A	-	-
Nomilin	1063-77-0	-	-	-	-	-	-	-	-	-	-
Nonanal	124-19-6	-	-	-	-	-	-	-	-	-	-
Nonanoic Acid (= Pelargonic Acid)	112-05-0	-	-	-	A	-	-	-	-	-	-
Nootkatone	4674-50-4	-	-	-	-	-	-	-	-	-	-
Novaluron	116714-46-6	U, GHS 5	-	SN, R	A	A	A	A	A	A	A
Nucleopolyhedroviruses (= Nuclear Polyhedrosis viruses = NPV)	-	-	-	-	A	-	A[37]	-	P[38]	-	-
Octadecanoic Acid (= Stearic Acid)	57-11-4	-	-	-	-	-	-	-	-	-	-
Octanoic Acid (= Caprylic Acid)	124-07-2	-	-	-	A	-	-	-	-	-	-
Octenal	124-13-0	-	-	-	#	-	-	-	-	-	-
Oleic Acid	112-80-1	-	-	-	C	-	-	-	A	-	-
Paris Green (= Copper(II) Acetoarsenite)	12002-03-8	Ib, GHS 2	-	-	C	-	-	-	-	CB	-
P-Cymene	99-87-6	-		-	-	-	-	-	-	-	-
Pentanoic Acid (= Valeric Acid)	109-52-4	-	-	-	-	-	-	-	-	-	-
Permethrin	52645-53-1	II, GHS 4	-	SN, R, E	AV	A	A	A	A	A	A
Phenothrin	26002-80-2	U, GHS 5	-	-	AV	-	-	A	A	-	A
Phoxim	14816-18-3	II, GHS 4	-	SO	C	-	-	A	A	-	-
Phrymarolin-I	38303-95-6	-	-	-	-	-	-	-	-	-	-
Picaridin (= Icaridin)	119515-38-7	-	-	SN	AV	A	A	-	AV?	-	-
Pilocarpene	92-13-7	-	-	-	-	-	-	-	-	-	-
Pinene	1330-16-1	-	-	-	#	A	-	-	-	-	-
Pinocamphone	547-60-4	-	-	-	-	-	-	-	-	-	-
Piperidine	110-89-4	-	-	-	-	-	-	-	-	-	-
Piperine	94-62-2	-	-	-	A	-	A	-	-	-	-
Piperonyl Butoxide (= PBO)	51-03-6	U, GHS 5	-	SN, R, E	AV	A	A	-	A	-	A
Pirimiphos-methyl	29232-93-7	II, GHS 4	-	SN, R, E	A	A	-	A	A	AV	-

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
Plant – Cinnamon (*Cinnamomum verum = C. zeylanicum)*[a]	-	-	-	-	A[b]	-	-	-	-	-	-
Plant – Citronella, Ceylon (*Cymbopogon nardus*)	89998-15-2	-	-	-	E[c]	-	-	-	-	-	-
Plant – Citronella, Java (*Cymbopogon winterianus*)	91771-61-8	-	-	-	E	-	-	-	-	-	-
Plant – Clove (*Syzygium aromaticum*)	-	-	-	-	E/C[d]	-	-	-	-	-	-
Plant – Garlic (*Allium sativum*)	-	-	-	-	E	-	A	-	A	-	A
Plant – Mint (*Mentha* spp.)	-	-	-	-	E	-	-	-	-	-	-
Plant – Peppermint (*Mentha × piperita*)	-	-	-	-	E	-	-	-	-	-	-
Plant – Rosemary (*Rosmarinus officinalis*)	-	-	-	-	#/E	-	-	-	-	-	-
Plant – Sesame (*Sesamum indicum*)	-	-	-	-	E	-	-	-	-	-	-
Plant – Thyme (*Thymus vulgaris or T. zygis*)	84292-51-1	-	-	-	E	-	-	-	-	-	-
Plant Oil – Alaska Yellow Cedar (*Callitropsis nootkatensis*)	1069136-34-0	-	-	-	-	-	-	-	-	-	-
Plant Oil – Anise (*Pimpinella anisum*) (= Aniseed Oil)	8007-70-3	-	-	-	A	-	-	-	-	-	-
Plant Oil – Atlantic Cedar (*Cedrus atlantica*)	8023-85-6	-	-	-	-	-	-	-	-	-	-
Plant Oil – Balsam Fir (*Abies balsamea*)	85085-34-3	-	-	-	A	-	-	-	-	-	-
Plant Oil – Balsam Torchwood (*Amyris balsamifera*)	8015-65-4	-	-	-	-	-	-	-	-	-	-
Plant Oil – Barbados Nut (*Jatropha curcas*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Basil, Holy (*Ocimum tenuiflorum = O. sanctum)*	-	-	-		-	-	-	-	-	-	-
Plant Oil – Basil, Sweet (*Ocimum basilicum*)	8015-73-4	-	-	-	-	-	-	-	-	-	-
Plant Oil – Bay Laurel = Sweet Bay (*Laurus nobilis*)	8007-48-5	-	-	-	-	-	-	-	A	-	-
Plant Oil – Beautyberry, American (*Callicarpa americana*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Beautyberry, Japanese (*Callicarpa japonica*)	1061737-07-2	-	-	-	-	-	-	-	-	-	-
Plant Oil – Bergamot (*Citrus ×aurantium* ssp. *bergamia*)	8007-75-8	-	-	-	A	-	-	-	-	-	-
Plant Oil – Betel = Betel Pepper (*Piper betle*)	84775-81-5	-	-	-	-	-	-	-	-	-	-
Plant Oil – Billygoat Weed (*Ageratum conyzoides*)	85480-32-6	-	-	-	-	-	-	-	-	-	-
Plant Oil – Birch (*Betula lenta*, etc.) (= Birch Bark Oil / Tar)	85251-66-7	-	-	-	A	-	-	-	-	-	-
Plant Oil – Blackcurrant (*Ribes nigrum*) Bud	97676-19-2	-	-	-	-	-	-	-	A	-	-
Plant Oil – Bugle = Bugleweed (*Ajuga spp.*)	various	-	-	-	-	-	-	-	-	-	-
Plant Oil – Cajeput (*Melaleuca leucadendron or M. quinquenervia*)	8008-98-8	-	-	-	-	-	-	-	-	-	-
Plant Oil – Camphor Laurel (*Cinnamomum camphora*)	8022-78-4	-	-	-	A	-	A	-	-	-	-
Plant Oil – Caraway (*Carum carvi*) Seed	8000-42-8	-	-	-	-	-	-	-	-	-	-
Plant Oil – Cardamom (*Elettaria cardamomum*)	8000-66-6	-	-	-	-	-	-	-	-	-	-
Plant Oil – Castor (*Ricinus communis*)	8001-79-4	-	-	-	A, E	-	A	-	-	-	-

[a] Some plants that are identified on this table apart from their oils because EPA formally listed both these plants and their oils as materials exempt from FIFRA registration requirements under section 25(b) of that law.

[b] EPA's 25(b) exemption list includes both cinnamon and cinnamon oil. In addition, cinnamon is a registered biopesticide.

[c] EPA's 25(b) exemption list includes both citronella and citronella oil. In addition, citronella oil is a registered biopesticide.

[d] EPA's 25(b) exemption list includes both cloves and clove oil. In addition, crushed clove was a registered biopesticide, but all products have been cancelled.

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
Plant Oil – Catnip = Catmint (*Nepeta cataria*)	8023-84-5	-	-	-	-	-	-	-	-	-	-
Plant Oil – Catnip (*Nepeta cataria*), Hydrogenated	952722-18-8	-	-	-	AV	-	-	-	-	-	-
Plant Oil – Cedar, Deodar (*Cedrus deodara*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Cedarwood (*Juniperus virginiana*, etc.)	8000-27-9	-	-	-	AV, E	-	P	-	-	-	-
Plant Oil – Cedarwood (*Thuja plicata*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Celery (*Apium graveolens*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Chamomile (*Chamaemelum nobile = Anthemis nobilis*)	8015-92-7	-	-	-	A	-	-	-	-	-	-
Plant Oil – Chamomile, German (*Matricaria chamomilla*)	8002-66-2	-	-	-	A	-	-	-	-	-	-
Plant Oil – Chastetree (*Vitex negundo*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Cinnamon (*Cinnamomum verum = C. zeylanicum)*	8015-91-6	-	-	-	E	-	-	-	-	-	-
Plant Oil – Citronella, Ceylon (*Cymbopogon nardus*)	8000-29-1	-	-	-	AV,E	-	A	-	A	-	A
Plant Oil – Citronella, Java (*Cymbopogon winterianus*)	8000-29-1	-	-	-	AV,E	-	A	-	A	-	A
Plant Oil – Citrus Oil / Citrus Extract (*Citrus* spp.)	68608-34-4	-	-	-	A?	-	A	-	A	-	-
Plant Oil – Clove (*Syzygium aromaticum*)	8000-34-8	-	-	-	A, E	-	A	-	A	-	-
Plant Oil – Coconut (*Cocos nucifera*)	8001-31-8	-	-	-	#	-	-	-	A	-	-
Plant Oil – Corn = Maize (*Zea mays ssp. Mays*)	8001-30-7	-	-	-	E	-	-	-	A	-	-
Plant Oil – Cotton (*Gossypium* spp.) (= Cottonseed Oil)	8001-29-4	-	-	-	E/C	-	-	-	-	-	-
Plant Oil – Cypress, Chinese Weeping (*Chamaecyparis funebris*)	1159574-01-2	-	-	-	-	-	-	-	-	-	-
Plant Oil – Epazote (*Dysphania ambrosioides*)	89997-47-7	-	-	-	A	-	-	-	-	-	-
Plant Oil – Eucalyptus (*Eucalyptus* spp. & *Corymbia* spp.)	8000-48-4	-	-	-	AV	-	A,P	-	A	-	-
Plant Oil – Fingerroot (*Boesenbergia rotunda*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Garlic (*Allium sativum*)	8000-78-0	-	-	-	AE[a]	-	A	-	A	-	A
Plant Oil – Garlic Chives (*Allium tuberosum*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Geranium, Rose (*Pelargonium graveolens*)	8000-46-2	-	-	-	AE[a]	-	A	-	-	-	-
Plant Oil – Geranium, Rasp-leaf (*Pelargonium radens*)	8000-46-2	-	-	-	AE[a]	-	A	-	-	-	-
Plant Oil – Ginger (*Zingiber officinale*)	8007-08-7	-	-	-	-	-	-	-	-	-	-
Plant Oil – Ginger, Cassumunar (*Zingiber montanum)*	864662-46-4	-	-	-	-	-	-	-	-	-	-
Plant Oil – Jojoba (*Simmondsia chinensis*)	61789-91-1	-	-	-	A	-	-	-	-	-	-
Plant Oil – Juniper (*Juniperus communis, etc.*) Berry	73049-62-4	-	-	-	-	-	-	-	-	-	-
Plant Oil – Lavandin (*Lavandula ×intermedia*)	8022-15-9	-	-	-	A	-	-	-	-	-	-
Plant Oil – Lavender (*Lavandula angustifolia*, etc.)	8000-28-0	-	-	-	-	A	-	-	-	-	-
Plant Oil – Lemon (*Citrus ×limon = C. limonum*)	8008-56-8	-	-	-	-	-	-	-	-	-	-
Plant Oil – Lemon Eucalyptus (*Corymbia citriodora*)	129828-24-6	-	-	-	-	A	-	-	-	-	-
Plant Oil – Lemongrass (*Cymbopogon citratus* or *C. flexuosus*)	72869-82-0	-	-	-	A, E	-	-	-	A	-	-
Plant Oil – Lignum-vitae (*Guaiacum* spp.)	9000-29-7	-	-	-	-	-	-	-	A	-	-
Plant Oil – Lime, Thai = Kaffir (*Citrus hystrix*)	929194-65-0	-	-	-	-	-	-	-	-	-	-

[a] This plant oil is exempt from FIFRA registration requirements, but some products have undergone formal registration. It is not clear if this includes products registered specifically for vector control use.

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
Plant Oil – Linseed = Flax (*Linum usitatissimum*)	8001-26-1	-	-	-	E	A	-	-	-	-	-
Plant Oil – Lopseed (*Phryma leptostachya*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Marigold, French (*Tagetes patula*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Marjoram (*Origanum majorana*)	8015-01-8	-	-	-	-	-	-	-	A	-	-
Plant Oil – May Chang = Litsea (*Litsea cubeba*)	68855-99-2	-	-	-	-	-	-	-	-	-	-
Plant Oil – Mint (*Mentha* spp.)	Many	-	-	-	A, E	-	-	-	-	-	-
Plant Oil – Mint, Field or Wild = Cornmint (*Mentha arvensis*)	68608-35-5	-	-	-	#	-	-	-	-	-	-
Plant Oil – Mugwort = Common Wormwood (*Artemisia vulgaris*)	68991-20-8	-	-	-	-	-	-	-	-	-	-
Plant Oil – Mustard (Black) (*Brassica nigra*)	8007-40-7	-	-	-	A	A[39]	-	-	-	-	-
Plant Oil – Neem (*Azadirachta indica*)	8002-65-1	-	-	-	AV	A[40]	-	-	-	A	-
Plant Oil – Niaouli (*Melaleuca viridiflora*)	8014-68-4	-	-	-	-	-	-	-	-	-	-
Plant Oil – Nutmeg (*Myristica fragrans*)	8008-45-5	-	-	-	-	-	-	-	-	-	-
Plant Oil – Olive (*Olea europaea*)	8001-25-0	-	-	-	A	-	-	-	A	-	-
Plant Oil – Orange, Bitter (*Citrus ×aurantium*)	68916-04-1	-	-	-	-	A	-	-	-	-	-
Plant Oil – Orange, Mandarin = Tangerine (*Citrus reticulata*)	8016-85-1	-	-	-	-	-	-	-	-	-	-
Plant Oil – Orange, Sour (*Citrus ×aurantium* ssp. *amara*)	8014-17-3	-	-	-	A	A	-	-	-	A	-
Plant Oil – Orange, Sweet (*Citrus ×sinensis*)	8008-57-9	-	-	-	A	A	-	-	-	A	-
Plant Oil – Oregano (*Origanum vulgare*)	862374-92-3	-	-	-	A	A	-	-	-	-	-
Plant Oil – Osage Orange (*Maclura pomifera*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Paracress (*Acmella oleracea*)	90131-24-1	-	-	-	-	-	-	-	-	-	-
Plant Oil – Patchouli (*Pogostemon cablin*)	8014-09-3	-	-	-	-	-	-	-	-	-	-
Plant Oil – Peanut (*Arachis hypogaea*)	8002-03-7	-	-	-	-	A	-	-	A	-	-
Plant Oil – Pennyroyal, American False (*Hedeoma pulegioides*)	8007-44-1	-	-	-	A	-	-	-	-	-	-
Plant Oil – Pennyroyal, European (*Mentha pulegium*)	8013-99-8	-	-	-	A	-	-	-	-	-	-
Plant Oil – Pepper, Black (*Piper nigrum*)	8006-82-4	-	-	-	E	-	-	-	A	-	-
Plant Oil – Peppermint (*Mentha ×piperita*)	8006-90-4	-	-	-	E	A	P	-	-	-	-
Plant Oil – Pillpod Sandmat (*Euphorbia hirta)*	84625-37-6	-	-	-	-	-	-	-	-	-	-
Plant Oil – Pine (*Pinus* spp.)	8002-09-3	-	-	-	AV	-	A	-	A	-	-
Plant Oil – Pine, Scots (*Pinus sylvestris*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Pine (*Pinus* spp.) Tar Oil (= Tall Oil)	91995-59-4	-	-	-	C	A[41]	-	-	A	-	-
Plant Oil – Prickly-ash (*Zanthoxylum spp.*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Pyrethrum (*Tanacetum cinerariifolium* etc.)	8003-34-7	-	-	-	A	A	-	-	-	-	-
Plant Oil – Rape Seed (*Brassica napus* or *B. rapa*) (= Canola Oil)	8002-13-9	-	-	-	A	-	-	-	A	-	-
Plant Oil – Rosemary (*Rosmarinus officinalis*)	8000-25-7	-	-	-	AE[a]	A	A	-	-	-	-
Plant Oil – Sabadilla (*Schoenocaulon officinale*)	84604-18-2	-	-	-	-	-	-	-	-	-	-
Plant Oil – Sesame (*Sesamum indicum*)	8008-74-0	-	-	-	E	-	-	-	-	-	-

[a] This plant oil is exempt from FIFRA registration requirements, but some products have undergone formal registration. It is not clear if this includes products registered specifically for vector control use.

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
Plant Oil – Sichuan Pepper = Timur (*Zanthoxylum armatum*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Soybean / Soya (*Glycine max*)	8001-22-7	-	-	-	AE[a]	-	A	-	A	-	-
Plant Oil – Soybean / Soya (*Glycine max*), Epoxylated	-	-	-	-	-	-	-	-	A	-	-
Plant Oil – Spearmint (*Mentha spicata or M. ×gracilis*)	8008-79-5	-	-	-	A	-	-	-	A	-	-
Plant Oil – Stinking Roger (*Tagetes minuta*)	-	-	-	-	-	-	-	-	-	-	-
Plant Oil – Summer Savory (*Satureja hortensis*)	8016-68-0	-	-	-	-	-	-	-	-	-	-
Plant Oil – Sunflower (*Helianthus annuus*)	8001-21-6	-	-	-	-	-	-	-	A	-	-
Plant Oil – Tansy (*Tanacetum vulgare*)	8016-87-3	-	-	-	-	-	-	-	-	-	-
Plant Oil – Tea Tree (multiple taxa; see Table A1)	68647-73-4	-	-	-	A	C[a]	-	-	A[42]	-	-
Plant Oil – Thyme (*Thymus vulgaris or T. zygis*)	8007-46-3	-	-	-	AV,E	-	P	-	P	-	-
Plant Oil – Turmeric (*Curcuma longa*)	8024-37-1	-	-	-	-	-	-	-	-	-	-
Plant Oil – Turmuric, Wild (*Curcuma aromatic*)	94349-73-2	-	-	-	-	-	-	-	-	-	-
Plant Oil – Vetiver (*Chrysopogon zizanioides*)	8016-96-4	-	-	-	-	-	-	-	-	-	-
Plant Oil – Violet (*Viola odorata*)	8024-07-5	-	-	-	-	-	-	-	-	-	-
Plant Oil – Wild Bergamot (*Monarda fistulosa*)	97952-61-9	-	-	-	-	-	-	-	-	-	-
Plant Oil – Wintergreen (*Gaultheria procumbens*)	90045-28-6	-	-	-	A	-	A	-	-	-	-
Plant Oil – Wormwood = Absinth (*Artemisia absinthium*)	8008-93-3	-	-	-	-	-	-	-	-	-	-
Plant Oil – Ylang Ylang (*Cananga odorata*)	68989-25-3	-	-	-	-	-	-	-	A	-	-
PMD (= p-Menthane-3,8-diol, Quwenling)	42822-86-6	-	-	-	AV	-	A	-	-	-	-
POE Isooctadecanol (= MMF)	52292-17-8	-	-	-	AV	-	-	-	-	-	-
Polyvinylpyrrolidone (= PVP)	9003-39-8	-	-	-	C	-	-	-	-	-	-
Potassium Laurate	10124-65-9	-	-	-	E	-	-	-	-	-	-
Potassium Silicate	1312-76-1	-	-	-	A	-	-	-	-	-	-
Potassium Sorbate	24634-61-5	-	-	-	E	A	-	-	A	-	A
Prallethrin	23031-36-9	II, GHS 4	-	SN	AV	A	A	A	-	A	-
Prodigiosin	82-89-3	-	-	-	-	-	-	-	-	-	-
Propanoic Acid (= Propionic Acid)	79-09-4	-	-	-	A	-	-	-	-	-	-
Propargite	2312-35-8	III, GHS 5	-	-	A	A	-	A	-	A	A
Propoxur	114-26-1	II, GHS 3	-	SN, R	A, VC	A	A	A	A	A	A
Propylene Glycol Monolaurate	27194-74-7	-	-	-	A[43]	-	-	-	-	-	-
Pulegone	89-82-7	-	-	-	-	-	-	-	-	-	-
Pyrethrin I	121-21-1	-	-	-	#	-	-	-	-	-	-
Pyrethrin II	121-29-9	-	-	-	#	-	-	-	-	-	-
Pyrethrins	8003-34-7	II, GHS 4	-	SO	AV	-	A	A	A	A	A
Pyrethrum Marc		-	-	-	#	-	-	-	-	-	-
Pyridaben	96489-71-3	II, GHS 4	-	-	A	A[44]	A	A	A	-	-
Pyridostigmine Bromide	101-26-8	-	-	-	#	-	-	-	-	-	-
Pyrimidifen	105779-78-0	-	-	-	-	-	-	-	-	-	-
Pyriproxyfen	95737-68-1	U, GHS 5	-	SN, R	AV	A	A	A	A	A	A
R-(-)-1-Octen-3-ol	3687-48-7	-	-	-	AV	-	A	-	-	-	-

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
Resmethrin	10453-86-8	III, GHS 4	-	-	AVC[45]	C[a]	A	A	A	-	-
RIDL (**R**elease of **I**nsects carrying a **D**ominant **L**ethal) genes	-	-	-	-	-	-	-	-	-	-	-
RNAi (= RNA Interference)	-	-	-	-	-	-	-	-	-	-	-
Rotenone (extracts of *L. utilis*, *Derris*, *Tephrosia*)	83-79-4	II, GHS 3	-	-	A,VC	-	A	A	A	-	A
Ryanodine	15662-33-6	-	-	-	A	-	-	-	-	-	-
S 220	-	-	-		-	-	-	-	-	-	-
Sabinene	3387-41-5	-	-	-	-	-	-	-	-	-	-
Saponins	8047-15-2	-	-	-	#	-	-	-	-	-	-
S-Bioallethrin (= Esbiol)	28434-00-6	-	-	SN, R	AV	A	-	A	-	A	-
Serratia entomophila	-	-	-	-	-	-	-	-	-	-	-
Serratia proteamaculans	-	-	-	-	-	-	-	-	-	-	-
S-Hydroprene	65733-18-8	-	-	-	AV	A	-	-	-	-	-
Silica Gel	7631-86-9	-	-	-	AV	-	A	-	-	-	-
Silicon Dioxide (Diatomaceous Earth)	63231-67-4	-	-	-	AV	-	A	A	A	-	-
Silicon Dioxide Nanoparticles	7631-86-9	-	-	-	-	-	-	-	-	-	-
Silver Nanoparticles	7440-22-4	-	-	-	P	-	-	-	-	-	-
S-Methoprene	65733-16-6	-	-	-	AV	A	-	-	-	-	-
Soap Salts – Ammonium Salts of Fatty Acids	84776-33-0	-	-	-	A	-	A	-	-	-	-
Soap Salts – Potassium Salts of Fatty Acids	67701-09-1	-	-	-	AV	C[a]	A	-	A	-	A
Soap Salts – Sodium Salts of Fatty Acids	61789-31-9	-	-	-	AV	-	-	-	-	-	-
Sodium Chloride	7647-14-5	-	-	-	E	-	A	-	A	-	-
Sodium Lauryl Sulfate	151-21-3	-	-	-	E	-	P	-	A	-	-
Sodium Metasilicate	6834-92-0	-	-	-	A	-	-	-	-	-	-
Spathulenol	6750-60-3	-	-	-	-	-	-	-	-	-	-
Spinetoram	935545-74-7	U, GHS 5	-	-	A	A	A	A	A	-	-
Spinosad	168316-95-8	III, GHS 5	-	SN, R	AV	A	A	A	A	A	A
Spinosyn A	131929-60-7	-	-	-	-	-	-	-	-	-	-
Spinosyn D	131929-63-0	-	-	-	-	-	-	-	-	-	-
SS 220 (= AI3-37220)	298207-27-9	-	-	-	-	-	-	-	-	-	-
Steinernema riobavis	-	-	-	-	-	-	-	-	-	-	-
Sulfoxaflor	946578-00-3	-	-	-	#	-	P	-	P	-	-
Sulfoxide	120-62-7	O	-	-	C	-	-	-	-	-	-
Sulfur	7704-34-9	III, GHS 5	-	-	AV	-	A	-	A	A	A
Sulfuryl Fluoride	2699-79-8	FUM	-	-	AV	A	A	A	A	-	-
SYN 131-1	n/a	-	-	-	-	-	-	-	-	-	-
Tartaric Acid	87-69-4	-	-	-	-	-	-	-	-	-	-

[a] Listed as registered within the last year, but not in latest available list. No details have been found on whether this reflects a formal cancellation or a withdrawal of registration for business or other reasons.

Active Ingredient	CAS RN	WHO[a]	Int.[b]	WHOPES[c]	USA[d], [e]	Aus.[f]	Can.[g]	China[h]	EU[i]	India[j]	SA[k]
Tasmanone	22595-52-4	-	-	-	-	-	-	-	-	-	-
Tau-Fluvalinate	102851-06-9	III, GHS 5	-	-	AV	A	-	-	A	-	A
Tebufenpyrad	119168-77-3	II, GHS 5	-	-	A	A[46]	-	-	A	-	-
Tefluthrin	79538-32-2	Ib, GHS 2	-	-	A	A	A	-	A	-	-
Temephos	3383-96-8	III, GHS 5	-	SN, R	AVC[47]	A	-	A	A	A	A
Terpineol	8000-41-7	-	-	-	C	-	-	-	-	-	-
Tetradecanoic Acid (= Myristic Acid)	544-63-8	-	-	-	-	-	-	-	-	-	-
Tetramethrin	7696-12-0	U, GHS 5	-	-	AV	A	A	A	A	-	A
Thiamethoxam	153719-23-4	-	-	-	AV	A	A	A	A	A	A
Thujic Acid	499-89-8	-	-	-	-	-	-	-	-	-	-
Thujone	546-80-5	-	-	-	-	-	-	-	-	-	-
Thymol	89-83-8	-	-	-	A	-	A	-	A	-	A
Tralomethrin	66841-25-6	II, GHS 3	-	-	AV	-	-	-	A	-	-
Trans-Allethrin	482370-76-3	-	-	-	-	-	-	-	-	-	-
Trans-Cinnamaldehyde	14371-10-9	-	-	-	#	-	-	-	-	-	-
Transfluthrin	118712-89-3	U, GHS 5	-	SN	-	A	-	A	-	A	-
Transpermethrin	61949-77-7	-	-	-	-	-	-	-	-	-	-
Trichlorfon	52-68-6	II, GHS 3	-	W	AV	A	A	A	A	A	A
Triethylene Glycol	112-27-6	-	-	-	AV	-	A	-	-	-	-
Trifluralin	1582-09-8	U, GHS 5	-	-	AV	-	A	A	A	A	-
Trilinolein	537-40-6	-	-	-	-	-	-	-	-	-	-
Triolein	122-32-7	-	-	-	-	-	-	-	-	-	-
Tripalmitin	555-44-2	-	-	-	-	-	-	-	-	-	-
Tristearin	555-43-1	-	-	-	-	-	-	-	-	-	-
Undecan-2-one (= Methyl Nonyl Ketone, 2-Undecanone)	112-12-9	III, GHS 5	-	-	AV	-	A	-	A	-	-
Undecanoic Acid (= Hendecanoic Acid)	112-37-8	-	-	-	-	-	-	-	-	-	-
Vanillin	121-33-5	-	-	-	#	-	-	-	-	-	-
Verbenol	473-67-6	-	-	-	#	-	-	-	-	-	-
Verbenone	80-57-9	-	-	-	-	-	A	-	-	-	-
(Z)-4-Decenal (= cis-4-Decenal)	21662-09-9	-	-	-	-	-	-	-	-	-	-
(Z)-9-Tricosene (= cis-9-Tricosene, Muscalure)	27519-02-4	-	-	-	AV	C[a]	A	-	-	-	A
Zeta-Cypermethrin	52315-07-8	Ib, GHS 3	-	-	AV	A	A	A	A	-	A
Zinc Oxide Nanoparticles	1314-13-2	-	-	-	-	-	-	-	-	-	-

[a] Listed as registered within the last year, but not in latest available list. No details have been found on whether this reflects a formal cancellation or a withdrawal of registration for business or other reasons.

Part C: Modes of Action and Use Patterns of Public Health Pesticides

Modes of Action for recognized or potential PHP's are addressed by the use of IRAC MOA codes, where they exist, and by description of the chemical type of the materials addressed. It is recognized that the modes of action for a number of the experimental materials is not well specified.

The use patterns for these materials is basically divided into experimental materials, with no registration as pesticides by any of the major regulatory authorities, and registered materials. Given the high costs of obtaining and maintaining pesticide registrations in many jurisdictions, it is presumed that registered materials are at least potentially available commercially. This table also briefly notes the degree of actual or potential vector control utility of the materials, and their primary modes of application.

Insecticide Resistance Action Committee (IRAC) Mode of Action (MOA) Groups:[48]

1 = Acetylcholinesterase (AChE) Inhibitors (Nerve Action)
- 1A = Carbamates
- 1B = Organophosphates

2 = GABA-gated Chloride Channel Antagonists (Nerve action)
- 2A = Cyclodiene Organochlorines
- 2B = Phenylpyrazoles (Fiproles)

3 = Sodium Channel Modulators (Nerve action)
- 3A = Pyrethroids & Pyrethrins
- 3B = DDT & Methoxychlor

4 = Nicotinic Acetylcholine Receptor (nAChR) Agonists (Nerve action)
- 4A = Neonicotinoids
- 4B = Nicotine
- 4C = Sulfoxaflor

5 = Nicotinic Acetylcholine Receptor (nAChR) allosteric activators (Nerve action)

6 = Chloride Channel Activators (Nerve and muscle action)

7 = Juvenile Hormone Mimics (Growth regulation)
- 7A = Juvenile Hormone Analogues
- 7B = Fenoxycarb
- 7C = Pyriproxyfen

8 = Miscellaneous Nonspecific (multi-site) Inhibitors
- 8A = Alkyl Halides
- 8B = Chloropicrin
- 8C = Sulfuryl Fluoride
- 8D = Borax
- 8E = Tartar Emetic

9 = Selective Homopteran Feeding Blockers (Nerve action)
- 9B = Pymetrozine [no 9A in table]
- 9C = Flonicamid

10 = Mite Growth Inhibitors (Growth regulation)
- 10A = Clofentezine, Hexythiazox, Diflovidazin
- 10B = Etoxazol

11 = Microbial Disruptors of Insect Midgut Membranes
- 11A = *Bacillus thuringiensis* and the Insecticidal Proteins they Produce
- 11B = Bacillus sphaericus

12 = Inhibitors of Mitochondrial ATP Synthase (Energy metabolism)
- 12A = Diafenthiuron
- 12B = Organotin Miticides
- 12C = Propargite
- 12D = Tetradifon

13 = Uncouplers of oxidative phosphorylation via disruption of the proton gradient (Energy metabolism)

14 = Nicotinic Acetylcholine Receptor (nAChR) Channel Blockers (e.g. Nereistoxin Analogues; Nerve action)

15 = Inhibitors of Chitin Biosynthesis, Type 0 (e.g. Benzoylureas; Growth regulation)

16 = Inhibitors of Chitin Biosynthesis, Type 1 (Growth regulation)

17 = Moulting Disruptor, Dipteran (Growth regulation)

18 = Ecdysone Receptor Agonists (e.g. Diacylhydrazines; Growth regulation)

19 = Octopamine Receptor Agonists (Nerve action)

20 = Mitochondrial Complex III Electron Transport Inhibitors (Energy metabolism)
- 20A = Hydramethylnon
- 20B = Acequinocyl
- 20C = Fluacrypyrim

21 = Mitochondrial Complex I Electron Transport Inhibitors (Energy metabolism)
- 21A = METI Acaricides and Insecticides
- 21B = Rotenone

22 = Voltage-dependent sodium channel blockers (Nerve action)
- 22A = Indoxacarb
- 22B = Metaflumizone

23 = Inhibitors of Acetyl CoA Carboxylase (e.g. Tetronic and Tetramic acid derivatives; Lipid synthesis, Growth regulation)

24 = Mitochondrial Complex IV Electron Transport Inhibitors (Energy metabolism)
- 24A = Phosphine
- 24B = Cyanide

25 = Mitochondrial Complex II Electron Transport Inhibitors (e.g. Beta-ketonitrile derivatives; Energy metabolism)

[26 and 27 undefined]

28 = Ryanodine Receptor Modulators (e.g. Diamides; Nerve and muscle action)

Un = Compounds of unknown or uncertain MoA

Table C. Mode of Action and Use Pattern of Recognized or Potential Public Health Pesticides

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
(+)-Citronellol	Monoterpenoid		X	Experimental material with PHP potential.
(-)-Citronellol	Monoterpenoid		X	Experimental material with PHP potential.
(-)-Isolongifolenone	Sesquiterpene		X	Experimental material with PHP potential.
1,3,3-trimethylcyclohex-1-ene-4-carboxaldehyde	Botanical		X	Experimental material with PHP potential.
1-Octen-3-ol	Botanical		Reg	Attractant for mosquitoes, etc.
2-Butyl-2-ethyl-1,3-propanediol	Poly alcohol		C	Fabric repellent treatment. Cancelled in U.S.; not known to be registered elsewhere.
2-Hydroxyethyl Octyl Sulfide			C	Repellent & insecticide. Cancelled in U.S.; not known to be registered elsewhere.
2-Phenethyl Propionate			Reg	US active registrations. & E
4-Terpineol	Botanical		X	Experimental material with PHP potential. EPA PC Code issued, but no evidence of products ever registered.
Abamectin	Microbial product, Macrocyclic Lactone	6	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Acepromazine			X	Veterinary product w/ PHP potential?
Acequinocyl	Unclassified	20B	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Acetaminophen			Reg	Reg for brown tree snake control; PHP potential?
Acetamiprid	Neonicotinoid	4A	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Acetic Acid			Reg	Multiple registrations, including U.S. Registration vs. vectors?
Aedes aegypti male pheromone	Pheromone		X	Experimental mosquito control with PHP potential.
AI-35765			X	Experimental insect and tick repellent with PHP potential.
Allethrin	Pyrethroid	3A	Reg	Insecticide & Spatial Repellent (e.g. coils). Cancelled in U.S., but widely used elsewhere.
Allethrin II	Pyrethroid	3A		
Allyl Isothiocyanate	Botanical		Reg	Only registered in U.S.
Alpha-Cypermethrin	Pyrethroid, Ester Type II	3A	Reg	Major mosquitocide globally.[b] WHOPES recommends for IRS, ITS's, and LLIN's. New format LLIN's in WHOPES evaluation.
α-Humulene	Botanical		X	Experimental material with PHP potential.
α-Ionone	Botanical		Reg	Registered in U.S. along; not vs. vectors.
α-Pinene	Botanical		Reg	Registered in Australia, but not in other major jurisdictions.
α-Terpineol	Botanical		X	Experimental material with PHP potential. EPA PC Code issued, but no evidence of

[a] MOA = Mode of Action, from IRAC

[b] Recommended for IRS (WP or SC) against malaria vectors[b], for treatment of mosquito nets (10% SC) for malaria vector control[b], and in LLIN's (coated on polyester or incorporated into polyethylene).[b]

Specifications published for technical material, WP, and SC[b]; and for material coated onto net filaments[b] and incorporated into net filaments.[b]

New LLIN's from BASF (Interceptor) and Clarke Mosquito Control (DuraNet) are under WHOPES evaluation.[b]

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
				products ever registered.
α-Thujone	Botanical		X	Experimental material with PHP potential.
Aluminum Phosphide	Inorganic	24A	Reg	Fumigant with historic registration vs. mosquitoes, but cancelled
Amitraz	Formamidine	19	Reg	Acaricide w/ Multiple active registrations
Ammonia	Inorganic		Reg	Multiple active registrations in U.S.; apparently not elsewhere.
Ammonium Bicarbonate	Inorganic		Reg	Active vector registration in U.S.; not elsewhere
Ammonium Fluorosilicate	Inorganic		C	Cancelled in U.S.; not known to be registered elsewhere.
Anethole			C	Cancelled in U.S.; not known to be registered elsewhere.
Arsenenic Acid	Inorganic		C	Cancelled in U.S.; not known to be registered elsewhere.
Arsenic Acid	Inorganic		Reg	Registered in U.S. and Australia
Arsenous Acid	Inorganic		C	Historic mosquito control material; now cancelled
Atrazine	Triazine		Reg	Herbicide with PHP potential; wide registration.
Avermectin	Microbial product, Macrocyclic Lactone	6	X	Experimental material with PHP potential. EPA PC Code issued.
Azadirachtin	Botanical	Un	Reg	Active registrations in multiple sites, including vector control
Azadirachtin B	Botanical	Un	X	Experimental material with PHP potential. EPA PC Code issued.
Azadirachtin H	Botanical	Un	X	Experimental material with PHP potential.
Azocyclotin	Heavy Metal, Organotin	12B	Reg	Acaricide; registered in China; not in U.S.
Bacillus thuringiensis subsp. *israelensis* (Bti) , serotype H-14	Bacterial products	11A	Reg	Globally significant biological mosquito larvicide, registered widely. Many varieties, with variations in registration and use patterns.
Bti strain AM65-52	Bacterial products	11A	Reg	Globally significant biological mosquito larvicide, registered in the U.S. and E.U., and recommended by WHOPES for larval control, including in containers.
Bti Strain BK, ATCC number 35646	Bacterial products	11A	X	Experimental mosquito larvicide with PHP potential. EPA PC Code issued.
Bti strain BMP 144	Bacterial products	11A	Reg	Mosquito larvicide; active registration in U.S. but not elsewhere.
Bti strain EG2215	Bacterial products	11A	Tech	Larvicide technical material, registered in U.S. but not elsewhere.
Bti Strain IPS-78	Bacterial products	11A	X	Experimental mosquito larvicide, not registered in any major jurisdiction.
Bti strain SA3A	Bacterial products	11A	Reg	Mosquito larvicide; active registration in U.S. but not elsewhere.
Beauveria amorpha	Fungus		X	Experimental entomopathogenic fungi with PHP potential
Beauveria bassiana	Fungus		Reg	Entomopathogenic fungi w/ multiple registrations, including U.S. Registration vs. vectors?
Beauveria brongniartii	Fungus		Reg	Entomopathogenic fungi w/ E.U. registration only. Registration vs. vectors?
Beauveria velata	Fungus		X	Experimental entomopathogenic fungi with PHP potential
Beauveria vermiconia	Fungus		X	Experimental entomopathogenic fungi with PHP potential
Beauvericin	Fungal product		X	Experimental natural material with PHP potential
Bendiocarb	Carbamate, N-methyl	1A	Reg	Widely registered mosquito adulticide. Recommended by WHOPES for IRS, but cancelled in U.S.
Benzyl Benzoate			Reg	Active reg. in U.S., but vector uses cancelled. Active registrations elsewhere.
β-Alanine			X	Experimental material with PHP potential.
Betabaculovirus (= Granulovirus = GV)	Virus		Reg	Reg in U.S. and EU, but only so far vs. the apple worm coddling moth *Cydia pomonella*. PHP potential?

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
β-Caryophyllene			X	Experimental material with PHP potential.
Beta-Cyfluthrin	Pyrethroid	3A	Reg	Insecticide. Widely registered.
Beta-Cypermethrin	Pyrethroid, Ester Type II	3A	Reg	Insecticide. Widely registered PHP, but not in U.S.
β-Ionone	Botanical		X	Experimental material with PHP potential.
β-Pinene	Botanical		X	Experimental material with PHP potential. EPA PC Code issued, but no evidence of products ever registered.
B-Terpineol	Botanical		C	Had U.S. reg., but now cancelled; not now registered elsewhere. 25 historic U.S. registrations for terpineols and beta-terpineols (not differentiated).
β-Thujone	Botanical		X	Experimental material with PHP potential.
BHT			C	Had U.S. reg., but now cancelled; not now registered elsewhere
Bifenthrin	Pyrethroid	3A	Reg	Widely registered mosquito adulticide, including in U.S.. Recommended by WHOPES for IRS.
Bioallethrin	Pyrethroid	3A	Reg	Widely registered mosquito adulticide and spatial repellent, including in U.S. Published WHOPES Specification.
Bioresmethrin	Pyrethroid	3A	Reg	Insecticide. Cancelled in U.S. but registered elsewhere
Bistrifluron		15	X	Experimental material with PHP potential.
Borax	Inorganic	8D	Reg	Fungicide with PHP potential. Multiple active registrations
Boric Acid	Inorganic		Reg	Multiple active registrations, including U.S. vector control
Bovidic Acid			X	Experimental material with PHP potential.
BPG	Polyalkyloxy		Reg	Multiple active registrations, including U.S. vector control
Buprofezin		16	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Butane			X	? – see Debboun et al 2007
Butanoic Acid	Fatty Acid		C	Recently cancelled in Australia and not known to be registered elsewhere
Butopyronoxyl			X	Experimental material with PHP potential. EPA PC Code issued.
Calcium Arsenate	Heavy Metal Salt		C	Cancelled in U.S. and failed registration in India
Callicarpenal			X	Experimental material with PHP potential.
Camphor	Botanical		Reg	Cancelled in U.S. and Australia but registration in China
Carbaryl	Carbamate	1A	Reg	Multiple active registrations, including U.S. vector control
Carbon Dioxide			Reg	Multiple active registrations, including U.S. vector control
Carboxylic Acids, C1-C3			Reg	Registered in U.S.
Carvacrol	Botanical		Reg	Registered in China; PC Code issued in U.S.
Carveol	Botanical		X	Experimental material with PHP potential.
Carvone	Botanical		Reg	Multiple active registrations, including U.S. vector control
Chlorantraniliprole	Anthranilic diamide	28	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Chlordane	OC	2A	Reg	Cancelled in U.S. and banned in India, but still allowed for some uses in E.U.
Chlorfenapyr	Pyrazole	13	Reg	Widely registered insecticide, including in U.S., with non-pyrethroid MOA. Registration vs. vectors? WHOPES evaluation on new formulation in progress.
Chlorfluazuron		15	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Chloropicrin		8B	Reg	Multiple active registrations, including U.S. vector control
Chlorphoxim	OP	1B	C	WHO Obsolete Pesticide; no active registrations

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
Chlorpyrifos	OP	1B	Reg	Widely used and highly effective insecticide with multiple registrations, including U.S. & India vector control (mosquito adulticide). Effective larvicide but this is generally not now recommended.
Chlorpyrifos-methyl	OP	1B	Reg	Multiple active reg, but not US nor necessarily vs. vectors
Chromafenozide		18	C	Cancelled in Australia & pending in E.U.
Chromobacterium subtsugae	Bacterial		Reg	Bacteria with multiple registrations, including U.S., vs. agricultural pests. Screening vs. mosquitoes not promising, but may be useful vs. other vectors.
Chrysoperla carnea	Predatory insect		Bio.	Recently introduced biocontral agent for some agricultural pests. No evidence of PHP potential.
Cinerin I	Pyrethrin	3A	X	Constituent of pyrethrum, not cost effective to synthesize or extract. PC Code
Cinerin II	Pyrethrin	3A	X	Constituent of pyrethrum, not cost effective to synthesize or extract. PC Code
Cinnamaldehyde	Botanical		Reg	Active U.S. reg., but not elsewhere. Major constituent of cinnamon oil; repels mosquitoes.
Citral	Botanical		Reg	Active U.S. reg., but not elsewhere
Citric Acid			Reg	Registered in Canada; exempt in U.S.
Citronellal	Botanical		X	Experimental material with PHP potential.
Citronellol	Botanical		Reg	Active U.S. & E.U. reg
Citronellyl Acetate	Botanical		X	Experimental material with PHP potential.
Coelomomyces spp.	Fungus		X	Experimental entomopathogenic fungi. Some varieties known to control/reduce mosquito populations, but not commercialized to date.
Conidiobolus coronatus	Fungus		X	Experimental entomopathogenic fungi. Some varieties known to infest sand flies, including *P. papatasi*, but not developed to date.
Copper Nanoparticles	Inorganic		X	Experimental material with PHP potential.
Corn Gluten Meal	Botanical		Reg	Active & Exempt in U.S. and registered in Canada
Coumaphos	OP	1B	Reg	Multiple active registrations, including U.S. vector control
Cryolite	Inorganic	Un	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Culicinomyces spp.			X	Experimental material with PHP potential.
CuniNPV	Virus		X	Experimental virus with PHP potential.
Cyantraniliprole	Anthranilic diamide	28	Reg	Reg in Canada and pending in E.U.
Cyflumetofen		25	Reg	Reg in Canada, pending in E.U., PC code issued
Cyfluthrin	Pyrethroid	3A	Reg	Major global mosquitocide, with multiple active registrations for a range of pests, including U.S. vector control. Recommended by WHO for IRS & ITN's.
Cyhalothrin	Pyrethroid	3A	Reg	Reg in China; PC Code issued
Cypermethrin	Pyrethroid, Ester Type II	3A	Reg	Insecticide and acaricide with multiple active registrations, including U.S., vs. ticks, bed bugs, and adult mosquitoes.
Cyphenothrin	Pyrethroid	3A	Reg	Insecticide. Multiple active registrations, including U.S. vector control
d-Allethrin	Pyrethroid	3A	Reg	Major mosquito spatial repellent and toxicant globally. Multiple active registrations, including U.S. vector control. WHOPES spec. published.
d-α-Pinene	Botanical		X	Experimental material with PHP potential. EPA PC Code issued, but no evidence of products ever registered.
DDT	OC	3B	Reg	Historically a very significant mosquitocide and PHP generally. Still recommended by

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
				WHOPES for IRS. Registration in E.U. & India (restricted use, for mosquito & sand fly control). Cancelled in U.S.
d-d, trans-Cyphenothrin	Pyrethroid	3A	Reg	Registered in China; not known to be registered elsewhere. Recommended by WHOPES for indoor and outdoor space spraying vs. mosquitoes.
Decanoic Acid	Fatty Acid		Reg	Active in U.S., but not necessarily vs. vectors
DEET			Reg	Primary topical insect and tick repellent globally for decades. Multiple active registrations, including U.S. & E.U. vector control.
Dehydrolinalool	Botanical		X	Experimental material with PHP potential.
Deltamethrin	Pyrethroid	3A	Reg	Major global mosquitocide, with multiple active registrations, including U.S. vector control. Recommended by WHOPES for IRS, ITN's, and LLIN's.
DEPA			X	Insect pheromone
Diafenthiuron		12A	Reg	Reg elsewhere, but cancelled in India. PC Code in U.S.
Diazinon	OP	1B	Reg	Insecticide. Multiple active registrations, including U.S. & India vector control. Some U.S. uses cancelled. WHOPES Spec. published.
Dibutyl Phthalate	Alkyl Phthalate		C	Cancelled in U.S. and Australia. Not known to be registered elsewhere.
Dichlorvos (= DDVP)	OP	1B	Reg	Highly volatile mosquitocide. Multiple active registrations, including U.S. & India vector control. WHOPES Spec. published.
Dicofol	OC	Un	Reg	Cancelled in U.S., but registered elsewhere
Dieldrin	OC		Reg	Cancelled in U.S. and India, but still allowed in E.U.
Diflubenzuron	Benzoylurea	15	Reg	Highly potent mosquito larvicide, recommended by WHOPES for general use and containers.. Multiple registrations, including U.S. & India vector control.
Dihydro-5-heptyl-2(3H)-furanone	Ketone		Reg	Reg in U.S. including vector control
Dihydro-5-pentyl-2(3H)-furanone	Ketone		Reg	Reg in U.S. including vector control
Dimethoate	OP	1B	Reg	Historic PHP, with WHOPES Spec. published. Widely registered, but not necessarily vs. vectors. All non-agricultural U.S. uses cancelled in 2000.
Dimethyl Phthalate	Alkyl Phthalate		C	Ectoparasiticide and insect repellent. Used on U.S. military uniforms in 1940's; now cancelled
Dinotefuran	Neonicotinoid	4A	Reg	Multiple active registrations, including U.S. vector control.
Di-n-propyl Isocinchomeronate			Reg	Multiple active registrations, including U.S. vector control.
Dioctyl Phthalate	Alkyl Phthalate		X	Experimental material with PHP potential. EPA PC Code issued.
Dipropylene Glycol	Glycol		C	Previously registered in U.S. vs. bed bugs, but now cancelled
D-Limonene	Botanical		Reg	Reg in U.S., not necessarily vs. vectors
DMC			X	Experimental material with PHP potential. EPA PC Code issued.
DNOC	Dinitrophenol derivative	13	C	U.S. reg. cancelled; not known to be registered elsewhere
Dodecanoic Acid	Fatty Acid		Reg	Reg in EU; PC Code issued
d-Phenothrin (= Sumithrin)	Pyrethroid	3A	Reg	Mosquitocide suitable for large-area applications. WHOPES Spec. and multiple active registrations, including U.S. vector control.
Dried Blood / Blood Meal	Animal Product		Reg	Not primarily PHP, but exempt status in U.S. allows use. Reg. in Canada and EU; reg cancelled in U.S.
d-Verbenone	Botanical		Reg	Registered in Canada only. Strong evidence of tick repellency.
Egg Solids			Reg	Active and exempt in U.S. Not primarily PHP, but exempt status allows use.

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
Elemol	Botanical		X	Experimental material with good tick repellency in the lab. Major constituent of Osage Orange (*Maclura pomifera*).
(E)-N-cyclohexyl-N-ethyl-2-hexenamide			X	Experimental material with PHP potential.
Endosulfan	OC	2A	Reg	Historically significant PHP, with active pesticide registrations in multiple sites, but pending cancellations of all products in U.S. and India.
Engyodontium album	Fungus		X	Experimental entomopathogenic fungus with PHP potential, esp. initially vs. cattle ticks.
Esbiothrin	Pyrethroid	3A	Reg	Subset of stereoisomers of allethrin, with good spatial repellence and toxicity. Multiple active registrations, including U.S. WHOPES Spec. published.
Esfenvalerate	Pyrethroid	3A	Reg	Multiple active registrations, including U.S. vector control.
Ethohexadiol (= Rutgers 612)			C	Repellent cancelled in U.S. in 1991. Not known to be registered elsewhere.
Etofenprox	Pyrethroid (Ether)	3A[a]	Reg	Photo-stable insecticide w/ multiple active registrations, including U.S. wide-area spray. Recommended by WHOPES for IRS and ITN's.
Etoxazole		10B	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Eucalyptol (=1,8-Cineole)	Botanical		Reg	Multiple active registrations, but not in U.S.
Eugenol	Botanical derivative		Reg	Multiple registrations, including U.S. Registration vs. mosquitoes & bed bugs
Fatty Acids: C7 – C20	Fatty Acid		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Fatty Acids, Long Chain	Fatty Acid		Reg	Multiple active registrations, but not in U.S.
Fatty Acids, Medium Chain	Fatty Acid		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Fatty Acids, Short Chain	Fatty Acid		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Fatty Acids, Very Long Chain	Fatty Acid		Reg	Reg only known in Canada
Fenazaquin		21A	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Fenitrothion	OP	1B	Reg	Multiple registrations, including U.S. Registration vs. vectors in India. Recommended by WHOPES for IRS vs. malaria vectors.
Fenoxycarb	JH	7B	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Fenpropathrin	Pyrethroid	3A	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Fenthion	OP	1B	Reg	Mosquito adulticide and larvicide, with WHOPES recommendation for larval control. Multiple registrations, including vs. vectors in India; cancelled in U.S.
Fipronil	Phenylpyrazole	2B	Reg	Multiple active registrations, including U.S. vector control
Fish Oil (= Cod Liver Oil)	Animal derived		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Flufenoxuron	Benzoylurea	15	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Formic Acid			Reg	Active reg. in U.S.; not specifically vector

[a] The mode of action of etofenprox is grouped by IRAC with the pyrethroids, but the chemistry of this molecule is significantly different from the bulk of these compounds, and it is not clear from a resistance management perspective that it should be added to this group. More broadly, it has been suggested that the MoA for Type I and Type II pyrethroids should be distinguished both for insects (e.g. Schleier and Peterson 2012. "The Joint Toxicity of Type I, II, and Non-ester Pyrethroid Insecticides." J Econ Entom 105:85-91.) and humans (USEPA 2011: "Pyrethrins/Pyrethroid Cumulative Risk Assessment" (10/4/11) regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0746-0003.

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
Gamma-Cyhalothrin	Pyrethroid	3A	Reg	Multiple active registrations, including U.S. vector control
Geraniol	Botanical		Reg	Active & exempt in U.S.; active reg. in EU
Geranyl Acetate	Botanical		X	Experimental material with PHP potential.
Geranylacetone	Botanical		X	Experimental material with PHP potential.
Haedoxane A	Lignin (Botanical)		X	Experimental material with low mosquito larvicide efficacy. Lopseed derivative.
Haedoxane E	Lignin (Botanical)		X	Experimental material with low mosquito larvicide efficacy. Lopseed derivative.
HBTX	Bacterial Product		X	Experimental bacterial metabolite with PHP potential.
HCH	OC		C	Only known reg was US; now cancelled
Heptanoic Acid	Fatty Acid		C	Only known reg was Australia; now cancelled. Apparently significant potential.
Hexadecanoic Acid	Fatty Acid		X	Experimental natural product with strong spatial mosquito repellency, e.g. when released by combustion of plant matter.
Hexahydro-1-(1-oxohexyl)-1H-azepine			X	Experimental material with PHP potential.
Hexanal	Aldehyde		X	Experimental material with PHP potential. EPA PC Code issued.
Hexanoic Acid	Fatty Acid		X	Experimental material with PHP potential. EPA PC Code issued.
Humulene Epoxide II	Botanical		X	Experimental material with PHP potential.
Hydramethylnon		20A	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Imidacloprid	Neonicotinoid	4A	Reg	Mult w/ US, w/ vector
Imiprothrin	Pyrethroid	3A	Reg	Mult w/ US, w/ vector
Indole	Botanical		Reg	US only after Austr Cancel
Indoxacarb		22A	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Intermedeol	Botanical		X	Experimental material with PHP potential.
IR3535			Reg	Globally significant topical repellent vs. mosquitoes and ticks. WHOPES Spec.
Isaria fumosorosea Apopka Strain 97	Fungus		Reg	Entomopathogenic fungi w/ multiple registrations, including U.S. Registration vs. vectors?
Isaria fumosorosea Strain FE 9901	Fungus		Reg	Entomopathogenic fungi w/ Canadian registration and pending elsewhere, including U.S. Registration vs. vectors?
Isaria fumosorosea Lilacinus Strain 251	Fungus		Reg	Entomopathogenic fungi w/ multiple registrations, including U.S. Registration vs. vectors?
Isoeugenol	Botanical		Reg	Major constituent of clove bud oil, with strong repellence to many insects, comparable to citronella. Reg. in Australia only. PHP use unclear.
Isopropyl Alcohol	Alcohol/Ether		Reg	Mult w/ US, w/ vector
Isopulegol	Botanical		X	Experimental material with PHP potential.
Ivermectin	Microbial product, Macrocyclic Lactone	6	Reg	Registered insecticide in China and veterinary drug in Australia. PHP potential unclear, but related compounds have good topical efficacy vs. mosquitoes.
Jasmolin I	Pyrethrin	3A	X	Constituent of pyrethrum, not cost effective to synthesize or extract. PC Code
Jasmolin II	Pyrethrin	3A	X	Constituent of pyrethrum, not cost effective to synthesize or extract. PC Code
Jodfenphos (= Iodofenphos)	OP	1B	Reg	Historically important mosquitocide, with reg. in EU and WHOPES Spec.
Kaolin	Inorganic		Reg	Multiple pesticide registrations, but little potential as PHP.
Lactic Acid			Reg	Mult w/ US, w/ vector
Lagenidium giganteum	Fungus		C	Larvicidal fungus only ever registered in U.S.; cancellation pending

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
Lambda-Cyhalothrin	Pyrethroid	3A	Reg	Globally significant mosquitocide, with WHOPES recommendations for use as outdoor space spray, IRS, and ITN's.
Lanolin	Animal derived		X	Experimental material with PHP potential. EPA PC Code issued.
Larvicidal Oil	Mineral Oils		Reg	Widely registered mosquito larvicides and pupacides. WHOPES Spec.
Lauryl Sulfate			Reg(E)	E in US
L-Carvone	Botanical		Reg	Mult w/ US, w/ vector
Lead Arsenate	Inorganic		C	C US; failed India
Limonene	Botanical		Reg	Active in US only; Vector
Limonin	Botanical		X	Experimental material with PHP potential.
Linalool	Botanical		Reg	Active in US only; Vector
Lindane	OC		Reg	Historically significant PHP, now banned or cancelled in major jurisdictions except EU. WHOPES Spec. published.
Linoleic Acid	Fatty Acid		X	Experimental natural product with strong spatial mosquito repellency, e.g. when released by combustion of plant matter.
L-Lactic Acid			Reg	Mult w/ US, w/ vector (Canada & US)
Lysinibacillus sphaericus (= *Bacillus sphaericus*)	Bacterial	11B	Reg	Bacterial mosquito larvicide w/ wide registration, including U.S.
Lysinibacillus sphaericus Serotype H5a5b Strain 2362 ATCC 1170	Bacterial	11B	Reg	Bacterial mosquito larvicide. This strain registered in U.S. and Canada.
Magnesium Phosphide	Inorganic	24A	Reg	Mult w/ US, vector cancelled
Malathion	OP	1B	Reg	Globally significant mosquito adulticide, recommended by WHOPES for outdoor space spray and IRS vs. mosquito vectors. WHOPES Spec.
Malic Acid			Reg	Registered pesticide in Australia and exempt in U.S. Some PHP potential.
Menthofuran			X	Experimental material with PHP potential. Volatile with significant toxicity to mosquitoes and other dipterans.
Metaflumizone		22B	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Metarhizium anisopliae Strain ESF1	Fungus		Reg	Entomopathogenic fungi w/ multiple registrations, including U.S. Registration vs. vectors?
Metarhizium anisopliae Strain F52	Fungus		Reg	Entomopathogenic fungi w/ multiple registrations, including U.S. vs. vectors.
Methoprene (RS)	JH analogues	7A	Reg	Globally significant mosquito larvicide.
Methoxychlor	OC	3B	Reg	Historically significant PHP, still active in EU; Cancelled in U.S. WHOPES Spec withdrawn as obsolete.
Methyl Bromide	Alkyl Halides	8A	Reg	Fumigant with wide registration and periodic, restricted use vs. vectors.
Methyl Cinnamate	Botanical		X	Experimental material with PHP potential.
Methylheptenone	Ketones		X	Experimental material with PHP potential. EPA PC Code issued.
Methyl Isoeugenol	Botanical		X	Experimental extract of Ceylon citronella and other botanical oils with insect repellency. PHP potential but not developed to date.
Methyl Salicylate			Reg	Multiple registrations, including U.S. Registration vs. vectors?
Metofluthrin	Pyrethroid	3A	Reg	Active US +; w/ vector
MGK® Repellent 11			C	Repellent cancelled in US; not known to have been registered elsewhere.
Minoxidil			X	Experimental material with PHP potential.

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
Naled	OP	1B	Reg	Active US +; w/ vector
n-Butylacetanilide			C	C in US; not known elsewhere
n-Butyl Formate			X	Volatile experimental material with significant toxicity to mosquitoes etc.
Nematodes			X	Experimental material with PHP potential.
Nepetalactone	Botanical		X	Experimental material with PHP potential.
Niclosamide			Reg	Multiple registrations, including U.S. WHOPES Spec.
Niclosamide-Olamine			Reg	Registered in China. WHOPES Spec.
N-Octyl Bicycloheptene Dicarboximide (= MGK® 264)	Dicarboximide		Reg	Synergist; Widespread registrations vs. vectors and other pests.
Nomilin	Liminoid (Botanical)		X	Experimental material with moderate efficacy as mosquito larvicide. Found in extracts of many citrus plants with insecticidal and/or repellent attributes.
Nonanal	Aldehyde		X	Experimental material with PHP potential.
Nonanoic Acid	Fatty Acid		Reg	Registered in U.S.; no vector registrations, but PHP potential.
Nootkatone	Botanical		X	Experimental material with good insect and tick repellency and good acaricidal action. Derived from Alaskan Yellow Cedar or grapefruit.
Novaluron	Benzoylurea	15	Reg	Multiple registrations, including U.S. Recommended by WHOPES for larval control, including in containers; possibly other PHP applications.
Nucleopolyhedroviruses = NPV	Virus		Reg	Viruses active against many types of insects, with wide registrations, including U.S. Potential shown vs. mosquitoes (CuniNPV), but no registration to date.
Octadecanoic Acid	Fatty Acid		X	Experimental natural product with strong spatial mosquito repellency, e.g. when released by combustion of plant matter.
Octanoic Acid	Fatty Acid		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Octenal	Aldehydes		X	Experimental material with PHP potential. EPA PC Code issued.
Oleic Acid	Fatty Acid		Reg	Registered in EU but cancelled in U.S. Natural product with strong spatial mosquito repellency, e.g. when released by combustion of plant matter.
Paris Green	Heavy Metal Salts		C	Historically significant mosquitocide, now cancelled or banned everywhere
P-Cymene	Botanical		X	Experimental botanical derivative, showing little independent insecticidal or repellent efficacy, although whole plant extracts work well.
Pentanoic Acid			X	Experimental material with PHP potential.
Permethrin	Pyrethroid	3A	Reg	Globally significant mosquitocide and repellent treatment for fabrics. WHOPES recommendations for indoor space spray, ITN's, and LLIN's.
Phenothrin	Pyrethroid	3A	Reg	Active US+ w/vector
Phoxim	OP	1B	Reg	Reg. in China + EU; Cancelled in U.S. WHOPES Spec.
Phrymarolin-I	Lignin (Botanical)		X	Experimental material with low mosquito larvicide efficacy. Lopseed derivative.
Picaridin (= Icaridin)	Piperidine (Botanical)		Reg	Widely registered topical repellent vs.mosquitoes, ticks, etc. WHOPES Spec.
Pilocarpene	Botanical		X	Experimental material with PHP potential.
Pinene	Botanical		Reg	Active registration in Australia. EPA PC Code issued, but no U.S. reg.
Pinocamphone	Botanical extract		X	Experimental material with some PHP potential. Major constituent of tansy plant with tick repellency, but low independent activity.
Piperidine			X	Experimental material with PHP potential.
Piperine			Reg	Multiple registrations, including U.S. Registration vs. vectors?

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
Piperonyl Butoxide (= PBO)			Reg	Synergist with global registrations for vector control. Recommended by WHOPES for use with space spraying, and LLIN with this material under WHOPES evaluation.
Pirimiphos-methyl	OP	1B	Reg	Globally significant mosquitocide, with WHOPES recommendation for use in IRS and larval control. Multiple registrations, including vs. vector in US & India.
Plant Oil – Alaska Yellow Cedar	Plant Extract		X	Experimental material with good insect and tick repellency and good acaricidal action. Major active fraction is nootkatone.
Plant Oil – Anise	Plant Extract		Reg	US only
Plant Oil – Atlantic Cedar			X	Experimental material with PHP potential.
Plant Oil – Balsam Fir	Plant Extract		Reg	US only
Plant Oil – Balsam Torchwood	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Barbados Nut	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Basil, Holy	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Basil, Sweet	Plant Extract		X	Experimental material with mild evidence of PHP potential.
Plant Oil – Bay Laurel = Sweet Bay	Plant Extract		Reg	EU only
Plant Oil – Beautyberry, American	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Beautyberry, Japanese	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Bergamot	Plant Extract		Reg	US only
Plant Oil – Betel	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Billygoat Weed	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Birch	Plant Extract		Reg	US only
Plant Oil – Blackcurrant Bud	Plant Extract		Reg	EU only
Plant Oil – Bugle	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Cajeput	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Camphor Laurel	Plant Extract		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Plant Oil – Caraway Seed	Plant Extract		X	Experimental material with low apparent PHP potential.
Plant Oil – Cardamom	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Castor	Plant Extract		Reg	Registered in U.S. and Canada
Plant Oil – Catnip	Plant Extract		X	Experimental material with PHP potential. Constituent pulegone is a powerful repellent and insect toxicant, but mammalian toxicity may limit PHP utility.
Plant Oil – Catnip, Hydrogenated	Plant Extract		RED	Registered in U.S. only, for use vs. vectors.
Plant Oil – Cedar, Deodar	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Cedarwood			Reg	Cedarwood oil is registered in U.S. and pending in Canada
Plant Oil – Celery			X	Experimental material with PHP potential.
Plant Oil – Chamomile	Plant Extract		Reg	U.S. only
Plant Oil – Chamomile, German			Reg	U.S. only
Plant Oil – Chastetree			X	Experimental material with PHP potential.
Plant and Plant Oil – Cinnamon	Plant Extract		Reg	Cinnamon and cinnamon oil can be used in the U.S., but not elsewhere. Constituent cinnamaldehyde may have utility vs. mosquitoes.
Plant and Plant Oil – Citronella, Ceylon	Plant Extract		Reg	Citronella and citronella oils are widely registered as PHP insect repellents.
Plant and Plant Oil – Citronella, Java	Plant Extract		Reg	Citronella and citronella oils are widely registered as PHP insect repellents.

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
Plant Oil – Citrus Oil	Plant Extract		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Plant and Plant Oil – Clove	Plant Extract		Reg	Clove oil has multiple registrations, including U.S., where the oil and whole plant are also exempt. Eugenol is a major insecticidal & repellent constituent.
Plant Oil – Coconut	Plant Extract		Reg	EU; PC Code US
Plant Oil – Corn	Plant Extract		Reg	E US; Reg EU
Plant Oil – Cotton	Plant Extract		EC	US only; E; Reg cancelled
Plant Oil – Cypress, Chinese Weeping	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Epazote	Plant Extract		Reg	US only
Plant Oil – Eucalyptus	Plant Extract		Reg	US+ w/ vector
Plant Oil – Fingerroot	Plant Extract		X	Experimental material with PHP potential.
Plant and Plant Oil – Garlic	Plant Extract		Reg	Garlic and garcil oil are widely registered.
Plant Oil – Garlic Chives	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Geranium, Rose	Plant Extract		Reg	AE US+ Canada
Plant Oil – Geranium, Rasp-leaf			Reg	AE US+ Canada
Plant Oil – Ginger	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Ginger, Cassumunar	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Jojoba	Plant Extract		Reg	US only
Plant Oil – Juniper	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Lavandin	Plant Extract		Reg	US only
Plant Oil – Lavender	Plant Extract		Reg	Austr only
Plant Oil – Lemon	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Lemon Eucalyptus	Plant Extract		Reg	Austr only
Plant Oil – Lemongrass	Plant Extract		Reg	AE US + EU
Plant Oil – Lignum-vitae	Plant Extract		Reg	EU only
Plant Oil – Lime, Thai	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Linseed = Flax	Plant Extract		Reg	E in US; reg Austr
Plant Oil – Lopseed	Plant Extract		X	Experimental material showing moderate larvicide efficacy.
Plant Oil – Marigold, French	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Marjoram	Plant Extract		Reg	EU only
Plant Oil – May Chang	Plant Extract		X	Experimental material with PHP potential.
Plant and Plant Oil – Mint	Plant Extract		Reg	Mint oil is registered in the U.S. only, and the plant and oil are also exempt. The type is poorly defined, but some some mints have PHP potential.
Plant Oil – Mint, Field	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Mugwort	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Mustard (Black)	Plant Extract		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Plant Oil – Neem	Plant Extract		Reg	AV US + Aust + India
Plant Oil – Niaouli	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Nutmeg	Plant Extract		X	Experimental material with PHP potential. Listed as an ingredient in “natural” insect repellents, but no proof of efficacy found.
Plant Oil – Olive	Plant Extract		Reg	Multiple registrations, including U.S. Registration vs. vectors?

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
Plant Oil – Orange, Bitter	Plant Extract		Reg	Austr
Plant Oil – Orange, Mandarin	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Orange, Sour	Plant Extract		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Plant Oil – Orange, Sweet	Plant Extract		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Plant Oil – Oregano	Plant Extract		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Plant Oil – Osage Orange	Plant Extract		X	Experimental material with PHP potential. The major constituent of this oil, elemol, repels ticks well in the lab.
Plant Oil – Paracress	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Patchouli	Plant Extract		X	Experimental material with PHP potential. Listed as an ingredient in "natural" insect repellents, but no proof of efficacy found.
Plant Oil – Peanut	Plant Extract		Reg	Eu + aust
Plant Oil – Pennyroyal, American False	Plant Extract		Reg	U.S. Reg. only. The constituent pulegone is a powerful repellent and insect toxicant, but mammalian toxicity may limit PHP utility.
Plant Oil – Pennyroyal, European	Plant Extract		Reg	U.S. Reg. only. The constituent pulegone is a powerful repellent and insect toxicant, but mammalian toxicity may limit PHP utility.
Plant Oil – Pepper, Black	Plant Extract		Reg	E US; EU reg
Plant & Plant Oil – Peppermint	Plant Extract		Reg	Peppermint oil is registered in Australia and the oil and plant are exempt in the U.S. The constituent pulegone is a powerful repellent and insect toxicant, but mammalian toxicity may limit PHP utility.
Plant Oil – Pillpod Sandmat	Plant Extract		X	Experimental material with some evidence of mosquito larvicidal activity, possibly due to presence of saponins.
Plant Oil – Pine	Plant Extract		Reg	AV UA; + 57 active & 1173 historic product registrations in the U.S.
Plant Oil – Pine, Scots	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Pine Tar Oil	Plant Extract		Reg	C in US; reg Aust + EU. 22 historic but 0 active product registrations in the U.S.
Plant Oil – Prickly-ash	Plant Extract		X	Experimental material; some plants of this genus have very good insecticidal and repellent potential vs. mosquitoes, etc.
Plant Oil – Pyrethrum	Plant Extract	3A	Reg	Insecticide; US+ Austr/ v
Plant Oil – Rape Seed = Canola Oil	Plant Extract		Reg	US & EU
Plant & Plant Oil – Rosemary	Plant Extract		Reg	Rosemary oil is widely registered as a pesticide, and the oil and plant are also exempt in the U.S. AI in "natural" insect repellents, but efficacy unproven.
Plant Oil – Sabadilla	Plant Extract		X	Experimental material with PHP potential.
Plant & Plant Oil – Sesame	Plant Extract		E	Sesame and Sesame oil are exempt in the U.S. but not registered anywhere. Sold as AI in "natural" insect and tick repellents, but efficacy unproven.
Plant Oil – Sichuan Pepper	Plant Extract		X	Experimental material with high mosquito repellency. Constituents include linalool (50%), limonene, methyl cinnamate, and cineole.
Plant Oil – Soybean	Plant Extract		Reg	Active registrations in multiple jurisdictions, including the U.S. Also exempt in U.S.
Plant Oil – Soybean, Epoxylated	Plant Extract		Reg	EU only
Plant Oil – Spearmint	Plant Extract		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Plant Oil – Stinking Roger	Plant Extract		X	Experimental material with weak evidence of PHP potential.
Plant Oil – Summer Savory			X	Experimental material with PHP potential.
Plant Oil – Sunflower	Plant Extract		Reg	Eu only

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
Plant Oil – Tansy	Plant Extract		X	Experimental material with good evidence of repellency vs. ticks. Close relative to pyrethrum plants.
Plant Oil – Tea Tree	Plant Extract		Reg	Us ; C austr; EU
Plant & Plant Oil – Thyme	Plant Extract		Reg	AVE; pending eu + canada
Plant Oil – Turmeric	Plant Extract		X	Experimental material with mosquito repellent potential.
Plant Oil – Turmuric, Wild	Plant Extract		X	Experimental material with PHP potential. Published evidence of strong mosquito repellency.
Plant Oil – Vetiver	Plant Extract		X	Experimental material with PHP potential.
Plant Oil – Violet	Plant Extract		X	Experimental material with PHP potential. Strong mosquito repellency in some studies.
Plant Oil – Wild Bergamot	Plant Extract		X	Experimental material with PHP potential. Reputed to repel mosquitoes, probably because of presence of thymol.
Plant Oil – Wintergreen	Plant Extract		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Plant Oil – Wormwood = Absinth	Plant Extract		X	Experimental material with PHP potential. Evidence of strong but short-lived repellency to mosquitoes and other public health pests.
Plant Oil – Ylang Ylang	Plant Extract		Reg	Registered only in E.U. Some evidence of mosquito repellency.
PMD	Botanical Derivative		Reg	Us + cand V
POE Isooctadecanol	Polyalkyloxy Compound		Reg	AV US
Polyvinylpyrrolidone	Polymer		C	Cancelled in U.S. and not known to have been registered elsewhere.
Potassium Laurate	Soap Salts		E	Soap salt exempt in U.S.; not registered elsewhere.
Potassium Silicate	Inorganic		Reg	US only
Potassium Sorbate			Reg	E US; reg elsewhere
Prallethrin	Pyrethroid	3A	Reg	Widely registered mosquitocide, with WHOPES Spec. published.
Prodigiosin	Bacterial Product		X	Experimental microbial metabolite (pigment) with moderate mosquito larvicidal activity.
Propanoic Acid	Carboxylic Acid		Reg	Us only
Propargite		12C	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Propoxur	N-Methyl Carbamate	1A	Reg	Widely registered mosquitocide with WHOPES recommendation for IRS use. Vector control uses cancelled in U.S.
Propylene Glycol Monolaurate			Reg	Us only
Pulegone	Monoterpene (botanical)		X	Experimental material with PHP potential. A powerful repellent and insect toxicant, but mammalian toxicity may limit PHP utility.
Pyrethrin I	Pyrethrin	3A	X	Constituent of pyrethrum, not cost effective to synthesize or extract. PC Code
Pyrethrin II	Pyrethrin	3A	X	Constituent of pyrethrum, not cost effective to synthesize or extract. PC Code
Pyrethrins	Botanical extracts	3A	Reg	Globally significant botanical mosquito adulticide, but WHOPES Spec. published.
Pyrethrum Marc	Botanical extract		X	Remains after extraction of pyrethrins from pyrethrum. Unregistered, but EPA PC Code issued. Low apparent insecticidal or repellent activity. .
Pyridaben		21A	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Pyridostigmine Bromide			X	Experimental material with PHP potential. EPA PC Code issued.
Pyrimidifen	Pyrimidine	21A	X	Experimental material with PHP potential.

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
Pyriproxyfen	JH	7C	Reg	Highly active IGR widely registered for control of vectors and other pests, with WHOPES recommendation for use vs. larval mosquitoes.
R-(-)-1-Octen-3-ol	Botanical		Reg	Us+cana v
Resmethrin	Pyrethroid	3A	Reg	Us+; US & Austr C
RIDL genes	Genetic material		X	Experimental (unregistered as a pesticide) patented genetic engineering approach to sterile male releases. In field experiments with mosquitoes.
RNAi	Genetic material		X	Experimental patented approach to highly selective pesticides, including PHP's. Experimentally demonstrated efficacy in mosquitoes.
Rotenone	Botanical	21B	Reg	Avc us +
Ryanodine	Botanical		Reg	Us only
S 220			X	Experimental material with somewhat lower repellency than the stereo-pure SS 220 molecule, but with perhaps lower synthesis cost.
Sabinene	Botanical		X	Experimental material with PHP potential.
Saponins	Botanical		X	Experimental material demonstrating mosquito larvicide potential. EPA PC Code issued.
S-Bioallethrin	Pyrethroid	3A	Reg	Widely registered mosquito adulticide and spatial repellent. WHOPES recommended for indoor space spraying vs. mosquitoes.
Serratia entomophila	Bacteria		X	Experimental bacteria that produce patented insecticidal protein genes with PHP potential.
Serratia proteamaculans	Bacteria		X	Experimental bacteria that produce patented insecticidal protein genes with PHP potential.
S-Hydroprene	JH analogue	7A	Reg	Us+ aust v
Silica Gel	Inorganic		Reg	US+can v
Silicon Dioxide	Inorganic		Reg	US+many v
Silicon Dioxide Nanoparticles	Inorganic		X	Experimental material with PHP potential.
Silver Nanoparticles	Inorganic		Pend	Silver nanoparticles are pending as a pesticide in the U.S., but not vs. vectors. PHP potential seems high.
S-Methoprene	JH analogue	7A	Reg	Mosquito larvicide w/ PHP registration in multiple jurisdictions.
Soap Salts – Ammonium	Soap Salts		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Soap Salts – Potassium	Soap Salts		Reg	Us+ v; c aust
Soap Salts – Sodium	Soap Salts		Reg	Us only v
Sodium Chloride	Inorganic		Reg	Us E + multi reg
Sodium Lauryl Sulfate	Soap Salt		Reg	Us E; reg eu, pending can
Sodium Metasilicate	Inorganic		Reg	Us only
Spathulenol	Terpenoid		X	Experimental material with good mosquito repellency. Extract of *Callicarpa japonica.*
Spinetoram		5	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Spinosad	Macrocyclic Lactone	5	Reg	Widely registered mosquito larvicide w/ WHO Recommendation for this use, including in containers specifically.
Spinosyn A	Macrocyclic Lactone	5	X	Experimental bacterial biotoxin with PHP potential. Major (50-95%) constituent of Spinosad.
Spinosyn D	Macrocyclic Lactone	5	X	Experimental bacterial biotoxin with PHP potential. Minor (5-50%) constituent of

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
				Spinosad.
SS 220			X	Experimental material with high repellency to mosquitoes and ticks, but not commercialized to date.
Steinernema riobavis			X	Experimental material with PHP potential.
Sulfoxaflor		4C	X	Experimental material with PHP potential.
Sulfoxide			C	C us; not known elsewhere
Sulfur	Inorganic		Reg	Multiple registrations, including vs. vectors in U.S.
Sulfuryl Fluoride	Inorganic	8C	Reg	Multiple registrations, including vs. vectors in U.S.
SYN 131-1			X	USDA-developed Experimental material with very strong evidence of PHP potential. Composition not yet disclosed.
Tartaric Acid			X	Experimental material with PHP potential.
Tasmanone	Botanical		X	Experimental material with PHP potential.
Tau-Fluvalinate	Pyrethroid	3A	Reg	Multiple registrations, including vs. vectors in U.S.
Tebufenpyrad	Pyrazole	21A	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Tefluthrin	Pyrethroid	3A	Reg	Multiple registrations, including U.S. Registration vs. vectors?
Temephos	OP	1B	Reg	Widely registered mosquito larvicide, with WHOPES recommendation for this use, including in containers (such as drinking water) specifically.
Terpineol	Botanical		C	Historic U.S. registrations for terpineols and beta-terpineols (not differentiated), but now cancelled, and not known to have been registered elsewhere.
Tetradecanoic Acid	Fatty Acid		X	Experimental material with PHP potential.
Tetramethrin	Pyrethroid	3A	Reg	Multiple registrations, including vs. vectors in U.S.
Thiamethoxam	Neonicotinoid	4A	Reg	Multiple registrations, including vs. vectors in U.S.
Thujic Acid	Botanical		X	Experimental material with PHP potential.
Thujone	Botanical		X	Experimental material with PHP potential.
Thymol	Botanical		Reg	Multiple registrations, including U.S. Registration vs. vectors?
Tralomethrin	Pyrethroid	3A	Reg	Multiple registrations, including vs. vectors in U.S.
Trans-Allethrin	Pyrethroid	3A	X	Experimental material with PHP potential.
Trans-Cinnamaldehyde	Botanical		X	Experimental natural product with PHP potential. EPA PC Code issued. Major constituent of cinnamon oil; repels mosquitoes.
Transfluthrin	Pyrethroid	3A	Reg	Widely registered volatile spatical repellent vs. mosquitoes and other pests. WHOPES Spec. published, but not registered in U.S.
Transpermethrin	Pyrethroid	3A	X	Subset of stereoisomers of permethrin, not independently registered.
Trichlorfon	OP	1B	Reg	Historically significant mosquitocide, but WHOPES Spec. withdrawn as obsolete. Widely registered vs. a range of pests, but PHP use unclear.
Triethylene Glycol	Glycol		Reg	U.S. and Canada reg. only, including vs. vectors.
Trifluralin	2,6-Dinitroaniline		Reg	U.S. reg. only, including vs. vectors.
Trilinolein	Triglyceride		X	Experimental natural product with strong spatial mosquito repellency, e.g. when released by combustion of plant matter.
Triolein	Triglyceride		X	Experimental natural product with strong spatial mosquito repellency, e.g. when released by combustion of plant matter.

Active Ingredient	Chemical Class	MOA[a]	Status	PHP Use Pattern
Tripalmitin	Triglyceride		X	Experimental natural product with strong spatial mosquito repellency, e.g. when released by combustion of plant matter.
Tristearin	Triglyceride		X	Experimental natural product with strong spatial mosquito repellency, e.g. when released by combustion of plant matter.
Undecan-2-one	Ketone (botanical)		Reg	Widely registered natural product with efficacy as mosquito repellent and also registered vs. ticks.
Undecanoic Acid	Fatty Acid		X	Experimental material with PHP potential. Known to be an effective spatial repellent (in burning plant matter) and topical repellent.
Vanillin	Botanical		X	Experimental material with PHP potential. EPA PC Code issued.
Verbenol	Botanical		X	Experimental material with PHP potential. EPA PC Code issued. Strong evidence of tick repellency.
Verbenone	Botanical		Reg	Registered in Canada only. Strong evidence of tick repellency.
(Z)-4-Decenal	Aldehyde		X	Experimental material with PHP potential.
(Z)-9-Tricosene			Reg	Widely registered, including in U.S.
Zeta-Cypermethrin	Pyrethroid, Ester Type II	3A	Reg	Widely registered mosquito adulticide also registered vs. ticks and bed bugs.
Zinc Oxide Nanoparticles	Inorganic		X	Experimental material with significant PHP potential.

Part D: Public Health Pesticides Recognized by WHOPES

On the global scale, the World Health Organization Pesticide Evaluation Scheme (WHOPES) has been the primary institution evaluating vector control tools for the past 50 years, and Table D lists PHP AI's that are recognized by WHOPES through Specifications and Recommendations, with some information about use patterns and current evaluations of new products. We note that WHOPES is not a regulatory body, and their recommendations and standards do not necessarily indicate that materials are superior to others that may be available. WHOPES recognition does, however, indicate that significant evaluation has been done by a credible, neutral program, and that a material is widely accepted as effective against vectors and reasonably safe for human health and the environment when used appropriately.

All information in this column comes from WHOPES, is publicly available, and is fully cited in the notes.

Table D. Public Health Pesticides recognized by the World Health Organization Pesticide Evaluation Scheme (WHOPES)

Active Ingredient	Chemical Class	WHO Specifications, Recommendations, and Current Evaluations	CAS RN	WHO Status[a]	Pub. Date[b]
Alpha-Cypermethrin	Pyrethroid	Recommended for IRS (WP or SC) against malaria vectors[49], for treatment of mosquito nets (10% SC) for malaria vector control[50], and in LLIN's (coated on polyester or incorporated into polyethylene).[51] Specifications published for technical material, WP, and SC[52]; and for material coated onto net filaments[53] and incorporated into net filaments.[54] New LLIN's from BASF (Interceptor) and Clarke Mosquito Control (DuraNet) are under WHOPES evaluation.[55]	67375-30-8	SN, R, E	2009, 2011, 2012
Bacillus thuringiensis israelensis (Bti), strain AM65-52	Microbial	Recommended for control of larval mosquitoes in general (125-750 g WDG/ha) and for container breeding in particular (1-5 mg/L).[56] Specifications published for WDG.[57] A granular formulation from Valent Biosciences is under WHOPES evaluation.	68038-71-1	SN, R, E	2007
Bendiocarb	Carbamate	Recommended for IRS (WP) against malaria vectors. Specifications published for technical material and WP.[58]	22781-23-3	SN, R	2009
Bifenthrin	Pyrethroid	Recommended for IRS (WP) against malaria vectors. Specifications published for technical material and WP.[59]	82657-04-3	SN, R	2012
Bioallethrin = d-trans-Allethrin	Pyrethroid	Specification published for technical material.[60]	260359-57-7	SN	2005
Brodifacoum	4-hydroxy-Coumarin	The only rodenticide with published WHOPES Specifications; these cover technical material, bait concentrate, and ready-to-use bait[61]	56073-10-0	SO	2009
Chlorfenapyr	Pyrazole	A SC formulation from BASF is under WHOPES evaluation for IRS use (Aug 2011). No WHO specifications have yet been published for this material.	122453-73-0	E	None
Chlorpyrifos	OP	Specifications published for technical material and EC.[62] Successfully evaluated as larvicide vs. *Anopheles*, but not now recommended for that purpose.[63]	2912-88-2	SN	2009
Cyfluthrin	Pyrethroid	Recommended for IRS (WP) against malaria vectors, and for treatment of mosquito nets (5% EW) for malaria vector control. Specifications published for technical material, WP, and EW.[64]	68359-37-5	SN, R	2004
d-Allethrin = Pynamin Forte	Pyrethroid	Specification published for technical material.[65]	584-79-2, 231937-89-6	SN	2002
DDT	OC	Recommended for IRS (WP) against malaria vectors. Specifications published for technical material, DP, and WP.[66]	50-29-3, 8017-34-3	SO, R	2009
d-d, trans-Cyphenothrin	Pyrethroid	Recommended for indoor or outdoor space spraying against mosquitoes, as EC.[67] Specifications published for technical material and EC.[68]	39515-40-7	SN, R	2005

[a] WHOPES Status: E = Products under evaluation; ER = Evaluation Report; R = Recommended products; SN = Specifications published under new procedure; SO = Specifications published under old procedure; W = Specifications withdrawn

[b] Date of most recent WHO Pesticide Evaluation Scheme (WHOPES) publication(s)

Active Ingredient	Chemical Class	WHO Specifications, Recommendations, and Current Evaluations	CAS RN	WHO Status[a]	Pub. Date[b]
DEET		WHOPES specifications previously issued, but now withdrawn as obsolete.[69]	134-62-3	W	2009
Deltamethrin	Pyrethroid	Recommended for indoor and outdoor space spraying against mosquitoes (ULV or EW)[69], for IRS (WP or WDG) against malaria vectors, for treatment of mosquito nets (by 1% SC or 25% WDT) for malaria vector control, and in LLIN's (coated on polyester, incorporated into polypropylene or polyethylene, or incorporated with PBO into polyethylene). Specifications published for technical material, DP, WP, aqueous SC, EC, ULV liquid, WDG, EW, and WDT[70]; coated onto net filaments[71]; incorporated into net filaments[72]; and incorporated into net filaments with PBO.[73] A SC formulation from Bayer is under WHOPES evaluation for IRS use (Aug 2011). New LLIN's from Bayer (LifeNet), Intelligent Insect Control (Netprotect), Tana Netting (DawaPlus 2.0), and Vestergaard-Frandsen (PermaNet 3.0, with PBO) are under WHOPES evaluation (Aug 2011).	52918-63-5	SO, R, E	2010, 2011
Diazinon	OP	Specifications published for technical material, WP, and EC.[74]	333-41-5	SO	1999
Dichlorvos = DDVP	OP	Specifications published for technical material and EC.[75]	62-73-7	SO	2009
Diflubenzuron	Benzoylurea	Recommended for control of mosquito larvae, for general use (25-100 g WP, tablets, or granules /ha) & container breeding (0.02-0.25 mg/L) in particular. Specifications published for technical material, WP, DP, and granules.[76]	35367-38-5	SN, R	2006
Dimethoate	OP	Specifications published for technical material and EC.[77]	60-51-5	SN	2006
d-Phenothrin = Sumithrin	Pyrethroid	Specification published for technical material.[78]	188023-86-1	SN	2004
Endosulfan	OC	Specifications published for technical material and EC.[79]	115-29-7	SO	2011
Esbiothrin = S-Biothrin	Pyrethroid	Specification published for technical material.[80]	584-79-2, 260359-57-5	SN	2004
Etofenprox = Ethofenprox	Pyrethroid (Ether)	Recommended for IRS (WP) against malaria vectors, and for treatment of mosquito nets (by 5% EW) for malaria vector control. Specifications published for technical material, WP, and EC.[81]	80844-07-1	SN, R	2007
Fenitrothion	OP	Recommended for IRS (WP) against malaria vectors. Specifications published for technical material, WP, and EC.[82]	122-14-5	SN, R	2010
Fenthion	Pyrethroid	Recommended for general control of mosquito larvae (22-112 g EC/ha) but not specifically for container breeding . Specifications published for technical material, WP, and EC.[83]	55-38-9	SN, R	2006
IR3535 = Ethyl Butylacetyl-aminopropionate		Specifications published for technical material.[84]	52304-36-6	SN	2006
Jodfenphos (ISO) = Iodofenphos	OP	WHOPES specifications previously issued, but now withdrawn as obsolete.[85]	18181-70-9	W	2010
Lambda-Cyhalothrin	Pyrethroid	Recommended for outdoor space spraying against mosquitoes (EC), for IRS (WP or CS) against malaria vectors, for treatment of mosquito nets (2.5% CS or 10% CS+binder for long-lasting treatment) for malaria vector control.	91465-08-6	SN, R, E	2003, 2011

Active Ingredient	Chemical Class	WHO Specifications, Recommendations, and Current Evaluations	CAS RN	WHO Status[a]	Pub. Date[b]
		Specifications published for technical material, EC, WP, and slow-release CS.[86] A new kit (Icon Maxx) from Syngenta for long-lasting treatment/ retreatment of mosquito nets is under WHOPES evaluation (Aug 2011).			
Larvicidal Oils	Mineral oils	Specifications published for larvicidal oils with and without added pesticides.[87]	8012-95-1	SO	1999
Lindane = Gammexane	OC	Specifications published for technical material, WP, DP, and EC.[88]	58-89-9	SO	2009
Malathion	OP	Recommended for outdoor space spraying against mosquitoes as a ULV liquid, and as WP for IRS against malaria vectors. Specifications published for technical material, DP, ULV liquid, and EC.[89] A new EW space spray formulation (Cheminova) is under WHOPES evaluation.	121-75-5	SN, R, E	2003
Methoprene (RS)		Evaluation Report published for (RS) Methoprene[90], but information incomplete for issuing formal specifications.	40596-69-8	ER	2007
Methoxychlor		WHOPES specifications previously issued, but now withdrawn as obsolete.[91]	72-43-5	W	2010
Niclosamide		Specifications published for technical material, technical concentrate, EC, and WP.[92]	50-65-7	SN	2002
Niclosamide-Olamine		Specifications published for technical material, technical concentrate, EC, and WP.[93]	1420-04-8	SN	2002
Novaluron	Benzoylurea	Recommended for control of mosquito larvae in general (10-100 g EC/ha) and in containers (0.01-0.05 mg/L) in particular. Specifications published for technical material and EC.[94]	116714-46-6	SN, R	2004
Permethrin	Pyrethroid	Recommended for indoor space spraying against mosquitoes (EW mixed with PBO and s-bioallethrin), for treatment of mosquito nets (as 10% EC) for malaria vector control, and incorporated into polyethylene for LLIN's. Specifications published for technical material (40:60 cis/trans)[95]; technical material and EC (25:75 cis/trans)[96]; incorporated into filaments of LLIN's[97], and for an EW formulation with s-Bioallethrin and PBO.[98] A new LLIN from Sumitomo Chemical (Olyset Plus) is under evaluation.	52645-53-1	SN, R, E	2009, 2011
Phoxim	OP	Specifications published for technical material and EC.[99]	14816-18-3	SO	2011
Picaridin = Icaridin	Piperidine	Specification published for technical material.[100]	119515-38-7	SN	2004
Piperonyl Butoxide = PBO		Recommended as a synergist for indoor space spraying against mosquitoes with permethrin and s-bioallethrin as EW. Specification published for technical material.[101] A new LLIN from Vestergaard-Frandsen (PermaNet 3.0, with Deltamethrin) is under WHOPES evaluation (Aug 2011).	51-03-6	SN, R, E	2011
Pirimiphos-methyl	OP	Recommended for IRS**Error! Bookmark not defined.** (WP or EC) against malaria vectors, and for control of mosquito larvae in general (50-500 g EC/ha) and in containers (1 mg/L). Specifications published for technical material and EC.[102] A micro-encapsulated formulation from Syngenta is under WHOPES evaluation for IRS use (Aug 2011).	29232-93-7	SN, R, E	2006
Prallethrin	Pyrethroid	Specification published for technical material.[103]	23031-36-9	SN	2004

Active Ingredient	Chemical Class	WHO Specifications, Recommendations, and Current Evaluations	CAS RN	WHO Status[a]	Pub. Date[b]
Propoxur	Carbamate	Recommended for IRS (WP) against malaria vectors. Specifications published for technical material and WP.[104]	114-26-1	SN, R	2005
Pyrethrins / Pyrethrum	Botanical extract	Specifications published for technical concentrate.[105]	121-21-1	SO	2009
Pyriproxyfen	Synthetic juvenoid	Recommended for control of mosquito larvae in general (10-50 g granular/ha) and in containers (0.01 mg/L) in particular. Specifications published for technical material and granules.[106]	95737-68-1	SN, R	2006
s-Bioallethrin = Esbiol	Pyrethroid	Recommended for indoor space spraying against mosquitoes (EW mixed with permethrin and PBO). Specifications published for technical material[107] and for an EW formulation with permethrin and PBO.[108]	28434-00-6	SN	2006
Spinosad	Microbial	Recommended for control of mosquito larvae in general (20-500 g tablet, granular, EC, or SC/ha) and in containers (0.1 – 0.5 mg/L) in particular. Specifications published for technical material, tablets, granules, EC, and SC.[109]	168316-95-8	SN, R	2011
Temephos	OP	Recommended for control of mosquito larvae, both for general use (56-112 g granular or EC/ha) and for container breeding (1 mg/L) in particular. Specifications published for technical material, granules, and EC.[110]	3383-96-8	SN, R	2011
Transfluthrin	Pyrethroid	Specification published for technical material.[111]	118712-89-3	SN	2006
Trichlorfon	OP	WHOPES specifications previously issued, but now withdrawn as obsolete.[112]	52-68-6	W	2010

Part E: Vector Control Chemicals in the U.S.

Within the U.S., the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and subsequent amendments allow for the use of pesticides (a statutory term which includes repellents, attractants, and other semiochemicals) against specific pests if these chemicals are either specifically registered for that purpose by the U.S. Environmental Protection Agency (EPA) or if they are listed as exempt from registration requirements (so-called 25(b) materials, after that section of FIFRA). Table E1 lists PHP's currently available for use in the U.S., including both registered and exempt materials, and focuses on their regulatory status. For Table E, PHP's are defined as chemicals which may be legally used against mosquitoes, ticks, sand flies, or bed bugs. Some attractants for filth and stable flies are included. These pests are diverse enough that almost all PHP AI's should be covered.

Table E2 lists pesticides that are not generally considered PHP's, but that have including mosquitoes or ticks on their labels in recent years; these tend to be wide-spectrum biocides for which expansive labels have been requested by registrants.

Tables E3 and E4 summarize the current regulatory status of PHP's and pesticides with high potential as PHP's in the U.S., by focusing on the large percentage of them that are currently undergoing some form of regulatory review or other scrutiny.

Table E1. Vector Control Chemicals Registered or Exempt from Registration in the U.S.

Active Ingredient (Chemical Class)	CAS RN (EPA PC)	PHP Use Pattern	Registration Status[a] [113]
1-Octen-3-ol (Botanical derivative; clover, alfalfa, etc.)	3391-86-4 (69037)	Attractant for certain species of mosquitoes and biting flies.	B. Reg 1997. (R)- isomer registered 2007. Fact Sheet 7/5/07. [114]
2-Phenethyl Propionate = 2-Phenylethyl Propionate = 2PEP (Botanical; extract of peanut)	122-70-3 (102601)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also registered as a biochemical pesticide vs. adult mosquitoes and other pests.	E, B. 25(b). Also Reg. 1983. Floral Insecticides Group. RR Case 3110 (Phenethyl Propionate, 9/29/10).[115]
Abamectin = Avermectin B1 (Macrocylic lactones)	65195-56-4 (122804)	Insecticide[116] registered vs. fire ants and reputedly vs. mosquitoes and ticks.	B. 2004.
Acetamiprid (Neonicotinoid: Chloronicotinyl)	135410-20-7 (99050)	An uncommon mosquitocide, but occassionally registered with bifenthrin for structural pest control of many insects, including mosquitoes.	C. Conditional Registration 3/15/02.[117] EPA Reduced Risk & OP Replacement insecticide
Allethrin Coils (Pyrethroids, ester Type I)	Varied RN's Varied PC Codes	Spatial repellent and toxicant vs. mosquitoes and other biting flies. Coils are no longer registered in the U.S. with solid racemic allethrin, but are formulated from one of several stereoisomeric mixtures (PC Codes 4003, 4004, 4005, and 4007).	C. Solid allethrin (PC 4002) registration cancelled in 1991. Coils are registered under other allethrin mixtures. RR initiated 3/31/10.
Amitraz (Formamidine)	33089-61-1 (106201)	Insecticide & acaricide registered vs. ticks. Used in flea and tick collars for pets, and for use vs. ectoparasites on farm animals.	C. RED 1995. RR initiated 3/31/10.
Ammonium Bicarbonate (Inorganic salt)	1066-33-7 (73401)	Insect attractant, registered as a mosquito lure in mixture with lactic acid	B. Reg. 2004[118]; Chem 1958 (?)
Atrazine (Triazine)	1912-24-9 (80803)	Widely used herbicide; also acaricide reputedly registered for use vs. ticks (PANNA).[119]	C. RED 2006. Updated Fact Sheet 9/2011. Petition in evaluation requesting ban on all uses.
Azadirachtin = Azadirachtin A (Botanical extract; Neem = *Azadirachta indica*)	11141-17-6 (121701)	Insecticide, IGR, and repellent with multiple modes of action. Registered vs. ticks.	B. 1994. Azadirachtin and Neem Oil Group: Fact Sheet 2001. [120] RR initiated 9/24/08.
Bacillus thuringiensis subsp. israelensis = Bti = Bti serotype H-14 (Microbial; bacterial extracts)	68038-71-1 (6401)	Mosquito larvicide.	M. Reg 1990.[121] RR initiated 9/30/11.
Bti strain AM65-52 (Microbial; bacterial extracts)	68038-71-1 (69162)	Mosquito larvicide.	M. Reg ca. 1990.[122] This is the WHO-recognized reference strain. RR.
Bti strain BMP 144 (Microbial; bacterial extracts)	68038-71-1 (6520)	Mosquito larvicide.	M. Reg 2005.[123] Registered as "solids, spores and insecticidal toxins." RR.

[a] B = Biopesticide; C = EPA Conventional Chemical; Micro = Microbial; P = Pending ; Reg. = first registration; RED = Reregistration Eligibility Decision; RR = Registration Review. Intellectual property (patent, etc.) data is provided here for a limited subset of materials, but will be more comprehensive in future editions).

Active Ingredient (Chemical Class)	CAS RN (EPA PC)	PHP Use Pattern	Registration Status[a] [113]
Bti strain EG2215 (Microbial; bacterial extracts)	68038-71-1 (6476)	Technical Material for fabricating larvicides.	M. Reg 1998.[124] RR initiated 9/30/11.
Bti strain SA3A (Microbial; bacterial extracts)	68038-71-1 (69210)	Mosquito larvicide.	M. Reg 2006. RR initiated 9/30/11.
Beauveria bassiana (Fungus)	63428-82-0 Various PC Codes	Entomopathogenic fungus potentially useful vs. mosquitoes, ticks, sand flies, and bed bugs, but not apparently registered as a PHP.	B. Five strains (ESC 170, GHA, ATCC 74040, 447, HF23) registered by EPA as biopesticides. RR initiated 9/29/10.
Beta-Cyfluthrin (Pyrethroid, Ester Type II)	68359-37-5 (118831)	Insecticide registered vs. mosquitoes (adults), ticks, and bed bugs for PCO and homeowner use. Contains the two most active cyfluthrin isomers. Sometimes coformulated with Imidacloprid.	C. Reg 1995. RR initiated 9/22/10.
Bifenthrin (Pyrethroid, Ester Type I)	82657-04-3 (128825)	Adulticide with registration vs. mosquitoes, ticks, bed bugs, and sand flies.	C. Reg 1989. RR Initiated 6/23/10.
Bioallethrin = d-trans-Allethrin (Pyrethroid, Ester Type I)	260359-57-7 (4003)	Mixture of stereoisomers of Allethrin. Adulticide & Spatial Repellent (Coils), with registration vs. mosquitoes, ticks, and bed bugs.	C. Revised RED May 2009. RR initiated 3/31/10.
Boric Acid (Inorganic)	10043-35-3, 11113-50-1 (11001)	Insecticide & acaricide registered vs. ticks & bed bugs.	C. RR initiated 6/24/09.
Butoxy Polypropylene Glycol = BPG (Polyalkyloxy Compound)	9003-13-8 (11901)	Insect and tick repellent applied to pets, horses, and their housing areas	C. Reg ca. 1960.[125] 20 active registrations (NPIRS 3/14/12).
Carbaryl (Carbamate, n-methyl)	63-25-2 (56801)	Adulticide registered vs. mosquitoes on turf or shrubbery, and vs. ticks, and bed bugs.	C. Reg. 1959? RED 8/1/08. Pet uses cancelled 12/16/09. RR initiated 9/22/10.
Carbon Dioxide (Natural product)	124-38-9 (16601)	Carbon Dioxide is registered as a fumigant and propellant/inert. As a PHP, it is used as an attractant for mosquitoes and other insects.	C. Reg 1948. RED 1991. RR initiated 3/26/08 & now closed. ESA review initiated 5/26/10.
Castor Oil (Botanical oil; *Ricinus communis*)	8001-79-4 (31608)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also registered biochemical pesticide, but apparently not for vectors specifically.	E, B. 25(b)Reg 1994. RR Plant Oils Group, initiated 3/29/10.
Cedarwood Oil (Botanical oil, *Juniperus virginiana*, etc.)	8000-27-9 (40505)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also registered insect repellent for topical use or for repelling flies and gnats from horses.	E, B. 25(b) RED 1993.[126] RR Completed 3/15/11 for repellent products.
Chlorfenapyr (Pyrazole)	122453-73-0 (129093)	Insecticide with registrations vs. bed bugs (and reportedly vs. mosquitoes[127]).	C. Reg 2001. No outdoor uses now registered. RR initiated 6/23/10.
Chloropicrin	76-06-2 (81501)	Fumigant registered vs. bed bugs.	C. Fact Sheet 7/10/08.[128] RED (Amended 5/27/09.[129] Managed in Soil Fumigants Group.[130]
Chlorpyrifos (OP)	2912-88-2 (59101)	Adulticide registered vs. mosquitoes and ticks. Also effective as a larvicide[131], but not often labeled for this use.	C. RED 7/1/06. RR initiated 3/18/09. EPA evaluating petition to cancel all registrations for this material.
Cinnamon & Cinnamon Oil (Botanical	8015-91-6	25(b) status allows use of the oil (and the entire plant if feasible) as a	E, B. Cinnamon and Cinnamon Oil

Active Ingredient (Chemical Class)	CAS RN (EPA PC)	PHP Use Pattern	Registration Status[a] [113]
extracts; *Cinnamomum zeylanicum*)	(129066)	larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Cinnamon is also a registered biochemical pesticide, but apparently not for vectors specifically.	are 25(b) materials; 25(b) Cinnamon is also a registered biopesticide.
Citric Acid (Botanical extract; many sources)	77-92-9 (21801)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also registered as an antimicrobial, with no specific vector control registrations.	E, B. 25(b)RED 1992. RR Final Decision 11/20/2009.
Citronella and Citronella Oil (Botanical; *Cymbopogon winterianus or C. nardus*)	8000-29-1 (21901)	25(b) status allows use of the oil (and the entire plant if feasible) as a larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also registered as a biopesticide vs. mosquitoes (spatial repellent). Citronella oil consists primarily of citronellal (32-45%), geraniol (11-13%), geranyl acetate (3-8%), and limonene (1-4%), which all have insecticidal and repellent attributes.	E, B. 25(b) RR in Plant Oils Group, initiated 3/29/10.
Cloves and Clove Oil (Botanical oil; *Syzygium aromaticum*)	8000-34-8 (220700 oil; 128895 cloves)	25(b) status allows use of cloves or clove oil as larvicide, adulticide, or repellent vs. vectors. Clove oil and crushed cloves are also registered biopesticides, but not specifically vs. vectors.	E, B. 25(b) Clove oil and crushed cloves are also registered biopesticides.
Corn Gluten Meal (Botanical extract; *Zea mays ssp. mays*)	66071-96-3 (100137)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also a registered biopesticide (herbicide), but not vs. vectors.[132]	E, B. 25(b). BRAD 3/4/03[133]
Corn Oil (Botanical oil; *Zea mays ssp. mays*)	8001-30-7 (none)	25(b) status allows use as mosquito repellent applied to skin, clothing, or animals. PHP efficacy unclear, but cited as one of the more effective substrates for botanical repellents.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Cottonseed Oil (Botanical oil; *Gossypium* spp.)	8001-29-4 (31602)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also a registered biopesticide, but not vs. vectors. PHP efficacy unclear, but cited as one of the more effective substrates for botanical repellents.	E, B. 25(b) Also registered biopesticide; Reg ca. 1982.
Coumaphos (OP)	56-72-4 (36501)	Insecticide & acaricide registered vs. ticks	C. RED 7/1/06.[134] RR initiated 6/25/08.
Cyfluthrin (Pyrethroid, Ester Type II)	68359-37-5 (128831)	Adulticide registered for PCO and homeowner use vs. mosquitoes, ticks, and bed bugs. Often coformulated with pyrethrins and PBO or imidacloprid.	C. Reg. 1989. RR initiated 9/22/10.
Cypermethrin (Pyrethroid, Ester Type II)	52315-07-8 (109702)	Insecticide registered in U.S. vs. mosquitoes, ticks, and bed bugs. Cypermethrin and zeta-Cypermethrin are registered in the U.S. and registration for Alpha-cypermethrin is pending.	C. Reg. 1984.[135] Revised RED 1/14/08.
Cyphenothrin (Pyrethroid, Ester Type II)	39515-40-7 (129013)	Adulticide registered vs. mosquitoes, ticks, and bed bugs	C. RR initiated 12/16/09.
d-Allethrin = Pynamin Forte (Pyrethroid, Ester Type I)	584-79-2, 231937-89-6 (4005)	Adulticide & Spatial Repellent (Coils), with registration vs. mosquitoes, ticks, and bed bugs	C. RED (Amended) 5/27/09. RR initiated 3/31/10.
DDVP = Dichlorvos (OP)	62-73-7 (84001)	Adulticide & Spatial Repellent (Treated strips) registered vs. mosquitoes, ticks, and bed bugs	C. RED 7/31/06. RR initiated 6/24/09.
DEET = N,N-Diethyl-meta-toluamide	134-62-3	Topical repellent registered vs. mosquitoes, ticks, sand flies, no-see-ums,	No patent. C. RED 4/1/98. Fact

Active Ingredient (Chemical Class)	CAS RN (EPA PC)	PHP Use Pattern	Registration Status[a] [113]
	(80301)	other flies, etc.	Sheet 4/1/98[136]
Deltamethrin (Pyrethroid, Ester Type II)	52918-63-5 (97805)	Adulticide registered vs. mosquitoes, ticks, and bed bugs, but with limited use patterns approved.	C. RR initiated 3/31/10.
Diazinon (OP)	333-41-5 (57801)	Insecticide and acaricide, now registered vs. ticks	Some active (e.g. ticks); mosquitoes cancelled
Diflubenzuron (Benzoylurea)	35367-38-5 (108201)	IGR – Larvicide (e.g. Dimilin).	C. Fact Sheet 8/1/97.[137] RED 6/1/07.
Dihydro-5-heptyl-2(3H)-furanone = Gamma-Undeccalactone (Furanone)	104-67-6 (122302)	Larvicide + Repellent (mostly as treated cloths)	C. RED 6/10/96[138]
Dihydro-5-pentyl-2(3H)-furanone = Gamma-Nonalactone (Furanone)	104-61-0 (122301)	Larvicide + Repellent (mostly as treated cloths)	C. RED 6/10/96
Dinotefuran (Neonicotinoid, Guanidine)	165252-70-0 (44312)	Broad spectrum insecticide in products labeled against multiple pests including mosquitoes, ticks, bed bugs, and sand flies.	C. 2004 Fact Sheet 9/1/04.[139] RR initiated 12/21/11.
Di-n-propyl Isocinchomeronate = MGK® Repellent 326	136-45-8 (47201)	Topical repellent and repels insects and ticks from dogs, cats, horses, and their bedding; typically coformulated with DEET & MGK® 264.	C. RED 9/23/03[140]
D-Limonene (Botanical derivative, extract of orange & other citrus oils)	5989-27-5 (79701)	Registered for use as a mosquito larvicide, insecticide spray, topical repellent vs. mosquitoes and ticks, and fly repellent tablecloth.	B. RED (Limonene) 1994. TRED (D-Limonene) 2005.[141] RR initated 9/22/10.
d-Phenothrin = Sumithrin / Phenothrin (Pyrethroid, Ester Type I)	188023-86-1 (69005)	Adulticide used in area-wide spray programs, sometimes coformulated with Prallethrin. Historic registrations vs. ticks and bed bugs, but status of these pests on labels is unclear.	C. EPA has used the names Phenothrin, D-Phenothrin, and Sumithrin as synonyms. Reg 1976. RED 9/25/08.[142] RR initiated 12/21/11.
Dried Blood (Animal byproduct)	68911-49-9, 90989-74-5 (611)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Dried blood was also a biopesticide (mammal repellent), but not vs. vectors.	E, BC. 25(b)Was a biopesticide under RR, but final products cancelled 2007.[143]
Egg Solids = Putrescent Whole Egg Solids (Natural product)	No CAS RN (105101)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also registered biopesticide but not vs. vectors	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Esbiothrin = S-Biothrin (Pyrethroid, Ester Type I)	584-79-2, 260359-57-5 (4007)	Mixture of stereoisomers of Allethrin.	C. Revised RED May 2009. RR initiated 3/31/10.
Esfenvalerate = S-Fenvalerate (Pyrethroid, Ester)	66230-04-4 (109303)	Adulticide registered vs. mosquitoes, ticks, and bed bugs	C. RR initiated 12/16/09.
Etofenprox = Ethofenprox (Pyrethroid, Ether)	80844-07-1 (128965)	Insecticide and acaricide registered vs. adult mosquitoes and ticks.	C. RR initiated 8/29/07; Amended Final Work Plan 12/6/11.
Eucalyptus Oil (Botanical oil, extract of Eucalyptus spp.)	8000-48-4 (40503)	Repels mosquitoes, ticks, and fleas from humans and clothing, dogs and cats, and homes	B. Reg 1948, RED 1993. RR (Plant Oils Group) initiated 3/29/10.
Eugenol (Botanical extract; from clove oil etc.)	97-53-0 (102701)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also registered biochemical pesticide, but	E, B. 25(b)Reg 1983. Floral Insecticides Group. RR in Plant Oils

Active Ingredient (Chemical Class)	CAS RN (EPA PC)	PHP Use Pattern	Registration Status[a] [113]
		apparently not for vectors specifically.	Group, initiated 3/29/10.
Fipronil (Pyrazole, phenylpyrazoles)	120068-37-3 (129121)	Insecticide & acaricide registered vs. ticks.	C. RR initiated 12/27/11.
Gamma-Cyhalothrin (Pyrethroid, Ester Type II)	76703-62-3 (128807)	Adulticide registered vs. mosquitoes, ticks, and bed bugs. One of the two stereoisomers that constitutes lambda-cyhalothrin.	C. RR initiated 12/22/10.
Garlic Oil (Botanical oil, extract of *Allium sativum*)	8000-78-0 (128827)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also registered biochemical pesticide, but apparently not for vectors specifically.	E, B. 25(b) RED (Garlic) 6/1/92.[144] RR Final Decision (Garlic Oil) 9/29/10.[145]
Geraniol (Botanical extract, from multiple sources)	106-24-1 (597501)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also a registered biochemical pesticide, but apparently not for vectors specifically.	E, B. 25(b)RR in Plant Oils Group, initiated 3/29/10.
Geranium Oil (Botanical oil, *Pelargonium graveolens*)	8000-46-2 (597500)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also a registered biochemical pesticide, but apparently not for vectors specifically.	E, B. 25(b)Active PC Code, but no active registrations now (NPIRS 3/14/12).
Imidacloprid (Neonicotinoid)	105827-78-9 (129099)	Insecticide registered vs. mosquitoes (e.g. Temprid SC, Bayer Environmental Science, EPA Reg. 432-1483), ticks, bed bugs, and sand flies.	C. RR initiated 12/17/08; Amended Final Work Plan 9/22/10.
Imiprothrin (Pyrethroid)	72963-72-5 (4006)	Insecticide registered vs. mosquitoes, ticks, and ed bugs. Used in common household products.	C. Fact Sheet 3/1/98.[146] RR initiated 9/31/11.
IR3535 = Ethyl Butylacetylaminopropionate	52304-36-6 (113509)	Topical repellent, registered vs. mosquitoes, ticks, and sand flies	C. Fact Sheet 1/1/2000[147]
Isopropyl Alcohol (Aliphatic Alcohol)	67-63-0 (47501)	Insecticide, acaricide, microbicide, and solvent registered vs. ticks & bed bugs	C. RED (Aliphatic Alcohols) Case 4003 = 1995, Case 4004 = 3/1/07.[148]
Lactic Acid	50-21-5 (128929)	Racemic Lactic Acid is an approved inert ingredient; L-Lactic acid is a registered insecticide	B. Reg 1988. RR Case 6062 (L-Lactic Acid) Complete = BRAD 6/30/09.
Lagenidium giganteum (Fungus)	No CAS RN (129084)	Entomopathogenic (larvicidal) fungus, registered but not successfully commercialized to date.	B. RR initiated 3/30/11.
Lambda-Cyhalothrin (Pyrethroid, Ester Type II)	91465-08-6 (128897)	Adulticide registered vs. mosquitoes, ticks, and bed bugs.	C. RR initiated 12/22/10.
Larvicidal Oil = Mineral Oil (Mineral oil, light, aliphatic)	8012-95-1, 68920-06-9 (63503)	Mineral oils are registered as a surface film larvicide & pupacide. Mineral oils previously registered vs. bed bugs but this use is canceled.	C. Registered as "Aliphatic Solvents." RED 11/29/07.[149]
Lauryl Sulfate (Botanical derivative)	151-41-7	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
L-Carvone (Botanical, extract of Spearmint = *Mentha spicata*)	6485-40-1 (79500)	Repellent for mosquitoes and biting flies.	B. 2009. Fact sheet 9/2/09.[150]
Lemongrass Oil (Botanical oil, extract of *Cymbopogon citratus*)	72869-82-0 (40502)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also a registered biochemical pesticide, but apparently not for vectors specifically.	E, B. 25(b)Reg. 1962. RR in Plant Oils Group, initiated 3/29/10.
Linalool (Monoterpenoid; Botanical	78-70-6	Spatial repellent, used outdoors in fragrance generators or candles to	B. Floral Insecticides Group. RR Case

Active Ingredient (Chemical Class)	CAS RN (EPA PC)	PHP Use Pattern	Registration Status[a] [113]
derivative, extract of Ceylon cinnamon, sassafras, etc.)	(128838)	repel mosquitoes, and indoors as an area treatment to repel fleas, mites, ticks, etc. Topical repellent applied to dogs and cats vs. mosquitoes and ticks.	6058 completed 9/17/08.[151]
Linseed Oil (Botanical oil; *Linum usitatissimum*)	8001-26-1	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
L-Lactic Acid (Natural product)	79-33-4 (128929)	L-Lactic acid, the biologically active optical isomer of lactic acid, is a biting insect and mosquito attractant registered for use in traps.	B. Reg 1988. RR Case 6062 Complete = BRAD 6/30/09.[152]
Lysinibacillus sphaericus Serotype H5a5b Strain 2362 ATCC 1170 (= *Bacillus sphaericus*, same strain) (Microbial)	143447-72-7 (119801)	Larvicide, applied alone or with Bti. Registered as "bacteria and bacterial extracts"	M. Reg 1991. Fact Sheet 1999.[153]
Malathion (OP)	121-75-5 (57701)	Insecticide and acaricide used in area-wide mosquito spray programs and also registered vs. ticks and bed bugs.	C. RED 7/1/09. RR in process.
Malic Acid (Natural product)	6915-15-7 (none)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Metarhizium anisopliae Strain F52 Spores (Fungal spores)	67892-13-1 (29056)	Registered vs. ticks	B. Fact Sheet 9/1/01.[154] RR initiated 9/30/09.
Methoprene (Synthetic juvenoid)	40596-69-8 (105401)	IGR – Larvicide; also registered vs. ticks	B. Reg. 1975. RED 3/1/91. Fact sheet 6/1/01.[155]
Metofluthrin (Pyrethroid)	240494-70-6 (109709)	Spatial repellent (outdoor use in treated strips or personal disseminator)	C. Reg 9/1/2006[156]
Mint Oil (Botanical oil; *Mentha* spp.)	8006-90-4 (128800)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also biochemical pesticide, but not for vectors specifically.	E, B. 25(b)Active PC Code but no current registrations (NPIRS 3/14/12).
Naled (OP)	300-76-5 (34401)	Adulticide used in area-wide spray programs.	C. RED 7/31/06. RR initiated 3/18/09.
Neem Oil (Botanical oil, *Azadirachta indica*)	8002-65-1 (25006)	Topical Repellent with registration as Clarified Hydrophobic Neem Oil or Cold Pressed Neem Oil vs. mosquitoes and ticks.	B. Azadirachtin and Neem Oil Group: Fact Sheet 2001. Cold Pressed Neem Oil Reg. 9/16/09; Fact Sheet 4/7/10[157]
N-Octyl Bicycloheptene Dicarboximide = MGK® 264 (Dicarboximide)	113-48-4 (57001)	Synergist registered in many products, including some labeled vs. mosquitoes, ticks, bed bugs, etc., but not for area-wide mosquito control.	C. Reg 1940's. RED 2006[158]
Nonanoic Acid = Pelargonic Acid (Fatty Acid)	112-05-0 (217500)	Registered vs. ticks on cattle.	B. 1992. Fact Sheet 4/1/00.[159] RR initiated 6/30/10.
Peppermint Oil (Botanical oil; *Mentha × piperita*)	8006-90-4	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Permethrin (Pyrethroid, Ester Type I)	52645-53-1 (109701)	Adulticide used in area-wide spray programs and insect and tick repellent treatment for fabrics, including nets and clothing.	C. RED (revised) 5/11/09[160]. RR initiated 6/29/11.
Picaridin = Icaridin (Piperidine, cyclic amine)	119515-38-7 (70705)	Topical repellent registered vs. mosquitoes, ticks, and sand flies	C. 2005.[161]
Pine Oil (Botanical oil; *Pinus* spp.)	8002-09-3	Topical repellent, and potential treatment for head lice as pediculicide	B. RED 10/2/06

Active Ingredient (Chemical Class)	CAS RN (EPA PC)	PHP Use Pattern	Registration Status[a] [113]
	(67002)	and ovicide[162]; EPA registered	
Piperonyl Butoxide = PBO	51-03-6 (67501)	Synergist commonly added to pyrethrin and pyrethroid adulticides, registered vs. mosquitoes (including area-wide control), ticks, bed bugs, and sand flies.	C. Reg 1950's. RED 6/14/06.[163] RR initiated 12/22/10.
PMD = p-Menthane-3,8-diol (Botanical derivative, lemon eucalyptus = *Corymbia citriodora*)	42822-86-6 (11550)	Topical repellent registered vs. mosquitoes & ticks	B. 2000. BRAD 5/1/2000.[164]
POE Isooctadecanol = MMF (Polyalkyloxy compound)	52292-17-8 (124601)	Surface film larvicide & pupacide (Agnique)	C. Reg 2/15/84. ReReg. Case 3119 (no RED). RR Case 3119 (Polyethoxylated Aliphatic Alcohols) not yet initiated.[165]
Potassium Laurate (Soap Salt)	10124-65-9 (79021)	Insecticide & acaricide in products labeled against multiple pests including mosquitoes; registration vs. mosquitoes and ticks	Reg starting 1947.[166] RED Soap Salts Group 1992. RR initiated 9/15/08.
Potassium Sorbate	24634-61-5 (none)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Prallethrin (Pyrethroid, Ester, Type I)	23031-36-9 (128722)	Adulticide used in area-wide spray programs, often in conjunction with d-phenothrin. Also spatial repellent, and registered vs. ticks, bed bugs, and sand flies.	C. Reg 1994. No RED. RR Case 7418; Docket not yet issued.
Pyrethrins (Botanical extract of pyrethrum; *Tanacetum cinerariifolium*)	8003-34-7 (69001)	Adulticide used in area-wide spray programs, usually synergized by PBO. Also registered vs. ticks, bed bugs, and sand flies	C. RED 6/07/06.[167] RR initiated 12/21/11.
Pyriproxyfen (IGR – Synthetic Juvenoid)	95737-68-1 (129032)	IGR Larvicide. Used experimentally for area-wide mosquito control. Also registered vs. ticks, bed bugs, and sand flies.	C. RR Summary Document 9/30/11
R-(-)-1-Octen-3-ol (Botanical derivative; clover, alfalfa, etc.)	3687-48-7 (69038)	Attractant / Lure for some mosquitoes and some other biting flies.	B. Reg. 2007. Fact Sheet 7/5/07.
Refined Oil of *Nepeta cataria* = Hydrogenated Catmint Oil (Botanical oil, extract of catnip)	952722-18-8 (4801)	Topical repellent; possible applications as spatial repellent	B. BRAD 8/25/10.[168]
Resmethrin (Pyrethroid, Ester Type I)	10453-86-8 (97801)	Adulticide used in area-wide spray programs, usually synergized by PBO; also registered vs. ticks and bed bugs	C. Reg 12/8/69. RED 6/14/06.[169] Notice posted of cancellation of all remaining products; in review. RR in progress; work plan intended summer 2012.
Rosemary and Rosemary Oil (Botanical; *Rosmarinus officinalis*)	8000-25-7 (597700, oil; 128893, herbs)	25(b) status allows use as larvicide, adulticide, or repellent. Also biochemical pesticides, but not for vectors specifically.	E, B. 25(b)PC numbers assigned to oil and herbs but no products registered.
S-Bioallethrin = Esbiol (Pyrethroid, Ester Type I)	28434-00-6, 28057-48-9 (4004)	Adulticide & Spatial Repellent (Coils), with registration vs. mosquitoes, ticks, and bed bugs. Recommended by WHO for space spraying.	C. Specified by EPA (2009) as >96% of the (S)(1R,3R) allethrin stereoisomer. RR initiated 3/31/10.
Sesame and Sesame Oil (Botanical oil; *Sesamum indicum*)	8008-74-0 (72401 oil, 128970)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also biochemical pesticides, but not for vectors specifically.	E, B.[170] 25(b) Sesame Oil Reg. Ground sesame plants were registered, but cancelled ca 2004.

Active Ingredient (Chemical Class)	CAS RN (EPA PC)	PHP Use Pattern	Registration Status[a] [113]
S-Hydroprene (IGR – Synthetic Juvenoid)	65733-18-8 (128966)	IGR – Adulticide (e.g. ZOECON 9204 FOGGER; EPA 2724-457, verified with NPIRS 4/25/12). Registration vs. mosquitoes, ticks, and bed bugs.	B. Reg 1986. Fact Sheet 2001[171]
Silica Gel (Inorganic)	7631-86-9 (72605)	Insecticide and acaricide (dessicant) in products labeled against ticks and bed bugs and possibly mosquitoes.[172]	C. Reg ca. 1956. Silica and Silicates Group RED 9/1/91.[173] RR initiated 3/26/08.
Silicon Dioxide = Diatomaceous Earth (Inorganic)	63231-67-4 (72602)	Insecticide and acaricide (dessicant) in products labeled against multiple pests including mosquitoes, ticks, and bed bugs	C. Reg ca 1960. Silica and Silicates Group RED 9/1/91. RR initiated 3/26/08.
S-Methoprene (IGR – Synthetic Juvenoid)	65733-16-6 (105402)	Biologically active stereoisomer of racemic Methoprene. IGR – Larvicide; also registered vs. ticks and bedbugs	B. Fact Sheet 6/1/01[174]
Soap Salts = Potassium (K), Sodium (Na), and Ammonium (NH_4) salts of fatty acids (Inorganic)	(79021, K) 79009, Na 31801, NH4)	Insecticide & acaricide in products labeled against multiple pests including mosquitoes, ticks, Africanized honeybees, etc. (eg. M-Pede).	Reg starting 1947. RED Soap Salts Group 1992.[175] RR initiated 9/15/08.
Sodium Chloride (Inorganic)	7647-14-5	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Not a common active ingredient in PHP's, but marketed for this purpose when mixed with other materials.[176]	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Sodium Lauryl Sulfate (Botanical extract, from coconut and palm oils)	151-21-3	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Soybean Oil (Botanical oil, extract of *Glycine max*)	8001-22-7 (31605)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also EPA registered to kill mites and some insects on food and feed, indoor and outdoor sites.	E, B. 25(b)Reg 1959. RED 1993. RR in Plant Oils Group, initiated 3/29/10.
Spinosad (Microbial)	168316-95-8 (110003)	Larvicide.	M. New Material Fact Sheet 7/19/99.[177] RR initiated 9/30/11.
Sulfur (Inorganic)	7704-34-9 (77501)	Registered vs. ticks.	C. RR Initiated 3/26/08. Draft Ecological Risk Assessment released.
Sulfuryl Fluoride (Inorganic)	2699-79-8 (78003)	Fumigant registered vs. ticks & bed bugs	
Tau-Fluvalinate = (2R)-Fluvalinate (Pyrethroid, Ester Type II)	102851-06-9 (109302)	Registered vs. adult mosquitoes and several other insects and mites.	C. Racemic material reg 1988. RED (Tau isomers) 9/1/05.[178] RR initiated 12/22/10.
Temephos (OP)	3383-96-8 (59001)	Mosquito larvicide, available for use only by MAD's and other public vector control entities . RED reported 25,000 – 40,000 lbs used annually. RR shows <500 lbs/yr in CA, but provides no data for other states. Also registered vs. sand flies?	C. Reg 1965. RED 2000. RR initiated 6/25/08. Notice of Cancellation 2/25/11, Final Decision Sept 2011.[179]
Tetramethrin (Pyrethroid, Ester Type I)	7696-12-0 (69003)	Registered vs. mosquitoes, ticks, bed bugs, and sand flies in home-owner and other small scale settings. Some information on potential as mosquitocide, but wide-area mosquito control is not labeled.	C. Revised RED Apr 2010.[180] RR initiated 12/21/11.
Thiamethoxam (Neonicotinoid)	153719-23-4 (60109)	Registered vs. mosquitoes. Some information on potential as mosquitocide.[181] Potential use in attractant toxic sugar baits for mosquitoes and/or sand flies?	C. Reg 1972(?). RR; comments on Work Plan due 2/21/2012.[182]
Thyme and Thyme Oil (Botanical oil;	8007-46-3 oil,	25(b) status allows use of whole plant, plant parts, or plant oil as larvicide,	E, B. 25(b)Thyme Oil Reg 2004. RR

Active Ingredient (Chemical Class)	CAS RN (EPA PC)	PHP Use Pattern	Registration Status[a] [113]
Thymus vulgaris)	84292-51-1 (597800 oil, 128894 herbs)	adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also registered acaricide vs. ticks.	in Plant Oils Group, initiated 3/29/10. Thyme herbs were registered, but cancelled in 2005.
Trichlorfon (OP)	52-68-6 (57901)	Registered vs. ticks	C. RR initiated 3/18/09.
Triethylene Glycol (Glycol)	112-27-6 (83501)	Registered delouser for animals, as well as disinfectant. Adjuvant in many products, including some labeled vs. mosquitoes (e.g. TETRAPERM AS TRA, Valent Biosciences, EPA Reg. 73049-416) and ticks. Bed bugs registrations cancelled.	C. Reg 1947. RED 2003.[183]
Trifluralin (Dinitroaniline)	1582-09-8 (36101)	Reputedly (PANNA) registered by EPA vs. mosquitoes and ticks and some information on potential as mosquitocide.[184]	C. Reg 1992. RED 1996 & TRED 2004.[185]
Undecan-2-one (Botanical derivative, extract of Rue, Tomatoes, etc.)	112-12-9 (44102)	Originally registered as a dog and cat repellent & training aid and an iris borer deterrent; widely publicized in 2002-2003 as natural mosquito repellent (Skeeter Shield), also registered vs. ticks	B?. RED 6/1/95[186]
White Pepper (Botanical extract; *Piper nigrum;* Piperaceae)	8006-82-4	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
(Z)-9-Tricosene = cis-9-Tricosene = Muscalure (synthetic analogue to natural product)	27519-02-4 (103201)	Attractant for many filth and stable flies (Muscalure Fly Attractant)	B. Reg 1975. RED 1994. RR initiated 12/22/10.
Zeta-Cypermethrin (Pyrethroid, Ester Type II)	52315-07-8 (129064)	Insecticide and acaricide registered vs. adult mosquitoes, ticks, bed bugs, etc.	C. Reg. 1972?. Revised RED 1/14/08.

Table E2. Other Pesticides with U.S. Registration vs. Arthropod Vectors

Active Ingredient (Chemical Class)	Identifiers (CAS RN; EPA PC Code)	PHP Use Pattern	Source
2-(2-(p-(diisobutyl) phenoxy) ethoxy) ethyl dimethyl ammonium chloride (Quaternary Ammonium Compound)	121-54-0 (69122)	Microbicide & disinfectant in products labeled against multiple pests including mosquitoes, ticks, and bed bugs	1, 3
Alkyl Dimethyl Benzyl Ammonium Chloride (60%C14, 25%C12, 15%C16) (Quaternary Ammonium Compound)	(69105)	Microbicide & disinfectant in products labeled against multiple pests including ticks and bed bugs	2, 3
Alkyl Dimethyl Benzyl Ammonium Chloride (60%C14, 30%C16, 5%C12, 5%C18) (Quaternary Ammonium Compound)	53516-76-0 (69143)	Microbicide & disinfectant in products labeled against multiple pests including ticks	2
Alkyl Dimethylethyl Benzyl Ammonium Chloride (68%C12, 32%C14) (Quaternary Ammonium Compound)	85409-23-0 (69154)	Microbicide & disinfectant in products labeled against multiple pests including mosquitoes	3
Aluminum Phosphide (Inorganic)	20859-73-8 (66501)	Fumigant in products labeled against multiple pests including mosquitoes	3
Bromine (Inorganic)	(8701)	Fumigant in products labeled against multiple pests including mosquitoes, ticks, and bed bugs	3
Glyphosate, Isopropylamine Salt		Herbicide used in mosquito habitat management.[187]	
Magnesium Phosphide (Inorganic)	12057-74-8 (66504)	Fumigant in products labeled against multiple pests including mosquitoes	3
Methyl Bromide (Inorganic)	74-83-9 (53201)	Broad-spectrum insecticide and fumigant in products labeled against multiple pests including mosquitoes and bed bugs	3
Ortho-Phenylphenol (Phenol)		Microbicide & disinfectant in products labeled against multiple pests including mosquitoes, ticks, and bed bugs	3
Ortho-Phenylphenol, Sodium Salt (Phenol)	132-27-4 (64104)	Microbicide & disinfectant in products labeled against multiple pests including mosquitoes, ticks, and bed bugs	3
Potassium Laurate (Soap Salt)	10124-65-9	Insecticide & acaricide in products labeled against multiple pests including mosquitoes; registration vs. mosquitoes and ticks	
Rotenone and other extracts of Cubé, Derris, etc. (Botanical extracts; roots of *Lonchocarpus utilis*, other *L.* spp., *Derris* spp., and *Tephrosia* spp.)	83-79-4 (Rotenone) (71001, 71003, 71004)	EPA registers rotenone (PC 71003), Derris resins other than rotenone (PC 71001), and Cubé resins other than rotenone (PC 71004) as piscicides (fish poisons). There is extensive literature on the efficacy of these materials as mosquito larvicides and ticks and bed bugs, but all non-piscicide uses were cancelled in 2006.	3, 5[188]
Soap Salts = Potassium (K), Sodium (Na), and Ammonium (NH_4) salts of fatty acids (Inorganic)	(79021, K) 79009, Na 31801, NH4)	Insecticide & acaricide in products labeled against multiple pests including mosquitoes; registration vs. mosquitoes and ticks	2, 3, 5[189]
Tetrachlorvinphos (TCVP), Z-isomer = Gardona (cis-isomer) (OP)	22248-79-9 (83702)	Broad-spectrum insecticide in products labeled against multiple pests including mosquitoes and ticks. Registered with mosquito control on labels.	2, 3, 5[190]

Table E3. Recognized Vector Control Chemicals under Regulatory Review in the U.S. (April 2012)

Active Ingredient (Chemical Class)	EPA PC	Registration Status[a] [191]
2-Hydroxyethyl Octyl Sulfide = MGK® Repellent 874	46301	C. No current registrations. Notice that EPA is not opening an RR docket "because this pesticide is not included in any products actively registered under FIFRA" (6/23/10).[192]
2-Phenethyl Propionate (Botanical)	102601	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. RR Case 3110 (Phenethyl Propionate, 9/29/10); Final Workplan 3/31/11.[193]
Allethrin Coils (Pyrethroids)	Varied	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10); Final Work Plan 8/11/10.[194]
Alpha-Cypermethrin (Pyrethroid)	209600	C. Registration pending (EPA Pers. Comm 2/2012).
Amitraz (Formamidine)	106201	C. RR Case 234 = Docket EPA-HQ-OPP-2009-1015 (3/31/10); Final Work Plan 9/13/10[195]
Atrazine (Triazine)	80803	C. RED 4/6/06; Update Fact Sheet 9/2011.[196] Petition in evaluation requesting ban on all uses.[197]
Azadirachtin A (Botanical)	121701	B. RR Case 6021 = Docket EPA-HQ-OPP-2008-0632 (9/24/08); Final Work Plan 3/17/09.[198]
Bacillus thuringiensis subsp. israelensis = Bti serotype H-14	6401	M. RR Case 247 (*Bacillus thuringiensis*, 9/30/11); Preliminary Work Plan 9/30/11.[199]
Bti strain AM65-52 (Microbial)	69162	M. RR Case 247 (*Bacillus thuringiensis*, 9/30/11); Preliminary Work Plan 9/30/11
Bti strain BMP 144 (Microbial)	6520	M. RR Case 247 (*Bacillus thuringiensis*, 9/30/11); Preliminary Work Plan 9/30/11
Bti strain SA3A (Microbial)	69210	M. RR Case 247 (*Bacillus thuringiensis*, 9/30/11); Preliminary Work Plan 9/30/11
Bti strain EG2215 (Microbial)	6476	M. RR Case 247 (*Bacillus thuringiensis*, 9/30/11); Preliminary Work Plan 9/30/11
Beauveria bassiana (Fungus)	Various[200]	M. RR Case 6057 = Docket EPA-HQ-OPP-2010-0564 (9/29/10); Final Work Plan 9/27/11.[201]
Beta-Cyfluthrin (Pyrethroid)	118831	C. Case 7405 (Cyfluthrins, 9/22/10). Final Work Plan 3/9/11.[202]
Bifenthrin (Pyrethroid)	128825	C. RR Case 7402 = Docket EPA-HQ-OPP-2010-0384 (6/23/10); Final Work Plan 12/27/10.[203]
Bioallethrin = d-trans-Allethrin	4003	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10); Final Work Plan 8/11/10.
Boric Acid (Mineral)	11001	C. RR Case 24 (Boric Acid and Sodium Borate Salts, 6/24/09); Final Work Plan 10/21/09.[204]
Carbaryl (Carbamate)	56801	C. RR Case 80 = Docket EPA-HQ-OPP-2010-0230 (9/22/10); Final Work Plan 2/28/11.[205]
Carbon Dioxide (Natural product)	16601	C. RR Case 4190 (Carbon, Carbon Dioxide, and Sawdust, 3/26/08); Final Work Plan 9/4/08; now closed. Draft Ecological Risk Assessment and Endangered Species Effects Determination 5/26/10.[206]
Castor Oil (Botanical)	031608	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. RR Case 8201 (Vegetable and Flower Oils, 3/29/10).
Cedarwood Oil (Botanical)	40505	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. RR completed 3/15/11.[207]
Chlorfenapyr (Pyrazole)	129093	C. RR Case 7419 = Docket EPA-HQ-OPP-2010-0467 (6/23/10); Final Work Plan 12/8/10[208]
Chlorpyrifos (OP)	59101	C. RR Case 100 = Docket EPA-HQ-OPP-2008-0850 (3/18/09); Final Work Plan 9/25/09.[209] Projected time line: Data submission Apr-Jun 2012; Comments on Ecological Risk Assessment Oct-Dec 2013; Petition (9/12/07) to revoke all tolerances and cancel all registrations; suspensed pending Preliminary Human Health Risk Assessment (7/1/11); FIFRA SAP to meet Apr 2012; comments due 3/27/12.[210]
Cinnamon & Cinnamon Oil (Botanical)	129066	E, B. Cinnamon and Cinnamon Oil are 25(b) materials; EPA is increasing requirements for efficacy data for 25(b) PHP claims. Cinnamon is also a registered biopesticide not facing new regulatory requirements.

[a] B = Biopesticide; C = EPA Conventional Chemical; M = Microbial; P = Pending ; Reg. = first registration; RED = Reregistration Eligibility Decision; RR = Registration Review

Active Ingredient (Chemical Class)	EPA PC	Registration Status[a] [191]
Citric Acid (Botanical)	21801	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. RR completed 11/20/2009.[211]
Citronella and Citronella Oil (Botanical)	21901	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); RR Case 8202 (Flower Oils, 9/30/11).
Cloves & Clove Oil (Botanical)	220700, 128895	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. Clove oil (PC 220700) and crushed cloves (PC 128895) are also registered biopesticides not facing new regulatory requirements.
Corn Gluten Meal (Botanical)	100137	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. Also a registered biopesticide not facing new regulatory requirements at this time.
Corn Oil (Botanical)	none	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Cottonseed Oil (Botanical)	31602	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. Also a registered biopesticide not facing new regulatory requirements at this time.
Coumaphos (OP)	036501	C. Case 0018 = Docket EPA-HQ-OPP-2008-0023 (6-25-08). Final Work Plan 11-25-08[212]
Cyfluthrin (Pyrethroid)	128831	C. Case 7405 (Cyfluthrins, 9/22/10). Final Work Plan 3/9/11.[213]
Cyphenothrin (Pyrethroid)	129013	C. Case 7412 = Docket EPA-HQ-OPP-2009-0842 (12/16/09). Final Work Plan 6/18/10.[214]
d-Allethrin = Pynamin Forte	4005	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10); Work Plan 8/11/10.
DDVP = Dichlorvos (OP)	84001	C. RR Case 310 = Docket EPA-HQ-OPP-2009-0209 (6/24/09). Final Work Plan 12/1/09.[215]
Deltamethrin (Pyrethroid)	97805	C. RR Case 7414 = Docket EPA-HQ-OPP-2009-0637 (3/31/10). Final Work Plan 9/13/10.[216]
Diazinon (OP)	57801	C. RR Case 0238 = Docket EPA-HQ-OPP-2008-0351 (6/25/08). Final Work Plan 11/28/08.[217]
Dihydro-5-heptyl-2(3H)-furanone	122302	C. RR Case 3138 (Tanol Derivs = Furanone, 9/30/11).[218]
Dihydro-5-pentyl-2(3H)-furanone	122301	C. RR Case 3138 (Tanol Derivs = Furanone, 9/30/11).
Dimethoate (OP)	35001	C. All vector control uses have been cancelled. RR Case 0088 = Docket EPA-HQ-OPP-2009-0059 (3/18/09). Final Work Plan 9/22/09.[219] Petition to revoke tolerances under review.[220]
Dinotefuran (Neonicotinoid)	044312	C. RR Docket EPA-HQ-OPP-2011-0920 (12/14/11). Summary Document 12/21/11[221]
D-Limonene (Botanical)	79701	B. RR Case 3083 = Docket EPA-HQ-OPP-2010-0673 (9/22/10); Final Work Plan 1/24/2011.[222]
d-Phenothrin = Sumithrin / Phenothrin (Pyrethroid)	69005	C. RR Case 0426 = Docket EPA-HQ-OPP-2011-0539 (12/21/11); Summary Document 12/19/11[223]
Dried Blood (Animal byproduct)	611	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. Was a biopesticide under RR (Case 4030), but final products cancelled 2007.
Egg Solids = Putrescent Whole Egg Solids (Natural product)	105101	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. RR Case 4079 (Egg Solids) = EPA-HQ-OPP-2010-0726 (9/29/10).[224]
Endosulfan (OC)	79401	C. Cancellation and phase-out of all existing endosulfan uses in the United States by 7/31/16.[225]
Esbiothrin (Pyrethroid)	4007	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10); Work Plan.
Esfenvalerate (Pyrethroid)	109303	C. RR Case 7406 = Docket EPA-HQ-OPP-2009-0301 (12/16/09). Final Work Plan 6/23/10. [226]
Etofenprox =(Pyrethroid)	128965	C. RR Case 7407 = Docket EPA-HQ-OPP-2007-0804 (8/29/07). Amended Final Work Plan 12/16/11.[227]
Eucalyptus Oil (Botanical)	40503	B. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); RR Case 8202 (Flower Oils, 9/30/11).
Eugenol (Botanical)	102701	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); RR Case 8202 (Flower Oils, 9/30/11).
Fipronil (Pyrazole)	129121	C. RR Case 7423 = Docket EPA-HQ-OPP-2011-0448 (6/29/11). Final Work Plan 12/27/11.[228]
Gamma-Cyhalothrin (Pyrethroid)	128807	C. RR Case 7437 = Docket EPA-HQ-OPP-2010-0479 (12/22/10). Final Work Plan 6/14/11.[229]
Garlic & Garlic Oil (Botanical)	128827	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. RR Case 4007 (Garlic Oil) = Docket EPA-HQ-OPP-2009-0113 (3/25/09) has been completed.
Geraniol (Botanical)	597501	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. RR Case 8201 (Vegetable and Flower

Active Ingredient (Chemical Class)	EPA PC	Registration Status[a] [191]
		Oils, 3/29/10); RR Case 8202 (Flower Oils, 9/30/11).
Geranium Oil (Botanical)	597500	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. Also a registered biopesticide not facing new regulatory requirements at this time.
Imidacloprid (Neonicotinoid)	129099	C. RR Case 7605 = Dockets EPA-HQ-OPP-2008-0844 (12/17/08) and EPA-HQ-OPP-2010-0734. Amended Final Work Plan 9/22/10.[230]
Imiprothrin (Pyrethroid)	4006	C. RR Case 7426 = Docket EPA-HQ-OPP-2011-0692 (9/31/11).[231]
Lagenidium giganteum (Fungus)	129084	B. RR Case 6068 = Docket EPA-HQ-OPP-2011-0193 (3/30/11). Final Work Plan 7/7/11.[232]
Lambda-Cyhalothrin (Pyrethroid)	128897	C. RR Case 7408 = Docket EPA-HQ-OPP-2010-0480 (12/22/10). Final Work Plan 6/14/11.[233]
Lauryl Sulfate (Botanical)	none	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Lemongrass Oil (Botanical)	40502	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); RR Case 8202 (Flower Oils, 9/30/11).
Linseed Oil (Botanical)	none	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Malathion (OP)	57701	C. RR Case 248 = Docket EPA-HQ-OPP-2009-0317 (6/24/09); Final Work Plan 12/17/09.[234]
Malic Acid (Natural product)	none	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Metarhizium anisopliae Strain F52 Spores (Fungal spores)	29056	B. RR initiated 9/30/09.[235] Revised Final Work Plan 10/27/10.
Mint Oil (Botanical)	128800	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. Also a registered biopesticide not facing new regulatory requirements at this time.
Naled (OP)	34401	C. RR Case 92 = Docket EPA-HQ-OPP-2009-0053 (3/18/09). Final Work Plan 8/31/09.[236]
N-Octyl Bicycloheptene Dicarboximide = MGK® 264 (Dicarboximide)	113-48-4 (57001)	Synergist registered in many products, including some labeled vs. mosquitoes, ticks, bed bugs, etc., but not for area-wide mosquito control.
Nonanoic Acid = Pelargonic Acid (Fatty Acid)	217500	B. RR Case 6077 (Pelargonic Acid, Salts and Esters) = Docket EPA-HQ-OPP-2010-0424 (6/30/10); Final Work Plan 12/28/10.[237]
Peppermint Oil (Botanical)	none	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Permethrin (Pyrethroid)	109701	C. RR Case 2510 = EPA-HQ-OPP-2011-0039 (6/29/11). Final Work Plan 12/2/11.[238]
Piperonyl Butoxide = PBO	67501	C. RR Case 2525 = EPA-HQ-OPP-2010-0498 (12/22/10). Final Work Plan 5/27/11[239]
POE Isooctadecanol (Agnique MMF)	124601	C. RR Case 3119 (Polyethoxylated Aliphatic Alcohols) not yet initiated.
Potassium Sorbate	none	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Propoxur	47802	C. All mosquito control use patterns have been cancelled. RR Case 2555 = Docket EPA-HQ-OPP-2009-0806 (12/16/09), Final Work Plan 6/17/10.[240]
Pyrethrins (Botanical)	69001	C. RR Case 2580 = Docket EPA-HQ-OPP-2011-0885 (12/21/11). Summary Document 12/13/11.[241]
Pyriproxyfen (Synthetic Juvenoid)	129032	C. RR Case 7424 = Docket EPA-HQ-OPP-2011-0677 (9/30/11). Summary Document 9/30/11[242]
Resmethrin (Pyrethroid)	97801	C. Notice posted of cancellation of all remaining products; in review.[243] RR Case 421 in progress, but no docket posted; work plan intended summer 2012.
Rosemary & Rosemary Oil (Botanical)	597700, oil 128893, herbs	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. Rosemary oil and plants are also registered biopesticides, but are not facing new regulatory requirements at this time.
S-Bioallethrin = Esbiol (Pyrethroid)	4004	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10); Work Plan 8/11/10.
Sesame and Sesame Oil (Botanical)	72401, oil 128970, herbs	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.[244] Sesame oil and plants are also registered biopesticides, but are not facing new regulatory requirements at this time.
Silica Gel (Mineral)	72602	C. RR Case 4081 (Silica and Silicates) = Docket EPA-HQ-OPP-2007-1140 (3/26/08). Final Work Plan.[245]
Silicon Dioxide = Diatomaceous Earth	72605	C. RR Case 4081 (Silica and Silicates) = Docket EPA-HQ-OPP-2007-1140 (3/26/08). Final Work Plan.

Active Ingredient (Chemical Class)	EPA PC	Registration Status[a] [191]
(Mineral)		
Soap Salts	various	C. RR Case 4083 (Soap Salts) = Docket EPA-HQ-OPP-2008-0519 (9/15/08). Final Work Plan 3/5/09.[246]
Sodium Chloride (Inorganic)	none	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Sodium Lauryl Sulfate (Botanical)	none	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Soybean Oil (Botanical)	31605	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); Final Work Plan 9/20/10.
Spinosad (Microbial)	110003	M. RR Case 7421 = Docket EPA-HQ-OPP-2011-0667 (9/30/11); Work Plan not yet released.[247]
Sulfur (Mineral)	77501	C. RR Case 31 = Docket EPA-HQ-OPP-2008-0176 (3/26/08); Draft Ecological Risk Assessment.[248]
Tau-Fluvalinate (Pyrethroid)	109302	C. RR Case 2295 = Docket EPA-HQ-OPP-2010-0915 (12/22/10); Final Work Plan 6/27/11.[249]
Temephos (OP)	59001	C. RR Case 6 = Docket EPA-HQ-OPP-2008-0444 (6/25/08); Work Plan 11/17/08. Notice of Cancellation of all remaining registrations 2/25/11, Final Decision Sept 2011, effective 2015, under appeal.[250]
Tetramethrin (Pyrethroid)	69003	C. RR Case 2660 = Docket EPA-HQ-OPP-2011-0907 (12/15/11); Preliminary Work Plan.[251]
Thiamethoxam (Neonicotinoid)	60109	C. RR Case 7614 = Docket EPA-HQ-OPP-2011-0581 (12/20/11); Preliminary Work Plan.[252]
Thyme and Thyme Oil (Botanical)	597800 oil, 128894	E, B.[253] EPA is increasing requirements for efficacy data for 25(b) PHP claims. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); RR Case 8202 (Flower Oils, 9/30/11).
Tralomethrin (Pyrethroid)	121501	C. RR Case 7400 = Docket EPA-HQ-OPP-2010-0116 (3/31/10). Final Work Plan 9/2010. Notice of Voluntary Cancellation of all remaining technical registrations 11/2010,[254] effective ca. 2012.
Trichlorfon (OP)	57901	C. RR Case 104 = Docket EPA-HQ-OPP-2009-0097 (3/18/09). Final Work Plan 9/16/09.[255]
White Pepper (Botanical)	none	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
(Z)-9-Tricosene = Muscalure	103201	B. RR Case 4112 = EPA-HQ-OPP-2010-0925 (12/22/10). Final Work Plan 6/30/11.[256]

Table E4. High-potential Vector Control Chemicals under U.S. Regulatory Review

Active Ingredient (Chemical Class)	EPA PC	Registration Status
Allyl Isothiocyanate	4901	B. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); RR Case 8202 (Flower Oils, 9/30/11).
Alpha-Ionone	129030	B. RR Case 8202 (Flower Oils) = Docket EPA-HQ-OPP-2011-0628 (9/30/11); Preliminary Work Plan 9/30/11.
Balsam Fir Oil = Fir Needle Oil	129035	B. RR Case 8202 (Flower Oils) = Docket EPA-HQ-OPP-2011-0628 (9/30/11); Preliminary Work Plan 9/30/11.
Bergamot Oil (Botanical)	129029	B. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); RR Case 8202 (Flower Oils, 9/30/11).
Betabaculovirus (= *Granulovirus* = Granulosis virus = GV) (Insect Viruses)	-	M. RR Case 4106 (Nucleopolyhedroviruses and Granuloviruses (Insect Viruses), 9/30/11).[257]
Borax (Mineral Salt)	11102	C. RR Case 24 (Boric Acid and Sodium Borate Salts) = Docket EPA-HQ-OPP-2009-0306 (6/24/09).
Canola Oil (Botanical)	11332	B. RR Case 8201 (Vegetable and Flower Oils) = Docket EPA-HQ-OPP-2009-0904 (3/29/10); Final Work Plan.
Chlorpyrifos-Methyl (OP)	059102	C. RR Case 8011 = Docket EPA-HQ-OPP-2010-0119 (03-31-10). Final work plan 9/29/10.[258]
Cinnamaldehyde (Botanical)	040506	B. RR Case 6032 = Docket EPA-HQ-OPP-2010-0918 (12-22-10). Final work plan 6/30/11.[259]
Indole (Botanical)	25000	B. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); RR Case 8202 (Flower Oils, 9/30/11).
Jojoba Oil (Botanical)	67200	B. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); Final Work Plan.
Lavandin Oil (Botanical)	40500	B. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); RR Case 8202 (Flower Oils, 9/30/11).
Mustard Oil (Botanical)	4901	B. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); RR Case 8202 (Flower Oils, 9/30/11).
Nucleopolyhedroviruses (= Nuclear Polyhedrosis viruses = NPV) (Viruses)	-	M. RR Case 4106 (Nucleopolyhedroviruses and Granuloviruses (Insect Viruses), 9/30/11).
Orange Oil (Botanical)	40517	B. RR Case 8201 (Vegetable and Flower Oils, 3/29/10); RR Case 8202 (Flower Oils, 9/30/11).
Pirimiphos-methyl	108102	C. RR Case 2353 = Docket EPA-HQ-OPP-2009-0056 (3/18/09); Final Work Plan 8/10/09.[260]
Propoxur	47802	C. RR Case 2555 = Docket EPA-HQ-OPP-2009-0806 (12/16/09), Final Work Plan 6/17/10.[261]
Spinetoram	110008, 110009	B. RR Case 7448 = Docket EPA-HQ-OPP-2011-0666 (9/30/11); Work Plan not yet released.[262]
Thymol (Botanical)	80402	B. RR Case 3143 = Docket EPA-HQ-OPP-2010-0002 (3/31/10). Final Work Plan 9/9/10.[263]

Table E5. PHP's registered or previously registered in U.S. but with significant vector control uses cancelled

Active Ingredient (Chemical Class)	Identifiers (CAS RN; EPA PC Code)	Use Pattern	Registration Type	Source[a]
2-Butyl-2-ethyl-1,3-propanediol	115-84-4 (41003)	Fabric-treatment repellent previously registered for use vs. mosquitoes, ticks, fleas, mites/chiggers, and leeches. Major constituent (30%) of insect repellent fabric treatment M-1960 from 1951 to 1980's (AFPMB 2008).[264]	C. Final product registration, EPA 6830-84, cancelled 1989 for failure to pay registration maintenance fees.[265]	1, 2, 3, 6
2-Hydroxyethyl Octyl Sulfide = MGK® Repellent 874	3547-33-9 (46301)	Insecticide & spatial repellent previously sold as MGK® Repellent 874 and registered in over 139 products, including many with mosquitoes on the labels. Many products were yard and patio foggers.	C. Reg. 1962. RED 1995.[266] All products including technical material cancelled by 10/14/08. No RR docket because no active registrations.	1, 3, 5
Alkyl Dimethylethyl Benzyl Ammonium Chloride (50%C12, 30%C14, 17%C16, 3%C18) (Quaternary HN_4 Compound)	8045-21-4 (69111)	Microbicide & disinfectant in products labeled against multiple pests, previously including bed bugs	C. PHP registrations apparently cancelled, but other registrations active.	2
Allethrin (Pyrethroid, Ester, Type I)	584-79-2 (4001, 4002)	Spatial repellent and mosquito adulticide, often used in mosquito coils.	C. 4001 (liquids) cancelled 1992; 4002 (solids) cancelled 1991.[267]	1, 6
Ammonium Fluosilicate	16919-19-0 (75301)	Insecticide previously registered vs. various taxa including bed bugs.	Reg 1982. All registrations cancelled	126
Anethole	104-46-1		C	
Arsenenic Acid	10102-53-1	Insecticide used in mosquito control from around 1920 to at least 1959.[268]	C. All registrations cancelled.	1
Arsenic Acid	7778-39-4	Insecticide used in mosquito control from around 1920 to at least 1959.[269]	C. Some registrations cancelled, but some products still registered (2012).	1
Arsenous Acid	13464-58-9	Insecticide used in mosquito control from around 1920 to at least 1959.[270]	C. All registrations cancelled.	1
Bendiocarb (N-methyl Carbamate)	22781-23-3 (105201)	Insecticide. Currently recommended by WHO for IRS against malaria vectors.	C. All registrations cancelled 12/31/01[271]	1, 3, 7
Benzyl Benzoate (Botanical extract)	120-51-4 (9501)	Historic insecticide & repellent. Now only used as a miticide and antimicrobial. Major constituent (30%) of U.S. military fabric treatment M-1960 from 1951 to 1980's (AFMPB).	C. All mosquito and tick uses cancelled, but other registrations continue.[272]	2, 3
Bioresmethrin (Pyrethroid, ester, Type I)	28434-01-7 (97802)	Insecticide. Set of stereoisomers of resmethrin, registered for a period as an independent A.I., but all registrations were cancelled in the face of new data requirements.	C. All product registrations cancelled.	1, 6
Calcium Arsenate	7778-44-1	Insecticide, used in mosquito control starting in 1920's.	C. All registrations cancelled.	1

[a] 1 = ESP OPP Chemical Search; 2 = PesticideInfo.org; 3 = IR-4 PHP DB; 4 = AlanWood; 5 = EPA Fact Sheet; 6 = NPIRS, 7 = WHOPES, 8 = IR-4 New Product DB

Active Ingredient (Chemical Class)	Identifiers (CAS RN; EPA PC Code)	Use Pattern	Registration Type	Source[a]
	(13501)			
Chlordane (OC)	57-74-9 (58201)	Insecticide	All registrations cancelled	3
Chlorphoxim (OC)	14816-20-7	Insecticide listed by WHO as "Believed to be Obsolete or Discontinued for Use as Pesticides" (WHO 2010, Table 6).	No U.S. registrations; regulatory history unclear.	1, 7
DDT (OC)	50-29-3 (29201)	Insecticide. Widely used in past for many PHP applications, including mosquito larval control and treatment of nets. Currently recommended by WHO for IRS against malaria vectors, and provided by USAID for malaria control.	All registrations cancelled	3, 7
Diazinon (OP)	333-41-5 (57801)	Insecticide and acaricide	Some active (e.g. ticks); mosquitoes cancelled	2, 3
Dibutyl Phthalate = DBP	84-74-2		C. All uses cancelled	
Dicofol (OC)	115-32-2 (10501)	A relative to DDT used since the 1950's and still registered in many countries including the U.S. Unclear if ever specifically registered as PHP. Very poor topical efficacy vs. adult mosquitoes in one study (LD50 vs. *Ae. aegypti* 1/9000 vs. permethrin; Pridgeon et al 2006).	C. PHP registrations previously cancelled. EPA Notice (6/22/11) to cancel all remaining U.S. registrations[273] and therefore not initiate RR.[274]	1, 6, 8
Dieldrin (OC)	60-57-1 (45001)	Insecticide & Metabolite[275]	All registrations cancelled	3
Dimethoate (OP)	60-51-5 (35001)	Insecticide and acaricide with wide range of target insects, including, historically, mosquitoes and other vectors.	C. Reg 1962. All non-agricultural uses cancelled 2000. RED July 2006; Revised RED 10/6/08.[276] RR 3/6/09.[277]	1, 6
Dimethyl Phthalate = DMP	131-11-3 (28002)	Ectoparasiticide and insect repellent. Used on U.S. military uniforms in 1940's, but formulation not stable in water.[278] Potential PHP utility unclear.	C. Cancelled (NPIRS)[279]	1, 2, 3, 6
Dipropylene Glycol (Glycol)	110-98-5 (68604)	Insecticide & Adjuvant	Previously registered for bed bug products, but now cancelled	2, 3
DNOC = 4,6-Dinitro-o-cresol = Phenol, 2-methyl-4,6-dinitro-	534-52-1 (37507)	Uncouples respiration/phosphorylation. Published evidence of efficacy vs. mosquitoes, but operational utility unclear.	C. All U.S. registrations cancelled.	1, 6, 8
Dried Blood (Animal byproduct)	68911-49-9, 90989-74-5 (611)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Dried blood was also a biopesticide (mammal repellent), but not vs. vectors.	E, BC. 25(b)Was a biopesticide under RR, but final products cancelled 2007.	1
Endosulfan (OC)	115-29-7 (79401)	Insecticide with vector control efficacy.	C. RED 2002.[280] Negotiated cancellation and phase out (11/10/10) of all U.S. registrations by 7/1/2016.[281]	1, 5
Ethohexadiol = Ethyl Hexanediol = Rutgers 612	94-96-2 (41001)	Ectoparasiticide and insect repellent. Used as repellent fabric treatment on U.S. military uniforms in 1940's, but superseded by M-1960 in 1951 (AFPMB 2008). PHP utility unclear.	C. Technical chemical (EPA 10352-34; Union Carbide) cancelled 1991.[282]	1, 2, 3, 6
Fenthion (OP)	55-38-9	Mosquitocide. Was used as a space spray in parts of the U.S.,	All U.S. registrations cancelled	3, 7

Active Ingredient (Chemical Class)	Identifiers (CAS RN; EPA PC Code)	Use Pattern	Registration Type	Source[a]
	(53301)	but also for IRS and larval control in malaria control campaigns in Africa.		
Fenoxycarb (carbamate)	72490-01-8	Insecticide/IGR with registrations against mosquitoes, fire ants and a range of other pests[283]	C. All registrations cancelled 9/28/2011[284]	1
Lead Arsenate	3687-31-8	Insecticide used in mosquito control starting in 1920's.	C. All registrations cancelled.	
Lindane = BHC = Gammexane = Gamexane (OC)	58-89-9 (9001)	An organochlorine insecticide widely used historically as a PHP. Used to control triatomines for control Chagas Diseas in Latin America from 1948 to 1982 when pyrethroids were introduced.[285]	RED 2002. Risk Assessment for Lindane and Other HCH Isomers 2006.[286] Product Cancellation Order 12/13/06. RR not initiated because no products.[287]	1, 5[288]
Methoxychlor (OC)	72-43-5 (34001)	Insecticide.	C. All registrations cancelled 2004.[289]	1, 6
N-Butylacetanilide	91-49-6 (401)	Major constituent of U.S. military fabric treatment M-1960 from 1951 to 1980's (AFPMB 2008).	C. Unclear when cancelled. No product registrations shown in NPIRS database and no registration data in EPA ChemicalSearch DB.	1, 3, 6
Paris Green = Copper(II) Acetoarsenite	12002-03-8	Very common mosquitocide from late 1920's until replaced with more selective materials.	C. All registrations cancelled.	1
Phoxim (OP)	14816-18-3 (598800)	Insecticide and acaricide used for veterinary ectoparasites; other PHP use patterns are not clear.	All registrations cancelled in EU 2007[290], and apparently in U.S., but unclear when cancelled. No product registrations shown in NPIRS database and no registration data in EPA ChemicalSearch DB.	1, 3, 6
Pine Tar Oil = Tall Oil = Wood Tar Distillates[46] (*Pinus spp.*)	91995-59-4 (67205)	Broad-spectrum insecticide.	All U.S. registrations cancelled by 199a (NPIRS).	1, 6
Propoxur (N-methyl Carbamate)	114-26-1 (47802)	Insecticide previously registered by adult mosquitoes (e.g. Baygon).[291] Current (April 2012) labels vs. fleas and dog ticks in pet kennels (e.g. SUPER HI-KIL FORMULA ONE, EPA Reg. 4972-30)	Many registrations cancelled but 34 still active (NPIRS April 2012). All mosquito control uses apparently canceled, but some labels not verified.[292]	1, 3, 5, 6, 7
Rotenone and other extracts of Cubé, Derris, etc. (Botanical; roots of *Lonchocarpus utilis*, other *L.* spp. + *Derris* and *Tephrosia* spp.)	83-79-4 (Rotenone) (71001, 71003, 71004)	Mosquito larvicide	All non-piscicide uses cancelled 2006	3, 5[293]
Solvent Naphtha (Petroleum), Light Aromatic[28] (Mineral Oils, Aromatic)	Various RN's (86803)	Surface film larvicide & pupacide	C. All registrations cancelled.	1, 3
Sulfoxide	120-62-7 (57101)	Insecticide & Synergist	Some registrations active	3
Terpineol	8000-41-7	Broad spectrum insecticide and biocide.	All registrations cancelled.	1, 6

Active Ingredient (Chemical Class)	Identifiers (CAS RN; EPA PC Code)	Use Pattern	Registration Type	Source[a]
	(67005)			
Thyme Herbs (Botanical; *Thymus vulgaris*)	8007-46-3 (128894 herbs)	25(b) status allows use of whole plant, plant parts, or plant oil as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also registered acaricide vs. ticks.	E, B. 25(b)Thyme Oil Reg 2004. RR in Plant Oils Group, initiated 3/29/10. Thyme herbs were registered, but cancelled in 2005.	
Tralomethrin (Pyrethroid)	66841-25-6 (121501)	Registered by EPA and some information on potential as mosquitocide	C. Reg 1993. RR initiated 3/31/10; Notice of Voluntary Cancellation of all remaining technical registrations 11/2010, effective ca 2012.	

Part F: Mosquito Control Chemicals in the U.S., by Use Pattern

Registered or Exempt from Registration

Table F3 covers Adult mosquito control including space sprays, barriers, spatial repellents, house-hold use, experimental, and 25(b), but excluding attractants.

Table F1. Mosquitocides in the U.S. – Larvicides and Pupacides

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern & Typical Products	Regulatory Status
2-Phenethyl Propionate (Botanical; extract of peanut)	122-70-3 (102601)	25(b) status allows use as mosquito larvicide, but no evidence of efficacy. Also registered biopesticide, but not for this use.	E, B. 25(b). RR initiated 9/29/10.
Bacillus thuringiensis subsp. israelensis = Bti = Bti serotype H-14 (Microbial)	68038-71-1 (6401)	Mosquito & Black Fly Larvicide (e.g. Mosquito Beater, Mosquito Bits, Bti Granule, Healthy Outdoors)	M. Reg 1990.[294]
Bti strain AM65-52 (Microbial; bacterial extracts)	68038-71-1 (69162)	Larvicide. WHOPES-recommended material for control of mosquito larvae, for general use (125-750 g/ha) and for container breeding (1-5 mg/L).	M. Reg ca. 1990.[295] This is the reference strain for Bti recognized by WHO.
Bti strain BMP 144 (Microbial; bacterial extracts)	68038-71-1 (6520)	Registered as "Bacillus thuringiensis subspecies israelensis Strain BMP 144 solids, spores and insecticidal toxins." Larvicide (e.g. BMP 144, Fourstar, Meridian, Summit, All Pro…)	M. Reg 2005. Registered as "solids, spores and insecticidal toxins."
Bti strain SA3A (Microbial; bacterial extracts)	68038-71-1 (69210)	Mosquito Larvicide (e.g. Teknar)	M. Reg 2006.
Bti strain EG2215 (Microbial; bacterial extracts)	68038-71-1 (6476)	Registered as Technical Material for fabricating larvicides. The original strain isolate for EG2215 is ONR-60A, which is identical to strain HD567 from the H. Dulmage USDA collection.	M. Reg 1998.
Castor Oil (Botanical oil; *Ricinus communis*)	8001-79-4 (31608)	25(b) status allows use as a mosquito larvicide. Also registered biochemical pesticide, but not for this use.	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.
Cedarwood Oil (Botanical oil, *Juniperus virginiana*, etc.)	8000-27-9 (40505)	25(b) status allows use as a mosquito larvicide. Also registered biopesticide, but not for this use.	E, B. 25(b).
Cinnamon & Cinnamon Oil (Botanical extracts; *Cinnamomum zeylanicum*)	8015-91-6 (129066)	25(b) status allows use of the oil (and the entire plant if feasible) as a mosquito larvicide. Cinnamon is also a registered biochemical pesticide, but not for this use.	E, B. 25(b).
Citric Acid (Botanical extract; many sources)	77-92-9 (21801)	25(b) status allows use as a mosquito larvicide, but efficacy has not been demonstrated. Also registered biopesticide, but as an anti-microbial, not as a vector control agent.	E, B. 25(b). RR Final Decision 11/20/2009.
Citronella and Citronella Oil (Botanical; *Cymbopogon winterianus* or *C. nardus*)	8000-29-1 (21901)	25(b) status allows use of the oil (and the entire plant if feasible) as a mosquito larvicide, but efficacy has not been demonstrated.	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.
Cloves and Clove Oil (Botanical oil; *Syzygium aromaticum*)	8000-34-8 (220700, 128895)	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated. Clove oil and crushed cloves are also registered biopesticides, but not for this use.	E, B. 25(b).
Corn Gluten Meal (Botanical extract; *Zea mays ssp. mays*)	66071-96-3 (100137)	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated. Also a registered biopesticide, but not for this use.	E, B. 25(b). BRAD 3/4/03
Corn Oil (Botanical oil; *Zea mays ssp. mays*)	8001-30-7	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Cottonseed Oil (Botanical oil;	8001-29-4	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been	E, B. 25(b) Also registered

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern & Typical Products	Regulatory Status
Gossypium spp.)	(31602)	demonstrated. Also a registered biopesticide, but not for this use.	biopesticide; Reg ca. 1982.
Diflubenzuron (Benzoylurea)	35367-38-5 (108201)	IGR Larvicide (e.g. Dimilin). WHOPES-recommended material for control of mosquito larvae, for general use (25-100 g/ha) and for container breeding (0.02-0.25 mg/L) in particular.	C. Fact Sheet 8/1/97.[296] RED 6/1/07.
Dihydro-5-heptyl-2(3H)-furanone = Gamma-Undeccalactone (Furanone)	104-67-6 (122302)	Registered larvicide, but sold mostly as a repellent in treated cloths	C. RED 6/10/96
Dihydro-5-pentyl-2(3H)-furanone =Gamma-Nonalactone (Furanone)	104-61-0 (122301)	Registered larvicide, but sold mostly as a repellent in treated cloths	C. RED 6/10/96
D-Limonene (Botanical derivative, extract of orange & other citrus oils)	5989-27-5 (79701)	Registered for use as a mosquito larvicide.	B. RED (Limonene) 1994. TRED (D-Limonene) 2005. RR initated 9/22/10.
Dried Blood (Animal byproduct)	68911-49-9, 90989-74-5 (611)	25(b) status allows use as mosquito larvicide. Dried blood was also a biopesticide (mammal repellent), now cancelled, but not vs. vectors.	E, BC. 25(b). Final B products cancelled 2007.
Egg Solids = Putrescent Whole Egg Solids (Natural product)	No CAS RN (105101)	25(b) status allows use as a mosquito larvicide. Also registered as a biopesticide but not for this use.	E, B. 25(b).
Eugenol (Botanical extract; from clove oil etc.)	97-53-0 (102701)	25(b) status allows use as mosquito larvicide, but efficacy or operational utility have not been demonstrated. Also a registered biopesticide, but not for this use.	E, B. 25(b). Reg 1983. Floral Insecticides Group. RR in Plant Oils Group, initiated 3/29/10.
Garlic Oil (Botanical oil, extract of *Allium sativum*)	8000-78-0 (128827)	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated. Also a registered biopesticide, but not for this use.	E, B. 25(b). PHP claims. RED (Garlic) 6/1/92. RR Final (Garlic Oil) 9/29/10.
Geraniol (Botanical extract, from multiple sources)	106-24-1 (597501)	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated. Also a registered biopesticide, but not for this use.	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.
Geranium Oil (Botanical oil, *Pelargonium graveolens*)	8000-46-2 (597500)	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated. Also a registered biopesticide, but not for this use.	E, B. 25(b). Active PC Code, but no registrations.
Lagenidium giganteum (Fungus)	No CAS RN (129084)	Entomopathogenic (larvicidal) fungus, known to reduce mosquito populations, and registered (e.g. Laginex) but not successfully commercialized to date.	B. RR in process; Final Work Plan 7/7/11.
Larvicidal Oil = Mineral Oil	8012-95-1, 68920-06-9 (63503)	Surface film larvicide & pupacide (e.g. Golden Bear = GB, BVI Oil). Mineral oil was previously registered vs. bed bugs but this use has been canceled.	C. Registered as "Aliphatic Solvents." RED 11/29/07.[297]
Lauryl Sulfate (Botanical derivative)	151-41-7	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Lemongrass Oil (Botanical oil, extract of *Cymbopogon citratus*)	72869-82-0 (40502)	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated. Also a registered biopesticide, but not for this use.	E, B. 25(b)1962. RR in Plant Oils Group, initiated 3/29/10.
Linseed Oil (Botanical oil; *Linum usitatissimum*)	8001-26-1	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated.	E. EPA is increasing requirements for efficacy data for 25(b) PHP

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern & Typical Products	Regulatory Status
			claims.
Lysinibacillus sphaericus Serotype H5a5b Strain 2362 ATCC 1170 (= *Bacillus sphaericus*) (Microbial)	143447-72-7 (119801)	Larvicide, applied alone (e.g. VectoLex, Spheratax) or with Bti (VectoMax). Evidence of high-level resistance in some sites.[298]	M. Reg 1991. Fact Sheet 1999.
Malic Acid (Natural product)	6915-15-7	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Methoprene (Synthetic juvenoid)	40596-69-8 (105401)	IGR – Larvicide (e.g. Altoside). Also registered vs. ticks. S-Methoprene is the biologically active enantiomer of methoprene, but the (RS) racemate is also marketed.	B. Reg. 1975. RED 3/1/91. Fact sheet 6/1/01
Mint Oil (Botanical oil; *Mentha* spp.)	8006-90-4 (128800)	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated. Also registered biochemical pesticide, but apparently not for vector control.	E, B. 25(b)Active PC Code but no current registrations (NPIRS 3/14/12).
Peppermint Oil (Botanical oil; *Mentha × piperita*)	8006-90-4	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated.	EPA will soon require efficacy data for PHP use.
POE Isooctadecanol = MMF (Polyalkyloxy compound)	52292-17-8 (124601)	Surface film larvicide & pupacide (e.g. Agnique)	C. Reg 2/15/84. ReReg. Case 3119 (no RED). RR Case 3119 (Polyethoxylated Aliphatic Alcohols) not yet initiated.[299]
Potassium Laurate (Soap Salt)	10124-65-9 (79021)	Insecticide in products labeled against multiple pests including mosquitoes; registration vs. mosquitoes unclear.	Reg starting 1947. RED Soap Salts Group 1992. RR initiated 9/15/08.
Potassium Sorbate	24634-61-5 (none)	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated.	EPA will soon require efficacy data for PHP use.
Pyriproxyfen (IGR – Synthetic Juvenoid)	95737-68-1 (129032)	IGR Larvicide (NyGuard). Used experimentally for area-wide mosquito control via dissemination to larval habitats and autodissemination by flying adult females to larval habitats; also registered vs. ticks, bed bugs, and sand flies. WHOPES-recommended for control of mosquito larvae, for general use (10-50 g/ha) and in containers (0.01 mg/L) in particular.	C. RR Summary Document 9/30/11
Rosemary and Rosemary Oil (Botanical; *Rosmarinus officinalis*)	8000-25-7 (597700; 128893)	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated. Also biochemical pesticides, but not for vectors specifically.	E, B. 25(b)PC numbers assigned to oil and herbs but no products registered.
Sesame and Sesame Oil (Botanical oil; *Sesamum indicum*)	8008-74-0 (72401 oil, 128970)	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated. Also biochemical pesticides, but not for vectors specifically.	E, B. 25(b)Sesame Oil Reg. Ground sesame plants were registered, but cancelled ca 2004.
S-Hydroprene (IGR – Synthetic Juvenoid)	65733-18-8 (128966)	IGR – Larvicide? Registration vs. mosquitoes, ticks, and bed bugs. EPA indicates that this material is used as a PHP.	B. Reg 1986. Fact Sheet 2001
S-Methoprene (IGR – Synthetic Juvenoid)	65733-16-6 (105402)	IGR – Larvicide (e.g. Altosid?); also registered vs. ticks and bedbugs. The biologically active enantiomer of Methoprene.	B. Fact Sheet 6/1/01
Soap Salts = Potassium (K), Sodium (Na), and Ammonium (NH_4) salts of fatty acids	(79021, K) 79009, Na 31801, NH4)	Insecticide & acaricide in products labeled against multiple pests including mosquitoes; registration as larvicide unclear?	Reg starting 1947. RED Soap Salts Group 1992. RR initiated 9/15/08.

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern & Typical Products	Regulatory Status
Sodium Chloride (Inorganic)	7647-14-5	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated.	EPA will soon require efficacy data for PHP use.
Sodium Lauryl Sulfate (Botanical extract, from coconut and palm oils)	151-21-3	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated. Marketed as both a mosquito repellent and larvicide, especially mixed with other constituents such as garlic oil[300]	EPA will soon require efficacy data for PHP use.
Soybean Oil (Botanical oil, extract of *Glycine max*)	8001-22-7 (31605)	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated. Also biopesticide, but not registered for this use.	E, B. 25(b)Reg 1959. RED 1993. RR in Plant Oils Group, initiated 3/29/10.
Spinosad (Microbial)	168316-95-8 (110003)	Larvicide. WHOPES-recommended material for control of mosquito larvae, for general use (20-500 g/ha) and for container breeding (0.1 – 0.5 mg/L).	M. New Material Fact Sheet 7/19/99. RR initiated 9/30/11.
Temephos (OP)	3383-96-8 (59001)	Larvicide; also registered vs. sand flies. WHOPES-recommended material for control of mosquito larvae, for general use (56-112 g/ha) and for container breeding (1 mg/L) in particular. Used for guinea worm eradication campaign and control of Simulium black flies which transmit Onchocerciasis in Africa.[301]	C. Reg 1965. RED 2000. RR initiated 6/25/08. Notice of Cancellation 2/25/11, Final Decision Sept 2011.
Thyme and Thyme Oil (Botanical oil; *Thymus vulgaris*)	8007-46-3 oil, 84292-51-1 (597800 oil, 128894 herbs)	25(b) status allows use as mosquito larvicide, but EPA will soon require efficacy data for PHP use. Also, biopesticide registered vs. ticks, but apparently not vs. mosquitoes.	E, B. 25(b)Thyme Oil Reg 2004. RR initiated 3/29/10 in Plant Oils Group. Thyme herbs cancelled in 2005.
White Pepper (Botanical, *Piper nigrum;* Piperaceae)	8006-82-4	25(b) status allows use as mosquito larvicide, but efficacy or utility have not been demonstrated.	EPA will soon require efficacy data for PHP use.

Table F2. Mosquitocides in the U.S. – Adulticides Registered for Area-wide Spraying

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory Status
Chlorpyrifos (OP)	2912-88-2 (59101)	Insecticide registered for area-wide mosquito spray programs (e.g. Dursban, Mosquitomist, Mosquito Master) and other uses. WHO specifications published for technical material and EC (2009).	C. RED 7/1/06. RR initiated 3/18/09. EPA evaluating petition to cancel all registrations for this material.
d-Phenothrin = Sumithrin / Phenothrin (Pyrethroid, Ester Type I)	188023-86-1 (69005)	Insecticide registered for area-wide mosquito spray programs, usually synergized by PBO (e.g. Anvil, Aqua-Anvil, Sumithrin), and sometimes with Prallethrin (e.g. Duet); and for other uses. WHO specification published for technical material (2004).	C. RED 9/25/08. RR initiated 12/21/11.
Etofenprox = Ethofenprox (Pyrethroid, Ether)	80844-07-1 (128965)	Insecticide registered for area-wide mosquito spray programs (e.g. Zenivex) and other uses. WHO specifications published (2007).	C. RR initiated 8/29/07; Amended Final Work Plan 12/6/11.
Malathion (OP)	121-75-5 (57701)	Insecticide registered for area-wide mosquito spray programs (e.g. Fyfanon) and other uses. Recommended by WHO for ULV space spraying against mosquitoes. WHO specifications published (2004).	C. RED 7/1/09. RR in process.
Naled (OP)	300-76-5 (34401)	Insecticide registered for area-wide mosquito spray programs (e.g. Dibrom, Trumpet) and other uses.	C. RED 7/31/06. RR initiated 3/18/09.
Permethrin (Pyrethroid, Ester Type I)	52645-53-1 (109701)	Insecticide registered for area-wide mosquito spray programs, usually synergized by PBO (e.g. Aqua-Reslin, Biomist, Kontrol, Permanone), and other uses. Recommended by WHO for space spraying against mosquitoes (with S-bioallethrin and PBO). WHO specifications published (2009).	C. RED (revised) 5/11/09. RR initiated 6/29/11.
Prallethrin (Pyrethroid, Ester Type I)	23031-36-9 (128722)	Insecticide registered for area-wide mosquito spray programs, sometimes coformulated with d-phenothrin & PBO (e.g. Duet), and other uses. Evidence of excitation of adult mosquitoes, with consequent increase in the likelihood of exposure to lethal dose of toxicant. WHO specifications published (2004).	C. 1985. EPA OPP ChemicalSearch shows no new regulatory activity.
Pyrethrins (Botanical. Extract of pyrethrum, *Tanacetum cinerariifolium*)	8003-34-7 (69001)	Insecticide registered for area-wide mosquito spray programs, usually synergized by PBO (e.g. Aqua-Hault, Evergreen, Pyrenone, Pyrocide), and other uses. WHO specifications published (2009).	C. RED 6/07/06. RR initiated 12/21/11.
Resmethrin (Pyrethroid, Ester Type I)	10453-86-8 (97801)	Insecticide registered for area-wide mosquito spray programs, usually synergized by PBO (e.g. Scourge). Other uses cancelled.	C. Reg 1969. RED 2006. Notice posted of cancellation of all products; in review. RR in progress; work plan summer 2012.

Table F3. Mosquitocides in the U.S. – Adult control products for all purposes

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	Mode of Action, PHP Use Pattern, & Typical Products	Regulatory
2-Phenethyl Propionate (Botanical; extract of peanut)	122-70-3 (102601)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also registered biochemical pesticide vs. adult mosquitoes and other pests.[302]	E, B. 25(b). Also Reg. 1983. RR initiated 9/29/10.
Acetamiprid (Neonicotinoid: Chloronicotinyl)	135410-20-7 (99050)	An uncommon mosquitocide, but occassionally registered with bifenthrin for structural pest control of many insects, including mosquitoes.	C. Conditional Registration 3/15/02. EPA Reduced Risk & OP Replacement insecticide
Allethrin Coils	Varied RN's Varied PC Codes	Spatial repellent and toxicant vs. mosquitoes and other biting flies. Coils are no longer registered in the U.S. with solid racemic allethrin, but are formulated from one of several stereoisomeric mixtures (PC Codes 4003, 4004, 4005, and 4007).	C. Solid allethrin (PC 4002) registration cancelled in 1991. Coils are registered under other allethrin mixtures. RR Allethrin Stereoisomers Group, 03-31-10).
Bifenthrin (Pyrethroid, Ester Type I)	82657-04-3 (128825)	Adulticide & Spatial Repellent (Barrier). Registration vs. mosquitoes, ticks, bed bugs, and sand flies. Recommended by WHO for IRS against malaria vectors. Good efficacy vs. mosquitoes in toxic attractant sugar baits.[303]	C. Reg 1989. RR Initiated 6/23/10.
Bioallethrin = d-trans-Allethrin (Pyrethroid, Ester)	260359-57-7 (4003)	Adulticide & Spatial Repellent (Coils), with registration vs. mosquitoes, ticks, and bed bugs	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10).
Carbaryl (Carbamate, n-methyl)	63-25-2 (56801)	Adulticide (e.g. SevinSL) registered vs. mosquitoes on turf or shrubbery, ticks, and bed bugs. Moderate topical efficacy reported vs. adult mosquitoes in one study (LD50 vs. *Ae. aegypti* 1/19 vs. permethrin; Pridgeon et al 2006).	C. Reg. 1959? Amended RED 8/1/08. All pet uses cancelled 12/16/09. RR initiated 9/22/10.
Castor Oil (Botanical oil; *Ricinus communis*)	8001-79-4 (31608)	25(b) status allows use as mosquitocide or repellent. Also registered biochemical pesticide, but apparently not for vectors specifically. Promoted as "natural" repellent.	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.
Cedarwood Oil (Botanical oil, *Juniperus virginiana*, etc.)	8000-27-9 (40505)	25(b) status allows use as an mosquitocide or spatial repellent. Also registered insect repellent for topical use or for repelling flies and gnats from horses.	E, B. 25(b). RR completed for topical and animal-applied repellents.
Chlorpyrifos (OP)	2912-88-2 (59101)	Adulticide registered vs. mosquitoes and ticks, registered for area-wide spraying.	C. RED 7/1/06. RR initiated 3/18/09. EPA evaluating petition to cancel all registrations for this material.
Cinnamon & Cinnamon Oil (Botanical extracts; *Cinnamomum zeylanicum*)	8015-91-6 (129066)	25(b) status allows use of the oil (and the entire plant if feasible) as a mosquito adulticide or repellent. Cinnamon is also a registered biochemical pesticide, but apparently not for vectors specifically.	E, B. 25(b).
Citric Acid (Botanical extract; many sources)	77-92-9 (21801)	25(b) status allows use as a mosquito adulticide or repellent. Efficacy or utility have not been demonstrated. Also registered biopesticide, but as an anti-microbial, not for vector control.	E, B. 25(b). RR Final Decision 11/20/2009.
Citronella and Citronella Oil (Botanical; *Cymbopogon winterianus* or *C. nardus*)	8000-29-1 (21901)	25(b) status allows use of the oil (and the entire plant if feasible) as a mosquitocide or repellent. Also registered as a biopesticide vs. mosquitoes (spatial repellent).	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	Mode of Action, PHP Use Pattern, & Typical Products	Regulatory
Cloves and Clove Oil (Botanical oil; *Syzygium aromaticum*)	8000-34-8 (220700, 128895)	25(b) status allows use as mosquitocide or repellent, but efficacy or utility have not been demonstrated.	E, B. 25(b).
Corn Gluten Meal (Botanical extract; *Zea mays ssp. mays*)	66071-96-3 (100137)	25(b) status allows use as mosquitocide or repellent, but efficacy or utility have not been demonstrated.	E, B. 25(b)BRAD 3/4/03
Corn Oil (Botanical oil; *Zea mays ssp. mays*)	8001-30-7	25(b) status allows use as mosquitocide or repellent, but efficacy or utility have not been demonstrated.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Cottonseed Oil (Botanical oil; *Gossypium* spp.)	8001-29-4 (31602)	25(b) status allows use as mosquitocide or repellent, but efficacy or utility have not been demonstrated.	E, B. 25(b) Also registered biopesticide; Reg ca. 1982.
Cyfluthrin (Pyrethroid, Ester Type II)	68359-37-5 (128831)	Adulticide (e.g. CyKick, Intruder) registered for PCO and homeowner use vs. mosquitoes, ticks, and bed bugs; often formulated together with pyrethrins and PBO (e.g.) or imidacloprid. Long photo-stability/residual action. Recommended by WHO for IRS against malaria vectors.	C. Reg. 1989. RR initiated 9/22/10.
Cyphenothrin (Pyrethroid, Ester Type II)	39515-40-7 (129013)	Adulticide registered vs. mosquitoes, ticks, and bed bugs	C. RR initiated 12/16/09.
d-Allethrin = Pynamin Forte (Pyrethroid, Ester Type I)	584-79-2, 231937-89-6 (4005)	Adulticide & Spatial Repellent (Coils), with registration vs. mosquitoes, ticks, and bed bugs	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10).
DDVP = Dichlorvos (OP)	62-73-7 (84001)	Adulticide & Spatial Repellent (Treated strips) registered vs. mosquitoes, ticks, and bed bugs	C. RED 7/31/06. RR initiated 6/24/09.
Deltamethrin (Pyrethroid, Ester Type II)	52918-63-5 (97805)	Adulticide registered vs. mosquitoes, ticks, and bed bugs. Recommended by WHO for space spraying against mosquitoes as ULV or as EW, for IRS against malaria vectors, for ITN's, and in LLIN's.	C. RR initiated 3/31/10.
Dinotefuran (Neonicotinoid, Guanidine)	165252-70-0 (44312)	Broad spectrum insecticide in products labeled against multiple pests including mosquitoes, ticks, bed bugs, and sand flies [304]	C. 2004 Fact Sheet 9/1/04. RR initiated 12/21/11.
D-Limonene (Botanical derivative, extract of orange & other citrus oils)	5989-27-5 (79701)	Registered for use as a mosquito larvicide, insecticidal spray, topical repellent vs. mosquitoes and ticks, and fly repellent tablecloth.	B. RED (Limonene) 1994. TRED (D-Limonene) 2005. RR initated 9/22/10.
d-Phenothrin = Sumithrin (Pyrethroid, Ester Type I)	188023-86-1 (69005)	Adulticide (e.g. Sumithrin) used in area-wide spray programs, sometimes together with Prallethrin (e.g. Duet)	C. RED (d-Phenothrin) 9/25/08. RR initiated 12/21/11.
Dried Blood (Animal byproduct)	68911-49-9, 90989-74-5 (611)	25(b) status allows use as mosquitocide or repellent. Dried blood was also a biopesticide (mammal repellent), but not vs. vectors.	E, BC. 25(b)Was a biopesticide under RR, but final products cancelled 2007.
Egg Solids = Putrescent Whole Egg Solids (Natural product)	No CAS RN (105101)	25(b) status allows use as mosquitocide or repellent, but efficacy has not been shown. Also registered as a biopesticide but not for these uses.	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Esbiothrin = S-Biothrin (Pyrethroid, Ester Type I)	584-79-2, 260359-57-5 (4007)	Mixture of stereoisomers of Allethrin.	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10).
Esfenvalerate (Pyrethroid, Ester)	66230-04-4 (109303)	Adulticide registered vs. mosquitoes, ticks, and bed bugs	C. RR initiated 12/16/09.

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	Mode of Action, PHP Use Pattern, & Typical Products	Regulatory
Etofenprox = Ethofenprox (Pyrethroid, Ether)	80844-07-1 (128965)	Insecticide and acaricide registered vs. mosquitoes and ticks, including for area-wise mosquito spraying. Recommended by WHO as an insecticide for IRS against malaria vectors, and for ITN's for malaria vector control.	C. RR initiated 8/29/07; Amended Final Work Plan 12/6/11.
Eugenol (Botanical extract; from clove oil etc.)	97-53-0 (102701)	Sold as botanical insecticide effective against mosquitoes and other "lawn and landscape pests". Also, topical repellent; registered vs. mosquitoes and bed bugs	EB. 25(b)Reg 1983. Floral Insecticides Group. RR in Plant Oils Group, initiated 3/29/10.
Gamma-Cyhalothrin (Pyrethroid, Ester Type II)	76703-62-3 (128807)	Adulticide registered vs. mosquitoes, ticks, and bed bugs	C. RR initiated 12/22/10.
Geraniol (Botanical extract, from multiple sources)	106-24-1 (597501)	25(b) status allows use as a mosquitocide. Also registered biopesticide but ticks registration unclear	E, B. 25(b)RR in Plant Oils Group, initiated 3/29/10.
Imidacloprid (Neonicotinoid)	105827-78-9 (129059)	Insecticide registered vs. mosquitoes (e.g. Temprid SC, Bayer Environmental Science, EPA Reg. 432-1483), ticks, bed bugs, and sand flies.	C. RR in progress; Final Work Plan 9/22/10.
Imiprothrin (Pyrethroid)	72963-72-5 (4006)	Insecticide registered vs. mosquitoes, ticks, and bed bugs	C. Fact Sheet 3/1/98. RR initiated 9/31/11.
Lambda-Cyhalothrin (Pyrethroid, Ester Type II)	91465-08-6 (128897)	Adulticide registered vs. mosquitoes, ticks, and bed bugs. Recommended by WHO as an insecticide for space spraying against mosquitoes as EC, for IRS against malaria vectors, and for long-lasting treatment of mosquito nets for malaria vectors.	C. RR initiated 12/22/10.
Lauryl Sulfate (Botanical derivative)	151-41-7	25(b) status allows use as mosquitocide.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Linalool (Monoterpenoid; Botanical derivative, extract of Ceylon cinnamon, sassafras, etc.)	78-70-6 (128838)	Botanical extract from many plants with insecticidal and repellent properties. Toxic MOA unclear (does not demonstrate MOA through [3H]-TBOB binding or 36Cl- uptake assays; Tong and Coats 2010). Spatial repellent, used outdoors in electronic fragrance generators or scented candles to repel mosquitoes, and indoors as an area treatment to repel fleas, mites, spiders and ticks. Also for topical application to dogs and cats.	B. Floral Insecticides Group. RR completed 2008.
Malathion (OP)	121-75-5 (57701)	Insecticide and acaricide used in area-wide spray programs and also registered vs. ticks and bed bugs. Recommended by WHO for space spraying against mosquitoes as a ULV liquid, and for IRS against malaria vectors.	C. RED 7/1/09. RR in process
Malic Acid (Natural product)	6915-15-7	25(b) status allows use as mosquitocide, but efficacy or utility have not been demonstrated.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Metofluthrin (Pyrethroid)	240494-70-6 (109709)	Spatial repellent (outdoor use in treated strips or personal disseminator)	C. Reg 9/1/2006
Naled (OP)	300-76-5 (34401)	Adulticide used in area-wide spray programs	C. RED 7/31/06. RR initiated 3/18/09.

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	Mode of Action, PHP Use Pattern, & Typical Products	Regulatory
Permethrin (Pyrethroid, Ester Type I)	52645-53-1 (109701)	Adulticide used in area-wide spray programs, usually synergized by PBO; recommended by WHO for space spraying against mosquitoes, with S-bioallethrin and PBO in emulsion of oil in water. Also insect and tick repellent treatment for fabrics, including nets and clothing; recommended by WHO for ITN's and in LLIN's.	C. RED (revised) 5/11/09. RR initiated 6/29/11.
Prallethrin (Pyrethroid, Ester, Type I)	23031-36-9 (128722)	Adulticide used in area-wide spray programs, often in conjunction with d-phenothrin (e.g. Duet). Evidence of excitation of adult mosquitoes, with consequent increase in likelihood of exposure to lethal dose of toxicant. Also spatial repellent and registered vs. ticks, bed bugs, and sand flies.	C. 1985. EPA OPP ChemicalSearch shows no new regulatory activity.
Pyrethrins (Botanical extract of pyrethrum; *Tanacetum cinerariifolium*)	8003-34-7 (69001)	Adulticide used in area-wide spray programs, usually synergized by PBO. Also registered vs. ticks, bed bugs, and sand flies	C. RED 6/07/06. RR initiated 12/21/11.
Resmethrin (Pyrethroid, Ester Type I)	10453-86-8 (97801)	Adulticide (e.g. Scourge) used in area-wide spray programs, usually synergized by PBO; also registered vs. ticks and bed bugs	C. Reg 1969. RED 2006. Notice posted of cancellation of all remaining products; in review. RR in progress; work plan intended summer 2012.
S-Bioallethrin = Esbiol (Pyrethroid, Ester Type I)	28434-00-6, 28057-48-9 (4004)	Adulticide & Spatial Repellent (Coils), with registration vs. mosquitoes, ticks, and bed bugs	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10).
Sesame and Sesame Oil (Botanical oil; *Sesamum indicum*)	8008-74-0 (72401 oil, 128970)	Sesame oil sold as botanical insecticide effective against mosquitoes and other "lawn and landscape pests".[305]	E, B. 25(b)Sesame Oil Reg. Ground sesame plants were registered, but cancelled ca 2004.
Sodium Chloride (Inorganic)	7647-14-5	25(b) status allows use as mosquitocide and repellent, but efficacy unclear.	E. 25(b)
Sodium Lauryl Sulfate (Botanical extract, from coconut and palm oils)	151-21-3	25(b) status allows use as mosquitocide and repellent, but efficacy unclear. Sold as botanical insecticide effective against mosquitoes and other "lawn and landscape pests."	E. 25(b)
Tau-Fluvalinate = (2R)-Fluvalinate (Pyrethroid, II)	102851-06-9 (109302)	Registered vs. mosquitoes and ticks and some information on potential as mosquitocide	C. Racemic material reg 1988. RED (Tau isomers) 9/1/05. RR initiated 12/22/10.
Tetramethrin (Pyrethroid, Ester Type I)	7696-12-0 (69003)	Registered by EPA vs. mosquitoes, ticks, bed bugs, and sand flies, and some information on potential as mosquitocide	C. Revised RED Apr 2010.[306] RR initiated 12/21/11.
Thiamethoxam (Neonicotinoid)	153719-23-4 (60109)	Registered by EPA and some information on potential as mosquitocide	
Thyme and Thyme Oil (Botanical oil; *Thymus vulgaris*)	8007-46-3 oil, 84292-51-1 (597800 oil, 128894 herbs)	25(b) status allows use as mosquito adulticide or repellent, but EPA will soon require efficacy data for these PHP uses. Also registered acaricide vs. ticks.	E, B. 25(b)Thyme Oil Reg 2004. RR in Plant Oils Group, initiated 3/29/10. Thyme herbs were registered, but cancelled in 2005.
Trifluralin (Dinitroaniline)	1582-09-8 (36101)	Registered by EPA vs. mosquitoes and ticks and some information on potential as mosquitocide	C. Reg 1992. TRED 2004.
Zeta-Cypermethrin	52315-07-8	Adulticide registered vs. mosquitoes, ticks, and bed bugs	C. Reg. 1972?. Revised RED 1/14/08.

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	Mode of Action, PHP Use Pattern, & Typical Products	Regulatory
(Pyrethroid, Ester Type II)	(129064)		

Table F4. Mosquitocides in the U.S. – Topical Repellents and Fabric Treatments

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory Status
2-Phenethyl Propionate (Botanical; extract of peanut)	122-70-3 (102601)	25(b) status allows use as mosquito repellent on skin, animals, or fabric. Sold as a "natural" repellent vs. mosquitoes, gnats, biting flies, and no-see-ums for skin or clothing application.[307] Also registered as a biopesticide, but not for this use.	E, B. 25(b). RR initiated 9/29/10.
Castor Oil (Botanical oil; *Ricinus communis*)	8001-79-4 (31608)	25(b) status allows use as mosquito repellent on skin, animals, or fabrics. Also registered biochemical pesticide, but apparently not for vectors specifically. Sold as "natural" repellent.[308]	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.
Cedarwood Oil (Botanical oil, *Juniperus virginiana*, etc.)	8000-27-9 (40505)	25(b) status allows use as mosquito repellent on skin, animals, or fabrics. Also registered insect repellent for topical use or for repelling flies and gnats from horses and previously used as repellent in pet collars. Used as active ingredient in "natural" insect repellents[309], but evidence for repelling mosquitoes (Ae. & An.) is mixed,[310] presumably because of variations in chemical content and processing.	E, B. 25(b). RR completed 3/15/11 for topical and animal-applied insect repellents.
Cinnamon & Cinnamon Oil (Botanical extracts; *Cinnamomum zeylanicum*)	8015-91-6 (129066)	25(b) status allows use of the oil (and the entire plant if feasible) as a mosquito repellent on skin, animals, or fabrics. Cinnamon is also a registered biochemical pesticide, but apparently not for vectors specifically.	E, B. 25(b).
Citric Acid (Botanical extract; many sources)	77-92-9 (21801)	25(b) status allows use as a mosquito repellent on skin, animals, or fabrics. Efficacy or utility have not been demonstrated. Also registered biopesticide, but as an anti-microbial, not as a vector control agent.	E, B. 25(b). RR Final Decision 11/20/2009.[311]
Citronella and Citronella Oil (Botanical; *Cymbopogon winterianus* or *C. nardus*)	8000-29-1 (21901)	25(b) status allows use of the oil (and the entire plant if feasible) as a topical & spatial repellent. Good evidence of efficacy. Used as active ingredient in "natural" insect repellents[312] and in spatial repellent candles.	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.
Cloves and Clove Oil (Botanical oil; *Syzygium aromaticum*)	8000-34-8 (220700, 128895)	25(b) status allows use as mosquito repellent on skin, animals, or fabrics, but EPA will soon require efficacy data for this PHP use. Incorporated as active ingredient in "natural" insect repellents.[313] Significant published evidence of high repellency for many mosquito species with a variety of assays[314], although the source of oil (bud vs. leaf) has significant impact (Shin-Ho et al 2009).	E, B. 25(b).
Corn Gluten Meal (Botanical extract; *Zea mays ssp. mays*)	66071-96-3 (100137)	25(b) status allows use as mosquito repellent applied to skin, clothing, or animals, but efficacy or utility have not been demonstrated.	E, B. 25(b)BRAD 3/4/03
Corn Oil (Botanical oil; *Zea mays ssp. mays*)	8001-30-7	25(b) status allows use as mosquito repellent applied to skin, clothing, or animals. There is little published evidence that this material has independent efficacy vs. public health pests, but it is frequently cited as one of the more effective substrates for botanical repellents.[315]	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Cottonseed Oil (Botanical oil; *Gossypium* spp.)	8001-29-4 (31602)	25(b) status allows use as mosquito repellent on skin, animals, or fabrics, but EPA will soon require efficacy data for this PHP use. Used as base ingredient in "natural" insect repellents[316], but efficacy and PHP utility is uncertain.	E, B. 25(b) Also registered biopesticide; Reg ca. 1982.
DEET = N,N-Diethyl-meta-toluamide	134-62-3 (80301)	Topical repellent registered vs. mosquitoes, ticks, sand flies, no-see-ums, other flies, etc. The "gold standard" for efficacy and duration vs. most vectors.	C. RED 4/1/98. Fact Sheet 4/1/98

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory Status
		Developed by the U.S. military and USDA after vector-borne disease problems during jungle warfare during World War II. It was originally tested as a pesticide on farm fields, and entered military use in 1946 and civilian use in 1957.	
D-Limonene (Botanical derivative, extract of orange & other citrus oils)	5989-27-5 (79701)	Registered for use as a topical repellent vs. mosquitoes and ticks, and fly repellent tablecloth	B. RED 1994. TRED (2005. RR; Final Work Plan 1/24/2011.
Dried Blood (Animal byproduct)	68911-49-9, 90989-74-5 (611)	25(b) status allows use as a mosquito repellent. Dried blood was also a biopesticide (mammal repellent), but not vs. vectors.	E, BC. 25(b)Was a biopesticide under RR, but final products cancelled 2007.
Egg Solids = Putrescent Whole Egg Solids (Natural product)	No CAS RN (105101)	25(b) status allows use as mosquito repellent, but efficacy has not been shown. Also registered as a biopesticide but not for this use.	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Eucalyptus Oil (Botanical oil, extract of Eucalyptus spp.)	8000-48-4 (40503)	Repels mosquitoes, ticks, and fleas from humans and clothing, dogs and cats, and homes	B. Reg 1948, RED 1993. RR (Plant Oils Group) initiated 3/29/10.
Eugenol (Botanical extract; from clove oil etc.)	97-53-0 (102701)	Constituent of many plants with repellent effects; registered vs. mosquitoes and bed bugs. Major constituents of clove oils, and significant evidence of mosquito repellency (Shin-Ho et al 2009).	EB. 25(b)Reg 1983. Floral Insecticides Group. RR in Plant Oils Group, initiated 3/29/10.
Geraniol (Botanical extract, from multiple sources)	106-24-1 (597501)	25(b) status allows use as insect and tick repellent on skin, animals, or fabrics. Also registered biopesticide but ticks registration unclear	E, B. 25(b)RR in Plant Oils, initiated 3/29/10.
IR3535 = Ethyl Butylacetylaminopropionate	52304-36-6 (113509)	Topical repellent, registered vs. mosquitoes, ticks, and sand flies	C. Fact Sheet 1/1/2000
Lauryl Sulfate (Botanical derivative)	151-41-7	25(b) status allows use as mosquito and tick repellent on skin, animals, or fabrics, but EPA will soon require PHP efficacy data.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
L-Carvone (Botanical, extract of Spearmint = *Mentha spicata*)	(79500)	Repellent for mosquitoes and biting flies.	B. 2009. Fact sheet 9/2/09.
Linalool (Monoterpenoid; Botanical derivative, extract of Ceylon cinnamon, sassafras, etc.)	78-70-6 (128838)	Botanical extract from many plants with insecticidal and repellent properties. Topical repellent vs. mosquitoes and ticks applied to dogs and cats (also indoor and outdoor spatial repellent).	B. Floral Insecticides Group. RR completed 2008.
Malic Acid (Natural product)	6915-15-7	25(b) status allows use as insect and tick repellent on skin, animals, or fabrics, but efficacy unclear.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Neem Oil (Botanical oil, *Azadirachta indica*)	8002-65-1 (25006)	Topical Repellent with registration vs. mosquitoes and ticks	B. Azadirachtin and Neem Oil Group: Fact Sheet 2001. Cold Pressed Neem Oil Reg. 9/16/09; Fact Sheet 4/7/10[317]
Permethrin (Pyrethroid, Ester Type I)	52645-53-1 (109701)	Fabric Treatment for clothing, bed nets, etc, with registration vs. mosquitoes, ticks, bed bugs, and sand flies. Also adulticide.	C. RED (revised) 5/11/09. RR initiated 6/29/11.
Picaridin = Icaridin (Piperidine, cyclic amine)	119515-38-7 (70705)	Topical repellent registered vs. mosquitoes, ticks, and sand flies	C. 2005.

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory Status
Pine Oil (Botanical oil; *Pinus* spp.)	8002-09-3 (67002)	Topical repellent; registered by EPA	B. RED 10/2/06
PMD = p-Menthane-3,8-diol (Botanical derivative)	42822-86-6 (11550)	Topical repellent registered vs. mosquitoes & ticks	B. 2000. BRAD 5/1/2000.[318]
Refined Oil of *Nepeta cataria* = Hydrogenated Catmint Oil (Botanical)	952722-18-8 (4801)	Topical repellent; possible applications as spatial repellent	B. BRAD 8/25/10.[319]
Soybean Oil (Botanical oil, extract of *Glycine max*)	8001-22-7 (31605)	Topical and spatial repellent sold under FIFRA 25(b); EPA registered to kill mites and beetles and other insects on "Food and feed crops, ornamental plants, indoor and outdoor sites"	E, B. 25(b)Reg 1959. RED 1993. RR in Plant Oils Group, initiated 3/29/10.
Sodium Chloride (Inorganic)	7647-14-5	25(b) status allows use as mosquito repellent on skin, animals, or fabrics, but efficacy unclear.	E. 25(b)
Sodium Lauryl Sulfate (Botanical extract, from coconut and palm oils)	151-21-3	25(b) status allows use as mosquito repellent on skin, animals, or fabrics, but efficacy unclear. Marketed as a mosquito repellent, especially with constituents such as garlic oil.[320]	E. 25(b)
Thyme and Thyme Oil (Botanical oil; Thymus vulgaris)	8007-46-3 oil, 84292-51-1 (597800 oil, 128894 herbs)	25(b) status allows use as larvicide, adulticide, or repellent, but EPA will soon require efficacy data. Registered acaricide vs. ticks.	E, B. 25(b)Thyme Oil Reg 2004. RR in Plant Oils Group, initiated 3/29/10. Thyme herbs were registered, but cancelled in 2005.
Undecan-2-one = Methyl Nonyl Ketone = 2-Undecanone = IBI 246 (Botanical derivative, extract of Rue, Tomatoes, etc.)	112-12-9 (44102)	Originally registered as a dog and cat repellent & training aid and an iris borer deterrent; widely publicized in 2002-2003 as natural mosquito repellent (Skeeter Shield), also registered vs. ticks	B?. Reg 6/1/95

Table F5. Mosquitocides in the U.S. – Veterinary Repellents

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory Status
2-Phenethyl Propionate (Botanical; extract of peanut)	122-70-3 (102601)	25(b) status allows use as mosquito repellent on animals. Also registered as a bipesticide, but not for this use.	E, B. 25(b). RR initiated 9/29/10.
Butoxy Polypropylene Glycol = BPG (Polyalkyloxy Compound)	9003-13-8 (11901)	Insect and tick repellent applied to pets, horses, and their housing areas	C. Reg ca. 1960. 20 active registrations (NPIRS 3/14/12).
Castor Oil (Botanical oil; *Ricinus communis*)	8001-79-4 (31608)	25(b) status allows use as mosquito repellent on skin, animals, or fabrics. Also registered biochemical pesticide, but apparently not for vectors specifically.	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.
Cedarwood Oil (Botanical oil, *Juniperus virginiana*, etc.)	8000-27-9 (40505)	25(b) status allows use as mosquito repellent on skin, animals, or fabrics. Also registered for repelling flies and gnats from horses and previously used as repellent in pet collars. Evidence for repelling mosquitoes (Ae. & An.) is mixed,[321] due to variations in chemical content and processing.	E, B. 25(b). RR completed 3/15/11 for topical and animal-applied insect repellents.
Cinnamon & Cinnamon Oil (Botanical extracts; *Cinnamomum zeylanicum*)	8015-91-6 (129066)	25(b) status allows use of the oil (and the entire plant if feasible) as a mosquito repellent on skin, animals, or fabrics. Also registered as a bipesticide, but not vs. vectors.	E, B. 25(b).
Citric Acid (Botanical extract; many sources)	77-92-9 (21801)	25(b) status allows use as a mosquito repellent on skin, animals, or fabrics. Efficacy or utility have not been demonstrated. Also registered biopesticide, but as an anti-microbial, not as a vector control agent.	E, B. 25(b). RR Final Decision 11/20/2009.[322]
Citronella and Citronella Oil (Botanical; *Cymbopogon winterianus* or *C. nardus*)	8000-29-1 (21901)	25(b) status allows use of the oil (and the entire plant if feasible) as a topical & spatial repellent. Good evidence of efficacy. Used as active ingredient in "natural" insect repellents[323] and in spatial repellent candles.	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.
Cloves and Clove Oil (Botanical oil; *Syzygium aromaticum*)	8000-34-8 (220700, 128895)	25(b) status allows use as mosquito repellent on skin, animals, or fabrics, but EPA will soon require efficacy data for this PHP use. Incorporated as active ingredient in "natural" insect repellents.[324] Significant published evidence of high repellency for many mosquito species with a variety of assays[325], although the source of oil (bud vs. leaf) has significant impact (Shin-Ho et al 2009).	E, B. 25(b).
Corn Gluten Meal (Botanical extract; *Zea mays ssp. mays*)	66071-96-3 (100137)	25(b) status allows use as mosquito repellent applied to skin, clothing, or animals, but efficacy or utility have not been demonstrated.	E, B. 25(b). BRAD 3/4/03
Corn Oil (Botanical oil; *Zea mays ssp. mays*)	8001-30-7	25(b) status allows use as mosquito repellent applied to skin, clothing, or animals. There is little published evidence that this material has independent efficacy vs. public health pests, but it is frequently cited as one of the more effective substrates for botanical repellents.[326]	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Cottonseed Oil (Botanical oil; *Gossypium* spp.)	8001-29-4 (31602)	25(b) status allows use as mosquito repellent on skin, animals, or fabrics, but EPA will soon require efficacy data for this PHP use. Used as base ingredient in "natural" insect repellents[327], but efficacy and PHP utility is uncertain.	E, B. 25(b) Also registered biopesticide; Reg ca. 1982.
Di-n-propyl Isocinchomeronate = MGK® Repellent 326	136-45-8 (47201)	Topical repellent and repels insects and ticks from dogs, cats, horses, and their bedding; typically mixed with DEET & MGK® 264	C. RED 9/23/03
D-Limonene (Botanical derivative, extract of orange & other citrus oils)	5989-27-5 (79701)	Registered for use as a topical repellent vs. mosquitoes and ticks, and fly repellent tablecloth	B. RED 1994. TRED (2005. RR; Final Work Plan 1/24/2011.

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory Status
Dried Blood (Animal byproduct)	68911-49-9, 90989-74-5 (611)	25(b) status allows use as a mosquito repellent. Dried blood was also a biopesticide (mammal repellent), but not vs. vectors.	E, BC. 25(b)Was a biopesticide under RR, but final products cancelled 2007.
Egg Solids = Putrescent Whole Egg Solids (Natural product)	No CAS RN (105101)	25(b) status allows use as mosquito repellent, but efficacy has not been shown. Also registered as a biopesticide but not for this use.	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Eucalyptus Oil (Botanical oil, extract of Eucalyptus spp.)	8000-48-4 (40503)	Repels mosquitoes, ticks, and fleas from humans and clothing, dogs and cats, and homes	B. Reg 1948, RED 1993. RR (Plant Oils Group) initiated 3/29/10.
Eugenol (Botanical extract; from clove oil etc.)	97-53-0 (102701)	Constituent of many plants with repellent effects; registered vs. mosquitoes and bed bugs. Major constituents of clove oils, and significant evidence of mosquito repellency (Shin-Ho et al 2009).	EB. 25(b)Reg 1983. Floral Insecticides Group. RR in Plant Oils Group, initiated 3/29/10.
Geraniol (Botanical extract, from multiple sources)	106-24-1 (597501)	25(b) status allows use as insect and tick repellent on skin, animals, or fabrics. Also registered biopesticide but ticks registration unclear	E, B. 25(b)RR in Plant Oils, initiated 3/29/10.
IR3535 = Ethyl Butylacetylaminopropionate	52304-36-6 (113509)	Topical repellent, registered vs. mosquitoes, ticks, and sand flies	C. Fact Sheet 1/1/2000
Lauryl Sulfate (Botanical derivative)	151-41-7	25(b) status allows use as mosquito and tick repellent on skin, animals, or fabrics, but EPA will soon require PHP efficacy data.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
L-Carvone (Botanical, extract of Spearmint = *Mentha spicata*)	(79500)	Repellent for mosquitoes and biting flies.	B. 2009. Fact sheet 9/2/09.
Linalool (Monoterpenoid; Botanical derivative, extract of Ceylon cinnamon, sassafras, etc.)	78-70-6 (128838)	Botanical extract from many plants with insecticidal and repellent properties. Topical repellent vs. mosquitoes and ticks applied to dogs and cats (also indoor and outdoor spatial repellent).	B. Floral Insecticides Group. RR completed 2008.
Malic Acid (Natural product)	6915-15-7	25(b) status allows use as insect and tick repellent on skin, animals, or fabrics, but efficacy unclear.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Neem Oil (Botanical oil, *Azadirachta indica*)	8002-65-1 (25006)	Topical Repellent with registration vs. mosquitoes and ticks	B. Azadirachtin and Neem Oil Group: Fact Sheet 2001. Cold Pressed Neem Oil Reg. 9/16/09; Fact Sheet 4/7/10[328]
Permethrin (Pyrethroid, Ester Type I)	52645-53-1 (109701)	Fabric Treatment for clothing, bed nets, etc, with registration vs. mosquitoes, ticks, bed bugs, and sand flies. Also adulticide.	C. RED (revised) 5/11/09. RR initiated 6/29/11.
Picaridin = Icaridin (Piperidine, cyclic amine)	119515-38-7 (70705)	Topical repellent registered vs. mosquitoes, ticks, and sand flies	C. 2005.
Pine Oil (Botanical oil; *Pinus* spp.)	8002-09-3 (67002)	Topical repellent; registered by EPA	B. RED 10/2/06
PMD = p-Menthane-3,8-diol (Botanical derivative)	42822-86-6 (11550)	Topical repellent registered vs. mosquitoes & ticks	B. 2000. BRAD 5/1/2000.[329]
Refined Oil of *Nepeta cataria* = Hydrogenated Catmint Oil (Botanical)	952722-18-8 (4801)	Topical repellent; possible applications as spatial repellent	B. BRAD 8/25/10.[330]
Soybean Oil (Botanical oil, extract of	8001-22-7	Topical and spatial repellent sold under FIFRA 25(b); EPA registered to kill	E, B. 25(b)Reg 1959. RED 1993.

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory Status
Glycine max)	(31605)	mites and beetles and other insects on "Food and feed crops, ornamental plants, indoor and outdoor sites"	RR in Plant Oils Group, initiated 3/29/10.
Sodium Chloride (Inorganic)	7647-14-5	25(b) status allows use as mosquito repellent on skin, animals, or fabrics, but efficacy unclear.	E. 25(b)
Sodium Lauryl Sulfate (Botanical extract, from coconut and palm oils)	151-21-3	25(b) status allows use as mosquito repellent on skin, animals, or fabrics, but efficacy unclear. Marketed as a mosquito repellent, especially with constituents such as garlic oil.[331]	E. 25(b)
Thyme and Thyme Oil (Botanical oil; Thymus vulgaris)	8007-46-3 oil, 84292-51-1 (597800 oil, 128894 herbs)	25(b) status allows use as larvicide, adulticide, or repellent, but EPA will soon require efficacy data. Registered acaricide vs. ticks.	E, B. 25(b)Thyme Oil Reg 2004. RR in Plant Oils Group, initiated 3/29/10. Thyme herbs were registered, but cancelled in 2005.
Undecan-2-one = Methyl Nonyl Ketone = 2-Undecanone = IBI 246 (Botanical derivative, extract of Rue, Tomatoes, etc.)	112-12-9 (44102)	Originally registered as a dog and cat repellent & training aid and an iris borer deterrent; widely publicized in 2002-2003 as natural mosquito repellent (Skeeter Shield), also registered vs. ticks	B?. Reg 6/1/95

Table F6. Mosquitocides in the U.S. – Attractants and Lures

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory
1-Octen-3-ol (Botanical derivative; clover, alfalfa, etc.)	3391-86-4 (69037)	Attractant for certain species of mosquitoes and biting flies. Generally contained in lures, cartridges, or other carrier products that are placed in or on electronic bug killer stations; often used in conjunction with CO_2 and/or heat.	B. Reg 1997. (R)- isomer registered 2007.
Ammonium Bicarbonate (Inorganic salt)	1066-33-7 (73401)	Insect attractant, registered as a mosquito lure in mixture with lactic acid[332]	B. Reg. 2004; Chem 1958 (?)
Carbon Dioxide (Natural product)	124-38-9 (16601)	Carbon Dioxide is registered as a fumigant and propellant/inert. As a PHP, it is used as an attractant for mosquitoes and other insects.	C. Reg 1948. RED 1991. RR initiated 3/26/08. & now closed. ESA review initiated 5/26/10.
L-Lactic Acid (Natural product)	79-33-4 (128929)	L-Lactic acid, the biologically active optical isomer of lactic acid, is a biting insect and mosquito attractant registered for use in traps. L-Lactic Acid was originally registered as a plant growth regulator, but is now only registered as an insect attractant.	B. Reg 1988. RR Case 6062 Complete = BRAD 6/30/09.
R-(-)-1-Octen-3-ol (Botanical derivative; clover, alfalfa, etc.)	3687-48-7 (69038)	Attractant / Lure. May be used in lures, cartridges, or other carrier products that are placed in or on electronic bug killer stations; will probably be generally used in conjunction with CO_2 and/or heat.	B. Reg. 2007.

Table F7. Mosquitocides in the U.S. – Synergists or Adjuvants as Active Ingredients

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	Mode of Action & PHP Use Pattern	Regulatory
N-Octyl Bicycloheptene Dicarboximide = MGK® 264 (Dicarboximide)	113-48-4 (57001)	Synergist registered in many products, including some labeled vs. mosquitoes, ticks, bed bugs, etc., but not for area-wide mosquito control.	C. Reg 1940's. RED 2006
Piperonyl Butoxide = PBO	51-03-6 (67501)	Synergist commonly added to pyrethrin and pyrethroid adulticides, registered vs. mosquitoes (including area-wide control), ticks, bed bugs, and sand flies. Recommended by WHO as a synergist for space spraying against mosquitoes.	C. Reg 1950's. RED 6/14/06.[333] RR initiated 12/22/10.
Triethylene Glycol (Glycol)	112-27-6 (83501)	Registered delouser for animals, as well as disinfectant. Adjuvant in many products, including some labeled vs. mosquitoes (e.g. TETRAPERM AS TRA, Valent Biosciences, EPA Reg. 73049-416) and ticks. Bed bugs registrations cancelled.	C. Reg 1947. RED 2003.[334]

Part G: Tick Control Chemicals in the U.S., by Use Pattern

Tables G1 and G2 summarize information on PHP's legal for use (either registered or 25(b) exempt) for use as tick toxicants or tick repellents in the U.S. While vector control research has largely focused on mosquitoes over the years, it is increasingly clear that a very large burden of disease is transmitted by ticks, both to humans and animals, and it appears that many of the other materials in this volume may join these lists in years to come. Ticks are taxonomically close to mites, and many novel miticides have come onto the agricultural market in recent years, but they are only now getting systematically screened as potential tick control agents.

Table G1. Tick Toxicants

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory
2-Phenethyl Propionate (Botanical; extract of peanut)	122-70-3 (102601)	25(b) status allows use as tick toxicant, but efficacy is unclear. Also registered biopesticide, but apparently not for ticks specifically.	E, B. 25(b). Floral Insecticides Group. RR initiated 9/29/10.
Amitraz (Formamidine)	33089-61-1 (106201)	Insecticide & acaricide registered vs. ticks. Used in flea and tick collars for pets, and for use vs. ectoparasites on farm animals.	C. RED 1995. RR Case 234 (3/31/10).
Atrazine (Triazine)	1912-24-9 (80803)	Widely used herbicide; also acaricide registered for use vs. ticks	C. RED 2006. Update Fact Sheet 9/2011.[335] Petition in evaluation requesting ban on all uses.
Azadirachtin = Azadirachtin A (Botanical extract; Neem = *Azadirachta indica*)	11141-17-6 (121701)	Insecticide, IGR, and repellent with multiple modes of action. Registered vs. ticks	B. 1994. Azadirachtin and Neem Oil Group: Fact Sheet 2001. RR Case 6021 (9/24/08).
Beauveria bassiana (Fungus)	63428-82-0 Various PC Codes	Entomopathogenic fungus potentially useful vs. mosquitoes, ticks, sand flies, and bed bugs, but not apparently registered as a PHP.	B. Five strains are registered by EPA as biopesticides (ESC 170, GHA, ATCC 74040, 447, HF23). RR initiated 9/29/10.
Beta-Cyfluthrin (Pyrethroid, Ester Type II)	68359-37-5 (118831)	Insecticide/acaricide registered for PCO and homeowner use vs. ticks; often formulated w/ imidacloprid. Long photo-stability/residual action. Good evidence of efficacy as barrier applied to vegetation.	C. Reg 1995. RR initiated 9/22/10.
Bifenthrin (Pyrethroid, Ester Type I)	82657-04-3 (128825)	Adulticide with registration vs. mosquitoes, ticks, bed bugs, and sand flies. Long photo-stability/residual action. Recommended for IRS (WP) against malaria vectors. Good evidence of efficacy as barrier applied to vegetation.	C. Reg 1989. RR Initiated 6/23/10.
Bioallethrin = d-trans-Allethrin (Pyrethroid, Ester Type I)	260359-57-7 (4003)	Adulticide & Spatial Repellent (Coils), with registration vs. mosquitoes, ticks, and bed bugs.	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10).
Carbaryl (Carbamate, n-methyl)	63-25-2 (56801)	Insecticide and acaricide registered for use on turf or shrubbery vs. ticks, etc.	C. Reg. 1959? Amended RED 8/1/08. All pet uses cancelled 12/16/09. RR initiated 9/22/10.
Castor Oil (Botanical oil; *Ricinus communis*)	8001-79-4 (31608)	25(b) status allows use as tick toxicant, but efficacy is unclear. Also registered biopesticide, but apparently not for ticks specifically.	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.
Cedarwood Oil (Botanical oil, *Juniperus virginiana*, etc.)	8000-27-9 (40505)	25(b) status allows use as tick toxicant, but efficacy is unclear. Also registered biopesticide, but apparently not for ticks specifically.	E, B. 25(b). RR completed for repellent products.
Chlorpyrifos (OP)	2912-88-2 (59101)	Adulticide registered vs. mosquitoes and ticks, registered for area-wide spraying.	C. RED 7/1/06. RR initiated 3/18/09. EPA evaluating petition to cancel all registrations for this material.
Cinnamon & Cinnamon Oil (Botanical extracts; *Cinnamomum zeylanicum*)	8015-91-6 (129066)	25(b) status allows use of the oil (and the entire plant if feasible) as a tick toxicant. Cinnamon is also a registered biochemical pesticide, but apparently not for vectors specifically.	E, B. 25(b).
Citric Acid (Botanical extract; many sources)	77-92-9 (21801)	25(b) status allows use as a tick toxicant, but efficacy unclear. Also registered biopesticide, but as an anti-microbial, not as a vector control agent.	E, B. 25(b). RR Final Decision 11/20/2009.

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory
Citronella and Citronella Oil (Botanical; *Cymbopogon winterianus* or *C. nardus*)	8000-29-1 (21901)	25(b) status allows use of the oil (and the entire plant if feasible) as a tick toxicant. Also registered as a biopesticide vs. mosquitoes, but not vs. ticks.	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.
Cloves and Clove Oil (Botanical oil; *Syzygium aromaticum*)	8000-34-8 (220700, 128895)	25(b) status allows use as tick toxicant, but efficacy is unclear. Also registered biopesticide, but apparently not for ticks specifically.	E, B. 25(b).
Corn Gluten Meal (Botanical extract; *Zea mays ssp. mays*)	66071-96-3 (100137)	25(b) status allows use as tick toxicant, but efficacy is unclear. Also registered biopesticide, but apparently not for ticks specifically.	E, B. 25(b)BRAD 3/4/03
Corn Oil (Botanical oil; *Zea mays ssp. mays*)	8001-30-7	25(b) status allows use as tick toxicant, but efficacy is unclear.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Cottonseed Oil (Botanical oil; *Gossypium* spp.)	8001-29-4 (31602)	25(b) status allows use as tick toxicant, but efficacy is unclear. Also registered biopesticide, but apparently not for ticks specifically.	E, B. 25(b) Also registered biopesticide; Reg ca. 1982.
Cyfluthrin (Pyrethroid, Ester Type II)	68359-37-5 (128831)	Insecticide/acaricide registered for PCO and homeowner use vs. ticks; often formulated together with pyrethrins and PBO or imidacloprid.	C. Reg. 1989. RR initiated 9/22/10.
Cypermethrin (Pyrethroid, Ester, Type II)	52315-07-8 (109702)	Insecticide/acaricide registered for use vs. ticks	C. Reg. 1984. Revised RED 1/14/08.
Cyphenothrin (Pyrethroid, Ester Type II)	39515-40-7 (129013)	Insecticide/acaricide registered for use vs. ticks	C. RR initiated 12/16/09.
d-Allethrin = Pynamin Forte (Pyrethroid, Ester Type I)	584-79-2, 231937-89-6 (4005)	Adulticide & Spatial Repellent (Coils), with registration vs. mosquitoes, ticks, and bed bugs	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10).
DDVP = Dichlorvos (OP)	62-73-7 (84001)	Adulticide & Spatial Repellent (Treated strips) registered vs. mosquitoes, ticks, and bed bugs	C. RED 7/31/06. RR initiated 6/24/09.
Deltamethrin (Pyrethroid, Ester Type II)	52918-63-5 (97805)	Insecticide/acaricide registered for use vs. ticks	C. RR initiated 3/31/10.
Dinotefuran (Neonicotinoid, Guanidine)	165252-70-0 (44312)	Insecticide/acaricide registered for use vs. ticks	C. 2004 Fact Sheet 9/1/04. RR initiated 12/21/11.
D-Limonene (Botanical derivative, extract of orange & other citrus oils)	5989-27-5 (79701)	Registered for use as an acaricide vs. ticks.	B. RED 1994. TRED (2005. RR; Final Work Plan 1/24/2011.
d-Phenothrin = Sumithrin / Phenothrin (Pyrethroid, Ester Type I)	26002-80-2 (69005)	Insecticide/acaricide registered for use vs. ticks	C. RED (d-Phenothrin) 9/25/08. RR initiated 12/21/11.
Dried Blood (Animal byproduct)	68911-49-9, 90989-74-5 (611)	25(b) status allows use as Tick toxicant. Dried blood was also a biopesticide (mammal repellent), but not vs. vectors.	E, BC. 25(b)Was a biopesticide under RR, but final products cancelled 2007.
Egg Solids = Putrescent Whole Egg Solids (Natural product)	No CAS RN (105101)	25(b) status allows use as a tick toxicant, but efficacy has not been shown. Also registered as a biopesticide but not for this use.	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Esbiothrin = S-Biothrin (Pyrethroid, Ester Type I)	584-79-2, 260359-57-5	Insecticide/acaricide reportedly registered for use vs. ticks	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10).

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory
	(4007)		
Esfenvalerate (Pyrethroid, Ester)	66230-04-4 (109303)	Insecticide/acaricide registered for use vs. ticks	C. RR initiated 12/16/09.
Etofenprox = Ethofenprox (Pyrethroid, Ether)	80844-07-1 (128965)	Insecticide/acaricide registered for use vs. ticks	C. RR initiated 8/29/07; Amended Final Work Plan 12/6/11.
Eugenol (Botanical extract; from clove oil etc.)	97-53-0 (102701)	25(b) status allows use as tick toxicant. Also registered biopesticide, but ticks status unclear	EB. 25(b)Reg 1983. Floral Insecticides Group. RR in Plant Oils Group, initiated 3/29/10.
Gamma-Cyhalothrin (Pyrethroid, Ester Type II)	76703-62-3 (128807)	Insecticide/acaricide registered for use vs. ticks	C. RR initiated 12/22/10.
Garlic Oil (Botanical oil, extract of *Allium sativum*)	8000-78-0 (128827)	25(b) status allows use as tick toxicant, but efficacy is unclear. Also registered biochemical pesticide, but apparently not for vectors specifically.	E, B. 25(b)RED (Garlic) 6/1/92. RR Final Decision (Garlic Oil) 9/29/10.
Geraniol (Botanical extract, from multiple sources)	106-24-1 (597501)	25(b) status allows use as tick toxicant. Also registered biopesticide, but ticks status unclear	E, B. 25(b)RR in Plant Oils Group, initiated 3/29/10.
Geranium Oil (Botanical oil, *Pelargonium graveolens*)	8000-46-2 (597500)	25(b) status allows use as tick toxicant, but efficacy is unclear.	E, B. 25(b)Biopesticide, but no registrations now.
Imidacloprid (Neonicotinoid)	105827-78-9 (129059)	Insecticide and acaricide registered vs. mosquitoes, ticks, bed bugs, and sand flies	C. RR Final Work Plan 9/22/10.
Imiprothrin (Pyrethroid)	72963-72-5 (4006)	Insecticide/acaricide registered for use vs. ticks	C. Fact Sheet 3/1/98. RR initiated 9/31/11.
Lambda-Cyhalothrin (Pyrethroid, Ester Type II)	91465-08-6 (128897)	Insecticide/acaricide registered for use vs. ticks	C. RR initiated 12/22/10.
Lauryl Sulfate (Botanical derivative)	151-41-7	25(b) status allows use as tick toxicant but efficacy unclear.	E. 25(b)
Lemongrass Oil (Botanical oil, extract of *Cymbopogon citratus*)	72869-82-0 (40502)	25(b) status allows use as tick toxicant, but efficacy unclear.	E, B. 25(b)1962. RR in Plant Oils Group, initiated 3/29/10.
Linseed Oil (Botanical oil; *Linum usitatissimum*)	8001-26-1	25(b) status allows use as tick toxicant but efficacy unclear.	E. 25(b)
Malathion (OP)	121-75-5 (57701)	Insecticide/acaricide registered for use vs. ticks	C. RED 7/1/09. RR in process
Malic Acid (Natural product)	6915-15-7	25(b) status allows use as tick toxicant but efficacy unclear.	E. 25(b)
Methoprene (Synthetic juvenoid)	40596-69-8 (105401)	Insecticide/acaricide registered for use vs. ticks	B. Reg. 1975. RED 3/1/91. Fact sheet 6/1/01
Mint Oil (Botanical oil; *Mentha* spp.)	8006-90-4 (128800)	25(b) status allows use as tick toxicant, but efficacy unclear. Also registered biopesticide, but ticks status unclear	E, B. 25(b)Active PC Code but no current registrations.
Neem Oil (Botanical oil, *Azadirachta indica*)	8002-65-1 (25006)	Topical Repellent with registration as Clarified Hydrophobic Neem Oil or Cold Pressed Neem Oil vs. mosquitoes and ticks.	B. Azadirachtin and Neem Oil Group: Fact Sheet 2001. Cold Pressed Neem Oil Reg. 9/16/09; Fact Sheet 4/7/10[336]
N-Octyl Bicycloheptene Dicarboximide = MGK® 264 (Dicarboximide)	113-48-4 (57001)	Synergist registered in many products, including some labeled vs. mosquitoes, ticks, bed bugs, etc., but not for area-wide mosquito control.	C. Reg 1940's. RED 2006

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory
Peppermint Oil (Botanical oil; *Mentha × piperita*)	8006-90-4	25(b) status allows use as tick toxicant. Sold as active ingredient in "natural" insect and tick control products, but efficacy unclear.	E. EPA will soon require efficacy data for PHP use.
Permethrin (Pyrethroid, Ester Type I)	52645-53-1 (109701)	Insecticide/acaricide reportedly registered for use vs. ticks	C. RED (revised) 5/11/09. RR initiated 6/29/11.
Piperonyl Butoxide = PBO	51-03-6 (67501)	Insecticide/acaricide synergist registered for use vs. ticks	C. Reg 1950's. RED 6/14/06.[337] RR initiated 12/22/10.
Potassium Potassium Laurate (Soap Salt)	10124-65-9 (79021)	Insecticide & acaricide in products labeled against multiple pests including ticks	Reg starting 1947. RED Soap Salts Group 1992. RR initiated 9/15/08.
Potassium Sorbate	24634-61-5 (none)	25(b) status allows use as tick toxicant but efficacy unclear.	E. 25(b)
Prallethrin (Pyrethroid, Ester, Type I)	23031-36-9 (128722)	Insecticide/acaricide and spatial repellent registered for use vs. ticks	C. 1985. EPA OPP ChemicalSearch shows no new regulatory activity.
Pyrethrins (Botanical; pyrethrum = *Tanacetum cinerariifolium*)	8003-34-7 (69001)	Insecticide/acaricide registered for use vs. ticks	C. RED 6/07/06. RR initiated 12/21/11.
Pyriproxyfen (IGR – Synthetic Juvenoid)	95737-68-1 (129032)	IGR Larvicide. Also registered vs. ticks, bed bugs, and sand flies.	C. RR Summary Document 9/30/11
Rosemary and Rosemary Oil (Botanical; *Rosmarinus officinalis*)	8000-25-7 (597700, oil; 128893, herbs)	25(b) status allows use as tick toxicant. Sold as active ingredient in "natural" insect and tick control products, but efficacy unclear. Also biochemical pesticides, but not for vectors specifically.	E, B. 25(b)PC numbers assigned to oil and herbs but no products registered.
S-Bioallethrin = Esbiol (Pyrethroid, Ester Type I)	28434-00-6, 28057-48-9 (4004)	Insecticide/acaricide and spatial repellent registered for use vs. ticks	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10).
Sesame and Sesame Oil (Botanical oil; *Sesamum indicum*)	8008-74-0 (72401 oil, 128970)	25(b) status allows use as tick toxicant, but EPA will soon require PHP efficacy data. Also biochemical pesticides, but not for vectors specifically.	E, B. 25(b)Sesame Oil Reg. Ground sesame plants were registered, but cancelled ca 2004.
S-Hydroprene (IGR – Synthetic Juvenoid)	65733-18-8 (128966)	Insecticide/acaricide reportedly registered for use vs. ticks	B. Reg 1986. Fact Sheet 2001
Silica Gel (Inorganic)	7631-86-9 (72605)	Insecticide and acaricide (dessicant) in products labeled against ticks and bed bugs and possibly mosquitoes.[338]	C. Reg ca. 1956. Silica and Silicates Group RED 9/1/91. RR initiated 3/26/08.
Silicon Dioxide = Diatomaceous Earth (Inorganic)	63231-67-4 (72602)	Insecticide and acaricide (dessicant) in products labeled against mosquitoes, ticks, and bed bugs	C. Reg ca 1960. Silica and Silicates Group RED 9/1/91. RR initiated 3/26/08.
S-Methoprene (IGR – Synthetic Juvenoid)	65733-16-6 (105402)	Insecticide/acaricide reportedly registered for use vs. ticks	B. Fact Sheet 6/1/01
Soap Salts = Potassium (K), Sodium (Na), and Ammonium (NH_4) salts of fatty acids (Inorganic)	(79021, K) 79009, Na 31801, NH4)	Insecticide & acaricide in products labeled against multiple pests including mosquitoes; registration vs. mosquitoes and ticks	Reg starting 1947. RED Soap Salts Group 1992. RR initiated 9/15/08.
Sodium Chloride (Inorganic)	7647-14-5	25(b) status allows use as tick toxicant but efficacy unclear.	E. 25(b)
Sodium Lauryl Sulfate (Botanical extract, from coconut and palm oils)	151-21-3	25(b) status allows use as tick toxicant but efficacy unclear.	E. 25(b)
Soybean Oil (Botanical oil, extract	8001-22-7	25(b) status allows use as tick toxicant, but EPA will soon require PHP	E, B. 25(b)Reg 1959. RED 1993. RR in Plant

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory
of *Glycine max*)	(31605)	efficacy data. Also registered biopesticide, but ticks status unclear	Oils Group 3/29/10.
Tau-Fluvalinate = (2R)-Fluvalinate (Pyrethroid, Ester Type II)	102851-06-9 (109302)	Insecticide/acaricide reportedly registered for use vs. ticks	C. Racemic material reg 1988. RED (Tau isomers) 9/1/05. RR initiated 12/22/10.
Tetramethrin (Pyrethroid, Ester Type I)	7696-12-0 (69003)	Insecticide/acaricide registered for use vs. ticks	C. Revised RED Apr 2010.[339] RR initiated 12/21/11.
Thyme and Thyme Oil (Botanical oil; *Thymus vulgaris*)	8007-46-3 oil, 84292-51-1 (597800 oil, 128894 herbs)	25(b) status allows use as tick toxicant, but efficacy unclear. Also registered acaricide vs. ticks.	E, B. 25(b)Thyme Oil Reg 2004. RR in Plant Oils Group, initiated 3/29/10. Thyme herbs were registered, but cancelled in 2005.
Triethylene Glycol (Glycol)	112-27-6 (83501)	Registered delouser for animals, as well as disinfectant. Adjuvant in many products, including some labeled vs. mosquitoes (e.g. TETRAPERM AS TRA, Valent Biosciences, 73049-416) and ticks. Bed bugs registrations cancelled.	C. Reg 1947. RED 2003.[340]
Trifluralin (Dinitroaniline)	1582-09-8 (36101)	Insecticide/acaricide registered for use vs. ticks	C. Reg 1992. TRED 2004.
White Pepper (Botanical extract; *Piper nigrum;* Piperaceae)	8006-82-4	25(b) status allows use as tick toxicant but efficacy unclear.	E. 25(b)
Zeta-Cypermethrin (Pyrethroid, Ester Type II)	52315-07-8 (129064)	Insecticide/acaricide registered for use vs. ticks	C. Reg. 1972?. Revised RED 1/14/08.

Table G2. Tick Repellents and Attractants

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory
2-Phenethyl Propionate (Botanical; extract of peanut)	122-70-3 (102601)	25(b) status allows use as tick repellent on skin, animals, or fabrics, but EPA will soon require efficacy data for these PHP uses.	E, B. 25(b). Floral Insecticides Group. RR initiated 9/29/10.
Amitraz (Formamidine)	33089-61-1 (106201)	Insecticide & acaricide registered vs. ticks. Used in flea and tick collars for pets, and for use vs. ectoparasites on farm animals.	C. RED 1995. RR Case 234 (3/31/10).
Azadirachtin = Azadirachtin A (Botanical extract; Neem = *Azadirachta indica*)	11141-17-6 (121701)	Insecticide, IGR, and repellent with multiple modes of action. Registered vs. ticks	B. 1994. Azadirachtin and Neem Oil Group: Fact Sheet 2001. RR Case 6021 (9/24/08).
Bioallethrin = d-trans-Allethrin (Pyrethroid, Ester Type I)	260359-57-7 (4003)	Adulticide & Spatial Repellent (Coils), with registration vs. mosquitoes, ticks, and bed bugs.	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10).
Butoxy Polypropylene Glycol = BPG (Polyalkyloxy Compound)	9003-13-8 11901	Insect and tick repellent applied to pets, horses, and their housing areas	C. Reg ca. 1960. 20 active registrations (NPIRS 3/14/12).
Carbon Dioxide (Natural product)	124-38-9 (16601)	Carbon Dioxide is registered as a fumigant and propellant/inert. As a PHP, used as an attractant.	C. Reg 1948. RED 1991. RR initiated 3/26/08 & now closed. ESA review initiated 5/26/10.
Castor Oil (Botanical oil; *Ricinus communis*)	8001-79-4 (31608)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Also registered biochemical pesticide, but apparently not for vectors specifically.	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.
Cedarwood Oil (Botanical oil, *Juniperus virginiana*, etc.)	8000-27-9 (40505)	25(b) status allows use as tick repellent on skin, animals, or fabrics. Also registered insect repellent for topical use or for repelling flies and gnats from horses and previously used as repellent in pet collars.	E, B. 25(b). RR completed 3/15/11 for topical and animal-applied repellents.
Cinnamon & Cinnamon Oil (Botanical extracts; *Cinnamomum zeylanicum*)	8015-91-6 (129066)	25(b) status allows use of the oil (and the entire plant if feasible) as a tick repellent on skin, animals, or fabrics. Cinnamon is also a registered biochemical pesticide, but apparently not for vectors specifically.	E, B. 25(b).
Citric Acid (Botanical extract; many sources)	77-92-9 (21801)	25(b) status allows use as a tick repellent, but efficacy has not been demonstrated. Also registered biopesticide, but not for this use pattern.	E, B. 25(b). RR Final Decision 11/20/2009.
Citronella and Citronella Oil (Botanical; *Cymbopogon winterianus* or *C. nardus*)	8000-29-1 (21901)	25(b) status allows use of the oil (and the entire plant if feasible) as a tick repellent on skin, animals, or fabrics. Also registered as a biopesticide vs. mosquitoes, but not ticks.	E, B. 25(b). RR in Plant Oils Group, initiated 3/29/10.
Cloves and Clove Oil (Botanical oil; *Syzygium aromaticum*)	8000-34-8 (220700, 128895)	25(b) status allows use as tick repellent on skin, animals, or fabrics. Also registered biopesticide but ticks registration unclear.	E, B. 25(b).
Corn Gluten Meal (Botanical extract; *Zea mays*	66071-96-3	25(b) status allows use as tick repellent on skin, animals, or	E, B. 25(b)BRAD 3/4/03

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory
ssp. mays)	(100137)	fabrics, but efficacy or utility have not been demonstrated.	
Corn Oil (Botanical oil; *Zea mays ssp. mays*)	8001-30-7	25(b) status allows use as tick repellent on skin, animals, or fabrics. There is little published evidence that this material has independent efficacy vs. public health pests, but it is frequently cited as one of the more effective substrates for botanical repellents.[341]	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Cottonseed Oil (Botanical oil; *Gossypium* spp.)	8001-29-4 (31602)	25(b) status allows use as tick repellent on skin, animals, or fabrics, but efficacy unclear. Also registered biopesticide, but apparently not for ticks specifically. Used as base ingredient in "natural" insect repellents[342], but PHP utility is uncertain.	E, B. 25(b) Also registered biopesticide; Reg ca. 1982.
d-Allethrin = Pynamin Forte (Pyrethroid, Ester Type I)	584-79-2, 231937-89-6 (4005)	Adulticide & Spatial Repellent (Coils), with registration vs. mosquitoes, ticks, and bed bugs	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10).
DDVP = Dichlorvos (OP)	62-73-7 (84001)	Adulticide & Spatial Repellent (Treated strips) registered vs. mosquitoes, ticks, and bed bugs	C. RED 7/31/06. RR initiated 6/24/09.
DEET = N,N-Diethyl-meta-toluamide	134-62-3 (80301)	"Gold standard" topical repellent registered vs. mosquitoes, ticks, and sand flies.	C. RED 4/1/98. Fact Sheet 4/1/98.
Di-n-propyl Isocinchomeronate = MGK® Repellent 326	136-45-8 (47201)	Repels insects and ticks from skin and from dogs, cats, horses, and bedding; often with DEET & MGK® 264	C. RED 9/23/03
D-Limonene (Botanical derivative, extract of orange & other citrus oils)	5989-27-5 (79701)	Registered for use as a topical repellent vs. ticks.	B. RED 1994. TRED (2005. RR; Final Work Plan 1/24/2011.
Dried Blood (Animal byproduct)	68911-49-9, 90989-74-5 (611)	25(b) status allows use as larvicide, adulticide, or repellent vs. mosquitoes, ticks, or other vectors. Dried blood was aa biopesticide, but not vs. vectors.	E, BC. 25(b)Final B. products cancelled 2007.
Egg Solids = Putrescent Whole Egg Solids (Natural product)	No CAS RN (105101)	25(b) status allows use as a tick repellent, but efficacy has not been shown. Also registered as a biopesticide but not for this use.	E, B. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Esbiothrin = S-Biothrin (Pyrethroid, Ester Type I)	584-79-2, 260359-57-5 (4007)	Mixture of stereoisomers of Allethrin.	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10).
Esfenvalerate (Pyrethroid, Ester)	66230-04-4 (109303)	Adulticide registered vs. mosquitoes, ticks, and bed bugs	C. RR initiated 12/16/09.
Eucalyptus Oil (Botanical oil, extract of Eucalyptus spp.)	8000-48-4 (40503)	Repels mosquitoes, ticks, and fleas from humans and clothing, dogs and cats, and homes	B. Reg 1948, RED 1993. RR (Plant Oils Group) initiated 3/29/10.
Eugenol (Botanical extract; from clove oil etc.)	97-53-0 (102701)	25(b) status allows use as tick repellent on skin, animals, or fabrics. Also registered biopesticide but tick registration unclear	EB. 25(b)Reg 1983. Floral Insecticides Group. RR in Plant Oils Group, initiated 3/29/10.
Gamma-Cyhalothrin (Pyrethroid, Ester Type II)	76703-62-3 (128807)	Adulticide registered vs. mosquitoes, ticks, and bed bugs	C. RR initiated 12/22/10.
Garlic Oil (Botanical oil, extract of *Allium sativum*)	8000-78-0	25(b) status allows use as tick repellent on skin, animals, or	E, B. 25(b)RED (Garlic) 6/1/92. RR Final

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory
	(128827)	fabrics. Also registered biochemical pesticide, but apparently not for vectors specifically.	Decision (Garlic Oil) 9/29/10.
Geraniol (Botanical extract, from multiple sources)	106-24-1 (597501)	25(b) status allows use as tick repellent on skin, animals, or fabrics. Also registered biopesticide but ticks registration unclear	E, B. 25(b)RR in Plant Oils Group, initiated 3/29/10.
Geranium Oil (Botanical oil, *Pelargonium graveolens*)	8000-46-2 (597500)	25(b) status allows use as tick repellent. Used as an active ingredient in "natural" insect and tick repellents[343], but efficacy and PHP utility is not clear.	E, B. 25(b)Active PC Code, but no current registrations.
IR3535 = Ethyl Butylacetylaminopropionate	52304-36-6 (113509)	Topical repellent, registered vs. mosquitoes, ticks, and sand flies	C. Fact Sheet 1/1/2000
Lauryl Sulfate (Botanical derivative)	151-41-7	25(b) status allows use as tick repellent on skin, animals, or fabrics, but EPA will soon require PHP efficacy data.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Lemongrass Oil (Botanical oil, extract of *Cymbopogon citratus*)	72869-82-0 (40502)	25(b) status allows use as tick repellent on skin, animals, or fabrics. Included as active ingredient in "natural" insect and tick repellents.[344]	E, B. 25(b)1962. RR in Plant Oils Group, initiated 3/29/10.
Linalool (Monoterpenoid; Botanical derivative, extract of Ceylon cinnamon, sassafras, etc.)	78-70-6 128838	Botanical extract from many plants with insecticidal and repellent properties. Spatial repellent, used indoors as an area treatment to repel fleas, mites, spiders and ticks. Topical repellent vs. mosquitoes and ticks when applied to dogs and cats.	B. Floral Insecticides Group. RR completed 2008.
Linseed Oil (Botanical oil; *Linum usitatissimum*)	8001-26-1	25(b) status allows use as tick repellent on skin, animals, or fabrics, but EPA will soon require PHP efficacy data.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Malic Acid (Natural product)	6915-15-7	25(b) status allows use as tick repellent on skin, animals, or fabrics, but EPA will soon require PHP efficacy data.	E. EPA is increasing requirements for efficacy data for 25(b) PHP claims.
Mint Oil (Botanical oil; *Mentha* spp.)	8006-90-4 (128800)	25(b) status allows use as tick repellent on skin, animals, or fabrics. Also registered biopesticide but ticks registration unclear.	E, B. 25(b)Active PC Code but no current registrations.
Neem Oil (Botanical oil, *Azadirachta indica*)	8002-65-1 (25006)	Topical tick repellent registered as Clarified Hydrophobic Neem Oil or Cold Pressed Neem Oil	B. Azadirachtin and Neem Oil Group: Fact Sheet 2001. Cold Pressed Neem Oil Reg. 9/16/09; Fact Sheet 4/7/10[345]
Nonanoic Acid = Pelargonic Acid (Fatty Acid)	112-05-0 (217500)	Registered vs. ticks on cattle.	B. 1992. Fact Sheet 4/1/00. RR initiated 6/30/10.
Peppermint Oil (Botanical oil; *Mentha × piperita*)	8006-90-4	25(b) status allows use as tick repellent on skin, animals, or fabrics. Used as an active ingredient in "natural" insect and tick repellents[346], but efficacy and PHP utility is not clear.	E. EPA will soon require efficacy data for PHP use.
Permethrin (Pyrethroid, Ester Type I)	52645-53-1 (109701)	Insect and tick repellent treatment for fabrics, including nets and clothing.	C. RED (revised) 5/11/09. RR initiated 6/29/11.
Picaridin = Icaridin (Piperidine, cyclic amine)	119515-38-7 (70705)	Topical repellent registered vs. mosquitoes, ticks, and sand flies	C. 2005.
Pine Oil (Botanical oil; *Pinus* spp.)	8002-09-3 (67002)	Topical repellent registered by EPA; tick registration status unclear	B. RED 10/2/06

Active Ingredient (Chemical Class)	CAS RN (EPA PC Code)	PHP Use Pattern	Regulatory
PMD = p-Menthane-3,8-diol (Botanical derivative, extract of lemon eucalyptus *Corymbia citriodora*)	42822-86-6 (11550)	Topical repellent registered vs. mosquitoes & ticks	B. 2000. BRAD 5/1/2000.[347]
Potassium Sorbate	24634-61-5 (none)	25(b) status allows use as tick repellent on skin, animals, or fabrics, but efficacy unclear.	E. 25(b)
Refined Oil of *Nepeta cataria* = Hydrogenated Catmint Oil (Botanical oil, extract of catnip)	952722-18-8 (4801)	Topical repellent; possible applications as spatial repellent (ticks?)	B. BRAD 8/25/10.[348]
Rosemary and Rosemary Oil (Botanical; *Rosmarinus officinalis*)	8000-25-7 (597700, oil; 128893, herbs)	25(b) status allows use as tick repellent on skin, animals, or fabrics, but efficacy unclear. AI in "natural" insect and tick repellents.[349] Also biochemical pesticides, but not for vectors specifically.	E, B. 25(b)PC numbers assigned to oil and herbs but no products registered.
S-Bioallethrin = Esbiol (Pyrethroid, Ester Type I)	28434-00-6, 28057-48-9 (4004)	Adulticide & Spatial Repellent (Coils), with registration vs. mosquitoes, ticks, and bed bugs.	C. RR Case 437 (Allethrin Stereoisomers Group, 03-31-10).
Sesame and Sesame Oil (Botanical oil; *Sesamum indicum*)	8008-74-0 (72401 oil, 128970)	25(b) status allows use as tick repellent on skin, animals, or fabrics. Sesame oil active ingredient in "natural" insect and tick repellents[350], but efficacy and PHP utility unclear. Also biochemical pesticides, but not for vectors specifically.	E, B. 25(b)Sesame Oil Reg. Ground sesame plants were registered, but cancelled ca 2004.
Sodium Chloride (Inorganic)	7647-14-5	25(b) status allows use as tick repellent on skin, animals, or fabrics, but efficacy unclear.	E. 25(b)
Sodium Lauryl Sulfate (Botanical extract, from coconut and palm oils)	151-21-3	25(b) status allows use as tick repellent on skin, animals, or fabrics, but efficacy unclear.	E. 25(b)
Soybean Oil (Botanical oil, extract of *Glycine max*)	8001-22-7 (31605)	25(b) status allows use as tick repellent on skin, animals, or fabrics, but efficacy unclear.	E. 25(b)
Thyme and Thyme Oil (Botanical oil; Thymus vulgaris)	8007-46-3 oil, 84292-51-1 (597800 oil, 128894 herbs)	25(b) status allows use as tick repellent on skin, animals, or fabrics, but efficacy unclear.	E, B. 25(b)Thyme Oil Reg 2004. RR in Plant Oils Group, initiated 3/29/10. Thyme herbs were registered, but cancelled in 2005.
Undecan-2-one = Methyl Nonyl Ketone = 2-Undecanone = IBI 246 (Botanical derivative, extract of Rue, Tomatoes, etc.)	112-12-9 (44102)	Originally registered as a dog and cat repellent & training aid and an iris borer deterrent; widely publicized in 2002-2003 as natural mosquito repellent (Skeeter Shield), also registered vs. ticks	B?. Reg 6/1/95
White Pepper (Botanical extract; *Piper nigrum;* Piperaceae)	8006-82-4	25(b) status allows use as tick repellent on skin, animals, or fabrics, but efficacy unclear.	E. 25(b)

Part H: Pesticides Registered in the U.S. with Potential Vector Control Uses

Table H1 lists vector control chemicals that are registered in the U.S. for some vector control purposes (defined as control of mosquitoes, ticks, sand flies, other biting flies, or bed bugs), and that have potential for expanded PHP use. These expanded uses can be new use patterns for currently labeled targets or new vector targets. The table presents chemical identifiers, mode of action, current and most likely expanded use patterns, and regulatory status.

Table H2 presents pesticides with vector control potential that are registered in the U.S., but only for use against other pests. Many of these are primarily agricultural products, while some are intended for household or veterinary use. Some are recently developed materials with registration numbers (EPA PC Codes) issued, but no registered end-use products to date. Table E5 identifies those materials in either Table H1 or H2 (i.e. registered for some uses in the U.S.) that are undergoing current regulatory review. While potential use patterns are not explicitly considered in most regulatory actions, it seems useful to be aware of the timing of reviews that may impact the availability or the potential range of uses of materials.

Table H1. Vector control chemicals registered in U.S. with potential for expansion to other vectors or use patterns

Active Ingredient & Chemical Class	CAS RN; EPA PC Code	Mode of Action, Current Uses, Potential Expanded Vector Control Use Pattern	Reg.
2-Phenethyl Propionate (Botanical; extract of peanut)	122-70-3 (102601)	25(b) status allows use as larvicide, adulticide, or repellent, but EPA will soon require efficacy data for these PHP uses. Also registered as a biochemical used as an insect attractant and repellent, but not specifically against vector species. PHP efficacy unclear.	E, B. 25(b). Floral Insecticides Group. RR initiated 9/29/10.
Abamectin = Avermectin B1 (Macrocylic lactones)	65195-56-4 (122804)	A mixture of two chemicals isolated from the soil bacterium *Streptomyces avermitilis.*[351] Insecticide registered vs. fire ants and reputedly vs. ticks. Good topical efficacy vs. adult mosquitoes (LD50 vs. *Ae. aegypti* 1/9 vs. permethrin; Pridgeon et al 2006), though not yet registered vs. mosquitoes (NPIRS 4/30/12).	B. 2004.
Acetamiprid (Neonicotinoid: Chloronicotinyl)	135410-20-7 (99050)	A rare mosquitocide, but occassionally registered with bifenthrin for structural pest control of many insects, including mosquitoes. Broad-spectrum insecticide with contact and systemic activity; typically via foliar applications; excellent on sucking pests like aphids and whitefly. Lab efficacy vs. mosquito larvae.[352] Patented mixture with bifenthrin for flying insect control, including mosquitoes.[353] Mixture with Beta-cypermethrin sold in China for public health and veterinary pests.[354]	C. Conditional Registration 3/15/02. EPA Reduced Risk & OP Replacement insecticide
Amitraz (Formamidine)	33089-61-1 (106201)	IRAC 19: Octopaminergic agonist. Insecticide & acaricide registered vs. ticks. Used in flea and tick collars for pets, and for use vs. ectoparasites on farm animals. Efficacy against ticks in challenge studies using fipronil/amitraz/(s)-methoprene. Topical efficacy vs. adult mosquitoes very poor in one study (LD50 vs. *Ae. aegypti* 1/8,000 vs. permethrin; Pridgeon et al 2006). Unclear potential for expansion of PHP use.	C. RED 1995. RR initiated 3/31/10.
Atrazine (Triazine)	1912-24-9 (8003)	Widely used herbicide; also acaricide registered for use vs. ticks. Unclear potential for expansion of PHP use patterns.	C. RED 2006. Update Fact Sheet 9/2011.[355] Petition requesting ban on all uses is under evaluation.
Azadirachtin = Azadirachtin A (Botanical extract; Neem = *Azadirachta indica*)	11141-17-6 (121701)	Botanical insecticide & acaricide with multiple modes of action and efficacy vs. wide range of pests. One of the three most active constituents of neem oil. Registered vs. ticks & marketed vs. bedbugs.[356] [357] Significant literature on efficacy vs. mosquitoes.[358] Moderate efficacy vs. ticks (acaricide & repellent)[359] ; tick control on cattle promising[360]	B. 1994. Azadirachtin and Neem Oil Group: Fact Sheet 2001. RR initiated 9/24/08.
Bti Strain BK, ATCC number 35646 (Microbial; bacterial spores & proteins)	68038-71-1 (6507)	PC Code issued for this Bti strain, which presumably could serve as a larvicide, but it does not appear that any end-use products have been registered.	M. RR initiated 9/30/11.[361]
Boric Acid (Inorganic)	10043-35-3, 11113-50-1 (11001)	Insecticide & acaricide registered vs. ticks & bed bugs. Good efficacy vs. mosquitoes in toxic attractant sugar baits.	C. RR initiated 6/24/09.
Cedarwood Oil (Botanical oil, *Juniperus virginiana, Thuja* spp. ,	8000-27-9 (40505)	25(b) status allows use as toxicant or repellent for public health pests. Also registered insect repellent for topical use or for repelling flies and	E, B. 25(b). RR Completed 3/15/11 for repellent products.

Active Ingredient & Chemical Class	CAS RN; EPA PC Code	Mode of Action, Current Uses, Potential Expanded Vector Control Use Pattern	Reg.
etc.)		gnats from horses and previously used as repellent in pet collars. Potential expansion of PHP registrations.	
Chlorfenapyr (Pyrazole)	122453-73-0 (129093)	Insecticide with U.S. registration vs. bed bugs (and mosquitoes?). Very large literature on efficacy and potential utility for mosquito control. Good larvicide potential in some studies (Ayesa et al 2006). Potential for use on ITN's vs. mosquitoes, including Cx. and An. Moderate efficacy vs. mosquitoes in toxic attractant sugar baits.[35] Moderate topical efficacy vs. adult mosquitoes in one study (LD50 vs. *Ae. aegypti* 1/40 vs. permethrin; Pridgeon et al 2006). Antagonism with PBO.[362]	C. Reg 2001. No outdoor uses now registered. RR initiated 6/23/10.
Chloropicrin	76-06-2 (81501)	Fumigant registered vs. bed bugs.	C. Fact Sheet 7/10/08. RED (Amended 5/27/09. Managed in Soil Fumigants Group.
Coumaphos (OP)	56-72-4 (36501)	Insecticide & acaricide registered vs. ticks	C. RED 7/1/06.[363] RR initiated 6/25/08.
Deltamethrin (Pyrethroid, Ester Type II)	52918-63-5 (97805)	Registered in the U.S. vs. mosquitoes, ticks, and bed bugs, but with limited use patterns, and not registered for area-wide mosquito control. Recommended by WHO for space spraying against mosquitoes as ULV or as EW, for IRS against malaria vectors, for ITN's, and in LLIN's.	C. RR initiated 3/31/10.
Diazinon (OP)	333-41-5 (57801)	Insecticide and acaricide, now registered vs. ticks	Some active (e.g. ticks); mosquitoes cancelled
Didecyl Dimethyl Ammonium Chloride (Quaternary NH_4)	(69149)	Microbicide & disinfectant in products labeled against multiple pests including ticks and bed bugs	
Etofenprox = Ethofenprox (Pyrethroid, Ether)	80844-07-1 (128965)	Insecticide and acaricide registered in U.S. vs. mosquitoes and ticks, including for area-wise mosquito spraying. Recommended by WHO as an insecticide for IRS against malaria vectors, and for ITN's for malaria vector control.	C. RR initiated 8/29/07; Amended Final Work Plan 12/6/11.
Fipronil (Pyrazole, phenylpyrazoles)	120068-37-3 (129121)	Insecticide & acaricide registered vs. ticks. Research has demonstrated potential efficacy vs. mosquitoes, but also considerable cross-resistance potential with halogenated OC's. (Darriet 2007)	C. RR initiated 12/27/11.
Imidacloprid (Neonicotinoid)	105827-78-9 (129059)	Insecticide and acaricide registered vs. mosquitoes, ticks, bed bugs, and sand flies. Evidence of potential significant utility as mosquito larvicide or adulticide.[364] Reasonable larvicide efficacy (84 ppm LC_{50} in *Ae. aegypti*, Ayesa et al 2006). Strong synergism by PBO in adults reported as evidence of high intrinsic toxicity of neonicotinoids to mosquitoes (Ayesa et al 2006).	C. RR Final Work Plan 9/22/10.
Isopropyl Alcohol (Aliphatic Alcohol)	67-63-0 (47501)	Insecticide, acaricide, microbicide, and solvent registered vs. ticks & bed bugs	C. RED (Aliphatic Alcohols) 3/1/07.
Lambda-Cyhalothrin (Pyrethroid, Ester Type II)	91465-08-6[25] (128897)	Adulticide registered vs. mosquitoes, ticks, and bed bugs. Recommended by WHO as an insecticide for space spraying against mosquitoes as EC, for IRS against malaria vectors, and for long-lasting treatment of mosquito nets for malaria vector control.	C. RR initiated 12/22/10.

Active Ingredient & Chemical Class	CAS RN; EPA PC Code	Mode of Action, Current Uses, Potential Expanded Vector Control Use Pattern	Reg.
Metaflumizone (Fungal extract)	139968-49-3 (281250)	Reputedly registered vs. ticks. Registration pending vs. fire ants.	C. Pending registration.[365]
Metarhizium anisopliae Strain F52 Spores (Fungal spores)	67892-13-1 (29056)	Registered vs. ticks. Spores of this fungus with unspecified strain have demonstrated efficacy vs. adult mosquitoes when applied in sunflower oil (Takken and Knols 2007).	B. Fact Sheet 9/1/01. RR initiated 9/30/09.
Nonanoic Acid = Pelargonic Acid (Fatty Acid, C9)	112-05-0 (217500)	Registered vs. ticks on cattle. Significant evidence of efficacy vs. mosquitoes as a larvicide (20 ppm),[366] and as an oviposition repellent.[367] Some evidence of action as an oviposition stimulant in some circumstances.[368]	B. 1992. Fact Sheet 4/1/00. RR initiated 6/30/10.
Silica Gel (Inorganic)	7631-86-9 (72605)	Insecticide and acaricide (dessicant) in products labeled against ticks and bed bugs and possibly mosquitoes.[369]	C. Reg ca. 1956. Silica and Silicates Group RED 9/1/91. RR initiated 3/26/08. [370]
Silicon Dioxide = Diatomaceous Earth (Inorganic)	63231-67-4 (72602)	Insecticide and acaricide (dessicant) in products coformulated with pyrethroids and PBO labeled against multiple pests including mosquitoes, ticks, and bed bugs.[371]	C. Reg ca 1960. Silica and Silicates Group RED 9/1/91. RR initiated 3/26/08.
Spinosad (Microbial)	168316-95-8 (110003)	Now registered as a mosquito larvicide, but the mode of action indicates potential utility as a mosquito adulticide (Darriet 2007; [372]	M. New Material Fact Sheet 7/19/99. RR initiated 9/30/11.
Sulfur (Inorganic)	(77501)	Registered vs. ticks. Proposed as a mosquito repellent.[373]	C. RR Initiated 3/26/08. Draft Ecological Risk Assessment released.
Sulfuryl Fluoride (Inorganic)	2699-79-8 (78003)	Fumigant registered vs. ticks & bed bugs	
Thyme and Thyme Oil (Botanical oil; *Thymus vulgaris* or *T. zygis*)	8007-46-3, 84292-51-1 (597800, 128894)	Registered acaricide vs. ticks. 25(b) status allows use as larvicide, adulticide, or repellent, but EPA will soon require efficacy data.	
Trichlorfon (OP)	52-68-6 (57901)	Registered vs. ticks	C. RR initiated 3/18/09.
Undecan-2-one (Botanical derivative; extract of Rue, Tomatoes, etc.)	112-12-9 (44102)	Originally registered as a dog and cat repellent & training aid and an iris borer deterrent; widely publicized in 2002-2003 as natural mosquito repellent (Skeeter Shield), also registered vs. ticks. Oviposition attractant for some mosquitoes.[374]	B?. RED 6/1/95[375]

Table H2. Pesticides with vector control potential registered in U.S. for pests other than vectors

Active Ingredient & Chemical Class	CAS RN; EPA PC Code	Mode of Action, Current Uses, and Potential Vector Control Use Pattern	Registration Type[a] & Status[b]
Acequinocyl (Quinolinone)	57960-19-7 (6329)	Broad spectrum miticide with novel mode of action, easy on beneficials[376] with long residual. Recent patent as tick control agent.[377] No published evidence found on efficacy vs. ticks. No published evidence of mosquitocide efficacy. Suggested by Malaria Ontology as A.I. of interest.[378]	C 2003. EPA Reduced Risk Product. Technical material and one end-use (miticide) product registered in U.S. (4/2012).
Acetic Acid = Vinegar = Ethanoic Acid	64-19-7 (44001)	Strong ovipostion attractant for many mosquitoes at some concentrations[379], but oviposition repellent at higher concentrations and larval toxicant at even higher levels (Hwang et al 1980; Kramer et al 1980).	B.
Allyl Isothiocyanate	57-06-7 (4901)	A key constituent in Oil of Mustard, which has evidence of efficacy as a mosquito repellent, etc.	B 1962. RED 1993. RR, Plant Oils Group, initiated 3/29/10. RR, Flower Oils, from 9/30/11.
Alpha-Ionone (Botanical extract; *Boronia megastigma*, etc.)	127-41-3 (129030)	EPA registered as a dog and cat repellent on plants and outdoor inanimate objects, such as lawn furniture. Also an attractant for adult rose chafer beetles. Some published evidence found of utility for control of public health pests.[380]	B. 1965. RED 1993. Two active U.S. registrations (4/2012). RR in Plant Oils Group, initiated 3/29/10.
Ammonia	7664-41-7 (5302)	Very significant mosquito attractant to humans and other mammals.[381]	C.
Anise Oil (Botanical oil; *Pimpinella anisum*)	8007-70-3 (4301)	Sold as pediculicide vs. human head lice.[382] Other PHP utility unclear, although there are citations of efficacy vs. mosquitoes.	B. 1952. RED 1993. RR in Plant Oils Group, initiated 3/29/10.
Anethole (Botanical extract; Anise, Fennel)	104-46-1 (15604)	A major constituent of many botanical oils with insect repellent and insecticidal actions[383], but PHP potential unclear.	B 1988.
Azocyclotin	41083-11-8 (484600)	New insecticide. Topical efficacy vs. adult mosquitoes poor in one study (LD50 vs. *Ae. aegypti* 1/180 vs. vs. permethrin; Pridgeon et al 2006).	Pending? PC Code assigned, but no U.S. registered technical materials nor end-use products.
Balsam Fir Oil = Fir Needle Oil (Botanical Oil, *Abies balsamea*)	85085-34-3 (129035)	PHP efficacy unclear, but contains alpha-pinene and other constituents which may provide PHP utility.	B. BRAD 4/26/07.[384] RR in Flower Oils Group, initiated 9/30/11.
Beauveria bassiana (Fungus)	63428-82-0 Various PC Codes	Entomopathogenic fungus typically applied to corn borer, grasshopper, cricket, locust, aphids and whitefly. Not commercialized vs. public health pests, but high apparent potential, including vs. malaria vector species.[385] Known to be effective vs. many types of mosquito larvae since 1966[386] and also against adults, including *An. gambiae* in the field. Evidence of significant ovicidal activity vs. *Ae. aegypti*.[387] Both fungal	B. Five strains are registered by EPA as biopesticides (ESC 170, GHA, ATCC 74040, 447, HF23). RR initiated 9/29/10.

[a] B = Biopesticide; C = EPA Conventional Chemical; Micro = Microbial; P = Pending

[b] Reg. = first registration; RED = Reregistration Eligibility Decision; RR = Registration Review; Plant Oils Group = managed as part of the EPA BPPD Vegetable and Flower Oils Group (Fact Sheet = epa.gov/opp00001/chem_search/reg_actions/registration/fs_G-114_01-Jul-01.pdf), which is in Reregistration (Docket EPA-HQ-OPP-2009-0904. Most recent action is "Vegetable and Flower Oils Final Work Plan" (9/23/10): regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0904-0006); Floral Insecticides Group = managed as part of the Floral Attractants, Repellents, and Insecticides Group ("Fact Sheet" = epa.gov/opp00001/chem_search/reg_actions/registration/fs_G-105_25-Sep-00.pdf).

Active Ingredient & Chemical Class	CAS RN; EPA PC Code	Mode of Action, Current Uses, and Potential Vector Control Use Pattern	Registration Type[a] & Status[b]
		conidiospores and blastospores are pathogenic in mosquitoes, with blastospore more toxic.[388] Efficacy of specific strains not necessarily specified in literature. Cost-effective mass production shown; many strains commercially available in Africa and elsewhere; ULV-CDA formulations of conidia indicate potential use in seasonally dry habitats. Good potential for commercialization as cattle tick control agent (Fernandes et al 2011). Considerable evidence of efficacy vs. ticks,[389] sand flies,[390] and tsetse flies.[391] Beauvericin and analogues with toxic properties have been isolated.[392]	
Bergamot Oil (Botanical oil; *Citrus bergamia*)[393]	8007-75-8 (129029)	EPA registered as a repellent for dogs and cats on ornamental plants, homes, and garbage cans, as impregnated solid material or pellets. Sold as an ingredient in "natural" insect repellents[394], but regulatory status for this use and vector control efficacy unclear. Recent review of essential oils vs. *Culex pipiens* (Shin-Ho et al 2009) showed moderate efficacy at 0.005 g/cm^2.	B. 1972. RED 1993. RR Vegetable and Flower Oils Group, initiated 3/29/10. RR Flower Oils Group, initiated 9/30/11.
Bifenazate (Carbazate)	149877-41-8 (586)	Miticide with new mode of action with quick knockdown and no cross resistance.[395] IRAC 25: "Neuronal inhibitor, unknown MoA." Controls a range of mites, including eggs and motiles, but safe on predatory mites. Topical efficacy vs. adult mosquitoes very poor in one study (LD50 vs. *Ae. aegypti* 1/30,000 vs. permethrin; Pridgeon et al 2006). Tick or other PHP efficacy & utility unclear.	C. Acaricide reg. 1999. Fact Sheet.[396] EPA Reduced Risk Pesticide.[397] U.S. registered technical material + 9 end-use products (4/2012).
Birch Bark Oil = Sweet Birch Oil = Birch Bark Tar (*Botanical extract; Betula lenta*)	119-36-8, 9041-28-5 (76601)	Methyl salicylate[26] is a major constituent of birch bark extracts (oils or tars), and good data exists on insect repellent properties of both the botanical material and the pure compound (Dekker et al 2011).	B. RED 2005.
Borax (Mineral Salt)	1303-96-4 (11102)	Borax has been known to work as a mosquito larvicide since the 1920's[398] and has more recently been touted as a low risk ant control measure[399], but it's utility as a PHP has not been demonstrated.	C. RR initiated 6/24/09. 26 active U.S. product registrations (4/2012).
Buprofezin (Thiadiazine)	69327-76-0 (275100)	IGR with unique mode of action inhibiting chitin synthesis. Good activity for nymphal stages of leafhoppers, planthoppers, scales, mealybugs, psylla, and whiteflies; very safe to bees. Efficacy vs. public health pests?	C 1971. Reduced Risk & OP-Replacement Pesticide. Six U.S. registrations (4/2012).
Camphor	76-22-2	Major constituent (23%) of some batches of essential oil of tansy, a highly effective tick repellent, but not significantly repellent when tested alone (Pålsson et al 2008). Mosquito larvicide and adulticide efficacy are low (Tabanca et al 2011).	B.
Canola Oil (Botanical Oil; Rape Seed = *Brassica napus*, etc.)[400]	10962-03-0 (11332)	Registered biochemical insecticide/miticide. Anecdotal evidence of vector control efficacy, but PHP utility unclear.	B. BRAD 10/9/98.[401] Plant Oils Group. RR in Plant Oils Group, initiated 3/29/10.
Caproic Acid = Hexanoic Acid (Fatty Acid, C6)	142-62-1 (128917)	Affects mosquito behavior. Evidence of oviposition attraction for *Ae. aegypti*402, but repellent in other studies.	B.
Carvacrol (Monoterpenoid; Botanical Extract from several plants)	499-75-2 (22104)	Plant extract with insecticidal and repellent properties. As insecticide, MOA = positive allosteric modulator at insect GABA receptors (Tong and Coats 2010)[403]. Good efficacy demonstrated vs. ticks, including *Ixodes scapularis* and *Amblyomma americanum*,[404] but PHP utility not yet demonstrated.	B. ca 1989. No U.S. registrations issued.
Chamomile Oil (*Anthemis nobilis* or	8015-92-7,	Recent review of essential oils vs. *Culex pipiens* (Shin-Ho et al 2009) showed	B.

Active Ingredient & Chemical Class	CAS RN; EPA PC Code	Mode of Action, Current Uses, and Potential Vector Control Use Pattern	Registration Type[a] & Status[b]
Matricaria chamomilla, Asteraceae)	84649-86-5 (128853)	moderate efficacy at 0.005 g/cm^2.	
Chenopodium ambrosiodes var. *ambrosiodes* extract (Botanical extract; see Epazote (*Dysphania ambrosioides*)	89997-47-7	Composition primarily of limonene and camphor, which give repellency and possibly soften cuticles, thereby disrupting respiration. Product developed by AgraQuest Inc has demonstrated efficacy vs. ag pests including mites, aphids, thrips, and whitefly. PHP potential seems high, given the mode(s) of action and published efficacy vs. mosquitoes[405] and ticks.[406] A patent has been issued for use vs. ticks.[407]	B
Chlorfluazuron	71422-67-8 (108202)	IGR with Moderate efficacy shown vs. mosquitoes (Armigeres subalbatus, Ae. albopictus, Ae. aegypti, Cx. tritaeniorhynchus, and Cx. quinquefasciatus).[408]	EPA Registration pending?
Chlorpyrifos-Methyl (OP)	5598-13-0 (59102)	Was used in U.S. as a stored-grain pesticide in the U.S. before having registrations cancelled in 2001. Recent studies propose potential PHP efficacy as a constituent of multi-AI ITN's for use vs. pesticide-resistant mosquitoes.[409]	C. Planned cancellation of all U.S. registrations by 12/31/01.[410] Two U.S. product registraions 4/2012. RR initiated 3/31/10.[411]
Chromobacterium subtsugae (Microbial – Bacterium)	None? (16329)	Biopesticide under USDA development. Metabolites are toxic to Colorado potato beetles, corn rootworms, diamondback moths, whiteflies and green stinkbug. USDA screening indicates no efficacy vs. mosquitoes, but unclear if potentially useful vs. ticks or other vectors (USDA Pers. Comm. 2/2012)	M. Two active U.S. registrations; none for vectors.
Cinnamaldehyde (Botanical extract)	104-55-2 (40506)	Trans-cinnamaldehyde is the naturally occurring stereoisomer, and the major constituent of cinnamon oil. Developed as Cinnacure and Cinnamite by Proguard for Aphids and mites. Evidence of mosquito control efficacy, but apparently not registered vs. vectors.	B. 1994. In BPPD Floral Insecticides Group, but in RR as a single material.[412] Two U.S. registrations 4/2012.
Cinnamon Oil (Botanical oil, *Cinnamomum zeylanicum*)		25(b) status allows use as larvicide, adulticide, or repellent, but EPA will soon require efficacy data. Also registered biochemical pesticide, but apparently not for vector control.	E, B. 25(b).
Citral (Botanical extract)	5392-40-5 (40510)	Constituent of plants with pronounced insecticidal and/or repellent efficacy. Active ingredient in some "natural" insect repellents.[413] Significant repellency to nymphal lone star ticks (*Amblyomma americanum*) and adult female yellow fever mosquitoes (*Ae. aegypti*) in lab assays, but PHP utility unclear.	B. New EPA registration 8/23/11.[414] Technical material registered in U.S. but no end used products 4/2012.
Citronellol (Botanical extract; numerous plants)	106-22-09 (167004)	Constituent in one of two stereoisomers (+,-) in many plants with strong attraction and/or repellency to insects. Apparently not registered for vector control. Evidence of repellency vs. mosquitoes and ticks[415] and other vectors[416], PHP efficacy has not been demonstrated. Now marketed as Biomite vs. mites in combination with citronellol, geraniol, nerolidol and narnesol.	E, B; Fact Sheet 4/22/02. Reg 2004.[417] One U.S. registration 4/2012.
Clofentezine (Tetrazine)		Developed as Apollo by Makhteshim-Agan. Acaricide for eggs of *Panonychus ulmi* and *Tetranychus* spp. PHP Efficacy?	C; 1993? Reduced Risk pesticide
Clothianidin (Neonicotinoid)		Contact and stomach activity; when applied to soil there is activity on corn root worm, cutworms, wireworms, chinch bug, white grub and flea beetle; may be used with biotech rootworm hybrids.	C; 2003? Reduced Risk & OP Replacement pesticide

Active Ingredient & Chemical Class	CAS RN; EPA PC Code	Mode of Action, Current Uses, and Potential Vector Control Use Pattern	Registration Type[a] & Status[b]
		PHP potential as toxicant in sugar baits?	
Cloves and Clove Oil (Botanical oil; *Syzygium aromaticum*)	8000-34-8 (220700 oil; 128895 cloves)	25(b) status allows use as larvicide, adulticide, or repellent, but EPA will soon require efficacy data. Also registered biochemical pesticide, but apparently not for vector control.	E, B. 25(b).
Coconut Oil (*Cocos nucifera*)	8001-31-8 (218700)	There is little published evidence that this material has independent efficacy vs. public health pests, but it is frequently cited as one of the more effective substrates for botanical repellents with demonstrated effectiveness. [418]	B. PC Code issued but no active U.S. registrations.
Cryolite = Trisodium hexafluoroaluminate (Inorganic)	15096-52-3 (75101)	Broad spectrum insecticide in products reportedly (PesticideInfo.org) labeled vs. multiple pests including mosquitoes, ticks, and bed bugs, but no other evidence found for such labels.	C. RED 6/1/96.[419] RR initiated 3/30/11.
Decanoic Acid = Capric Acid (Fatty Acid, C10)	334-48-5 (128955)	Has been known as an effective mosquito repellent since the 1940's. Highly effective mosquito repellent (spatial) when produced from burning plant matter; also effective topical repellent applied to skin or cloth, and larvicide, etc. (Jones et al 2012)	B.
Diafenthiuron	80060-09-9 (80251)	Recent introduction with new mode of action. Enhanced with use of PBO. Mitacide, but efficacy vs. ticks unproven. Evidence of moderate toxicity vs. adult mosquitoes in some studies (Ayesa et al 2006), but poor topical toxicity in others (LD50 vs. *Ae. aegypti* 1/1,000 vs. permethrin; Pridgeon et al 2008).	PC Code has been issued but no technical nor end-use products registered in U.S. (4/2012).
Etoxazole	153233-91-1 (107091)	Recent introduction by Valent as an ornamental pest control agent. PHP efficacy is unclear. Registrant indicated no screening done against public health pests (Pers. Comm. 2-11-2012)	C. Reg 2002. [420] Six U.S. registrations (4/2012).
Fenazaquin	120928-09-8 (44501)	Disruptor of mitochondrial respiration. Primarily agricultural use. PHP efficacy is unclear, as the registrant indicated it is not in 2012 development plan to screen against PH pests, and no work was done previously (Pers. Comm. 2-9-2012)	Reg 2010. Fact sheet [421]
Fenitrothion (OP)	122-14-5 (105901)	Common PHP in other jurisdictions, but not registered for these uses in the U.S. Tested on ITN's vs *Ae. aegypti*, but with poor results.422	C. Reg ca 1977. RED 1995. RED 2006. RR Work Plan 2009.[423]
Fenpropathrin (Pyrethroid)	39515-41-8 (127901)	Agricultural pesticide with unknown PH pest efficacy. As a pyrethroid, the M.O.A could be applicable to vectors.	C. Reg 1994. RR initiated 2010[424]
Fish Oil / Cod Liver Oil (Animal product)	8016-13-5 (122401)	Anecdotal evidence that fish oil works as a mosquito repellent when taken as a food supplement[425], but efficacy has not been demonstrated.	B.
Formic Acid = Methanoic Acid (Carboxylic Acid)	64-18-6 (214900)	Registered biopesticide for controlling Varroa and Tracheal mites in honeybees.[426] Demonstrated bioactivity (toxicity, repellency, oviposition attraction) vs. mosquitoes (Chaskopoulou et al 2009)[427] and ticks[428]. Direct toxicity to An. and Cx. was low, but possibly important toxic metabolite of volatile formats (Chaskopoulou et al 2009).	B. Reg ca 1964. Fact sheet 2005.[429] Two active U.S. registrations, both for miticides. Prior registrations have been canceled.
Geraniol (Botanical extract, from multiple sources)	106-24-1 (597501)	Constituent of plants with substantial insecticidal and/or repellent activity. Significant repellency to nymphal lone star ticks (*Amblyomma americanum*) and adult female yellow fever mosquitoes (*Ae. aegypti*) in lab assays (Weldon et al 2010). Apparently not registered vs. vectors. Now marketed as Biomite by Arysta Life Science (& Natural Plant Protection?) in a combination product	E, B. 25(b)RR in Plant Oils Group, initiated 3/29/10.

Active Ingredient & Chemical Class	CAS RN; EPA PC Code	Mode of Action, Current Uses, and Potential Vector Control Use Pattern	Registration Type[a] & Status[b]
		containing citronellol, geraniol, nerolidol and narnesol, registered vs. many mites.	
Hydramethylnon	67485-29-4 (118401)	Electron transport inhibitor registered in U.S. vs. ants, cockroaches, and other household pests. Moderate to good mosquito larvicide efficacy in some studies (70ppm LC_{50} in *Ae. aegypti*; Ayesa et al 2006), but not in others; low toxicity to adult mosquitoes.[430] PHP utility not yet shown.	C. RED 1998.[431]
Imiprothrin (Pyrethroid)	72963-72-5 (4006)	Useful for combating ants and other domestic pests. Existing product formulations evaluated for mosquito control. Found to completely control *Aedes* larvae for 4-5 months (Ritchie et al 2001).	C. RR summary document issued 9/16/2012. Under active case development.
Indole (Botanical Derivative)	120-72-9 (25000)	Substantial evidence of significance as a mosquito attractant in nature.[432] PHP efficacy or utility not yet demonstrated.	B. 1994. RR in Vegetable and Flower Oils Group, initiated 3/29/10. RR Flower Oils Group initiated 9/30/11.
Indoxacarb (Oxadiazine)	173584-44-6 (67710)	Potential utility vs. mosquitoes cited by Darriet (2007). Reasonable larvicide efficacy (79ppm LC_{50} in *Ae. aegypti*) reported (Ayesa et al 2006), but low toxicity vs. adults. Operational utility not yet shown. Widely registered in the U.S., but not necessarily for vectors.	C. Conditional Reg 10/30/10. Fact Sheet.[433]
Jojoba Oil (Botanical Oil)	61789-91-1 (67200)	Registered biopesticide to kill or repel whiteflies on all crops, and to kill powdery mildew on grapes and ornamentals. Anecdotal evidence of mosquito repellency[434], but efficacy not demonstrated.	B. 1996. RR, Vegetable and Flower Oils, initiated 3/29/10.
Lauric Acid = Dodecanoic Acid (Fatty Acid, C12)	143-07-7 (128918)	Has been known as an effective mosquito repellent since the 1940's. Highly effective mosquito repellent (spatial) when produced from burning plant matter; also effective topical repellent applied to skin or cloth, and larvicide, etc. (Jones et al 2012)	B.
Lavandin Oil (Botanical Oil; *Lavandula x intermedia*)	8022-15-9 (40500)	Registered biopesticide to repel cloths moths in homes, and especially in closets, drawers, and clothes storage containers. Listed as an active ingredient in some "natural" insect repellents[435], but efficacy and PHP utility unclear.	B. 1996.[436] RR, Vegetable and Flower OIls, initiated 3/29/10. RR, Flower Oils, initiated 9/30/11.
Metarhizium anisopliae Strain ESF1 (Fungus)	67892-13-1 (129056)	Entomopathogenic fungus with wide range of targets. Originally registered in the U.S. vs. termites, but with apparent potential vs. mosquitoes, ticks, bed bugs, etc. Spores of this fungus with unspecified strain have demonstrated efficacy vs. adult mosquitoes when applied in sunflower oil (Takken and Knols 2007).	B Fact Sheet 2001.[437]
Methylheptenone (Botanical extract)	110-93-0 (127601)	Volatile botanical which shows strong responses for mosquito odor receptors, indicating potential for utility as attractant or repellent.[438]	B.
Methyl Salicylate (Botanical extract or synthetic)	119-36-8 (76601)	Methyl salicylate[26] is a major constituent of birch bark extracts (oils or tars), and good data exists on insect repellent properties of both the botanical material and the pure compound (Dekker et al 2011).	B. RED 2005.
Mint Oil (Botanical oil; *Mentha* spp.)	8006-90-4 (128800)	25(b) status allows use as larvicide, adulticide, or repellent, but efficacy unclear. Also registered biochemical pesticide, but apparently not for vector control.	E, B. 25(b)Active PC Code but no current registrations (NPIRS 3/14/12).

Active Ingredient & Chemical Class	CAS RN; EPA PC Code	Mode of Action, Current Uses, and Potential Vector Control Use Pattern	Registration Type[a] & Status[b]
Mustard Oil (Botanical oil; *Brassica* spp., Brassicaceae)	57-06-7 (4901)	EPA registered to repel dogs, cats, and wildlife; and to repel and kill some insects (not mosquitoes specifically), spiders, centipedes, etc. in homes, ornamental plants, and garbage cans. Evidence published of mosquito repellent efficacy of several botanical oils in a mustard oil base.[439]	B 1962.[440] RED 1993. RR, Vegetable and Flower OIls, initiated 3/29/10. RR, Flower Oils, initiated 9/30/11.
Novaluon (Benzoylurea)	116714-46-6 (124002)	IGR registered vs. other pests and potentially as a mosquito larvicide. WHOPES-recommended compound for control of mosquito larvae, for general use (10-100 g/ha) and for container breeding (0.01-0.05 mg/L) in particular.	C. Conditional Reg 9/24/01.[441]
Nucleopolyhedroviruses (= Nuclear Polyhedrosis viruses = NPV) (Baculovirus)	- varied	Pathogens of many insects. Polyhedral inclusion and occlusion bodies from several insect species have been registerd by EPA, but yet from vector species. *Culex nigripalpus* NPV (=CuniNPV) has not been registered but has potential for PHP development if technical challenges can be met.[442]	R. Now in RR.
Octanoic Acid = Caprylic Acid (Fatty Acid)	124-07-2 (128919)	Highly effective spatial repellent vs. mosquitoes in some studies and incorporated in repellents vs. biting flies, ticks, and lice on cattle, but not registered as PHP for human use.	B. RR completed 6/3/09.[443]
Oil of Wintergreen (Botanical oil; *Gaultheria procumbens*)	119-36-8, 9041-28-5 (76601)	Methyl salicylate is the primary constituent of Oil of Wintergreen[26], and good data exists on insect repellent properties of both the botanical material and the pure compound (Dekker et al 2011).	B. RED 2005.
Olive Oil (Botanical Oil; *Olea europaea*)	8001-25-0 (31610)	Used as base ingredient in "natural" insect repellents[444], but efficacy and PHP utility is uncertain.	B.
Orange Oil (Botanical oil; *Citrus sinensis*, etc.)	8008-57-9 (40517, 79701)[22]	Promoted as a "natural" repellent[445] and insecticide for topical and/or spatial use, and particularly as a flea repellent[446], but not registered in the U.S. vs. vectors. EPA registered to repel dogs and cats from ornamental plants, homes, and garbage dumps. The major constituent of orange oil, d-limonene, is registered for use as an insecticide and insect repellent, including vs. mosquitoes and other vectors.	B 1972, RED 1993[447]
Oregano Oil (Botanical Oil; *Origanum vulgare*)	862374-92-3 (4300)	Promoted as a "natural" repellent,[448] but efficacy and PHP utility are unclear. One U.S. registration, not as a PHP.	B. Newly registered biopesticide in U.S. 2011.
Paecilomyces fumosoroseus (Fungus)		Penetrates insect cuticle. Control of pests on non-food crops. Demonstrated efficacy against mosquitoes and possibly ticks. Less virulent than Beauveria[449]	M. 1986[450]
Pennyroyal Oil, American (Botanical; *Hedeoma pulegioides*, Lamiaceae)	8007-44-1 (40509)	Crushed Pennyroyal leaves exhibit a very strong fragrance similar to spearmint. Pennyroyal is a traditional insect repellent and also a culinary herb, folk remedy, and abortifacient. The essential oil of pennyroyal is high in pulegone, a highly toxic volatile organic compound which affects mammals (esp. liver and uterine function) as well as insects. Pennyroyal leaves, both fresh and dried, are especially noted for repelling insects, including mosquitoes and fleas. However, topical use or ingestion of the plant's essential oil is dangerous due to its toxicity to both humans and animals, even at extremely low levels.[451]	B. ca 1987.
Pennyroyal Oil, European (Botanical; *Mentha pulegium*, Lamiaceae)	8013-99-8 (40509)	Crushed Pennyroyal leaves exhibit a very strong fragrance similar to spearmint. Pennyroyal is a traditional insect repellent and also a culinary herb, folk remedy, and abortifacient. The essential oil of pennyroyal is high in pulegone, a	B. ca 1987.

Active Ingredient & Chemical Class	CAS RN; EPA PC Code	Mode of Action, Current Uses, and Potential Vector Control Use Pattern	Registration Type[a] & Status[b]
		highly toxic volatile organic compound which affects mammalian liver and uterine function as well as insects. Evidence of repellency vs. squash bugs and Colorado potato beetles (Eason and LaManna 2000), but PHP efficacy unclear.	
Pirimiphos-methyl (OP)	29232-93-7 (108102)	Insecticide currently registered in the U.S. for stored grains, bulbs, and for ear tags in cattle. Recommended by WHO for IRS and larval mosquito control. Some early trials on ITN's vs. *Ae. aegypti* were not promising. [452]	C. RR 3/18/09.
Propanoic Acid = Propionic Acid	79-09-4 (77702)	Oviposition attractant for some mosquitoes,[453] but oviposition repellent at higher concentrations and larval toxicant at even higher levels (Hwang et al 1980; Kramer et al 1980).	B.
Ryanodine (Botanical extract; *Ryan speciosa*)	15662-33-6 (71502)	Blocks calcium channels (presynaptic action), resulting in a high concentration of these ions in the muscles, which therefore cause tetany quickly, with potential utility vs. mosquitoes (Darriet 2007)	B. Fact Sheet (3/1/99)[454]
Sodium Metasilicate	6834-92-0 (72604)	Use patent pending in India as a mosquito larvicide.[455] No published evidence of efficacy or safety found.	C. Insecticide and fungicide with 1 U.S. registration.
Spearmint Oil (Botanical Oil; *Mentha spicata*)	8008-79-5, 868742-18-1 (217400)	Promoted as a "natural" repellent,[456] but efficacy and PHP utility are unclear.	B. Reg ca 1995. No U.S. product registrations issued.
Spinetoram	935545-74-7 (110008, 110009)	Novel pesticide with evidence of mosquito control potential.	M. RR initiated 9/30/11
Tea Tree Oil (Botanical Oil; *Melaleuca alternifolia*)	68647-73-4 (28853)	Tea tree oil is a source of 1,8-Cineole or Eucalyptol (0-15%)[457], which appears to be an effective repellent for mosquitoes and other arthropods, but efficacy of the oil is unclear.	B. 1997?
Thymol (Botanical derivative from several plants)	89-83-8 (80402)	Botanical extract from plants with insecticidal and repellent properties. Toxic MOA = positive allosteric modulator at insect GABA receptors (Tong and Coats 2010). A potent mosquito larvicide in laboratory assays.[458] Repellent efficacy and operational utility unproven.	B. RED 1993. BRAD 2006. RR initiated 3/31/10.
Trichlorfon (OP)	52-68-6 (57901)	Registered vs. ticks. WHO Specifications withdrawn as obsolete.	C. RR initiated 3/18/09.
Uniconazole-P (Azole)	83657-22-1 (128976)	Registered by EPA as a fungicide and plant growth regulator and claimed use as mosquitocide, but product labels not verified	C. Reg ca 1988

Part I: Potential PHP's Registered Elsewhere but Not in the U.S.

Materials that are registered for use in other countries but not in the U.S. are listed in Table I, which includes together materials in three circumstances: those which have not yet been registered in the U.S., those which have been registered but that no longer have current registration, and those that are exempt. As noted before, U.S. law allows for product registrations to be cancelled either because of evidence of unreasonable risk or, much more commonly, because of business decisions by registrants, including evaluation that new data requirements are prohibitively costly relative to small markets. Materials that have been cancelled by EPA for safety reasons or that are on WHO's list of Obsolete Pesticides are not included in this table.

Table I. Potential vector control pesticides registered elsewhere but not in the U.S.

Active Ingredient & Chemical Class	CAS RN	Mode of Action & Potential Vector Control Use Pattern
Allethrin	584-79-2	Registered in many jurisdictions, but U.S. registrations have been canceled.
Alpha-Cypermethrin	67375-30-8	Registered in many jurisdictions, and registration pending in the U.S.
α-Pinene = Alpha-Pinene (Botanical extract from multiple plants)	80-56-8 (67004)	Major constituent (27%) of some batches of essential oil of tansy, a highly effective tick repellent; apparently not highly repellent when tested alone (Pålsson et al 2008). Registered in Australia, but no products registered in U.S. (4/2012).
Bay Leaf Oil = Daphne = Bay Laurel (Botanical Oil; *Laurus nobilis*)	8007-48-5	Listed as an active ingredient in "natural" insect repellents[459], and registered in the E.U. but not in the U.S. Efficacy and PHP utility unproven.
Beauveria brongniartii (Fungus)		Entomopathogenic fungus under development, in part, by the German government. Targeted to date vs. soil dwelling pests. Registered in the EU but not the U.S. Not commercialized vs. public health pests, but high apparent potential, including vs. malaria vector species.[460] Evidence of efficacy vs. mosquitoes, esp. *Ae. sierrenis*.[461] Cost-effective mass production shown; many strains commercially available in Africa and elsewhere; ULV-CDA formulations of conidia indicate potential use in seasonally dry habitats. Evidence of natural control of ticks, including *Ixodes*.[462] Evidentally good potential for commercialization as cattle tick control agent (Fernandes et al 2011).
Bendiocarb	22781-23-3	Registered in many jurisdictions, but U.S. registrations have been canceled.
Beta-Cypermethrin (Pyrethroid, Ester Type II)	65731-84-2, 7375-30-8[14]	Adulticide registered in some countries vs. mosquitoes, ticks, and bed bugs, but not in the U.S. Sometimes formulated with propoxur, chlorpyrifos, etc. Good efficacy vs. *Ae. aegypti*.[463]
Bioresmethrin	28434-01-7	Registered in many jurisdictions, but U.S. registrations have been canceled.
Bitter Orange Oil (*Citrus x aurantium*; *Citrus vulgaris*)	8014-17-3 68916-04-1	Published evidence of mosquito larvicide efficacy[464], but PHP utility unclear. Registered in Australia but not the U.S.
Blackcurrant Bud Oil (Botanical Oil; Ribes nigrum)	97676-19-2, 68606-81-5[465]	Registered in the EU as an insecticidal AI, this plant oil has no demonstrated efficacy vs. mosquitoes in the published literature.
Black Pepper Oil (Botanical oil; *Piper nigrum;* Piperaceae)	8006-82-4	Registered in the E.U. as an insecticidal AI, but PHP efficacy unclear. Recent review of essential oils vs. *Culex pipiens* (Shin-Ho et al 2009) showed moderate efficacy at 0.005 g/cm^2.
Chlordane	57-74-9	Registered in some other jurisdictions, but U.S. registrations have been canceled.
Corn Oil (Zea mays ssp. mays)	8001-30-7	Registered in the E.U., but exempt from registration requirements in the U.S.
Cyantraniliprole (Anthranilic Diamide)	736994-63-1	Binds to the ryanodine receptor. Known to control Lepidoptera and a range of other insects. PHP efficacy unclear. Registered in Canada and pending in the E.U., but not in the U.S.
Cyflumetofen (Benzoxylcyanoacetate derivative)	400882-07-7 (138831)	Acaricide effective against Tetranychus and Panonychus mites on multiple crops. Registered in Japan, Korea, Israel; submitted to Brazil and EU. PC Code issued in U.S. but no product registrations 4/2012. Patent issued for use vs. ectoparasites on domestic animals. PHP utility unclear. Registered in Canada and pending in the U.S. and E.U.
d-d, trans-Cyphenothrin	39515-40-7	Registered in some other jurisdictions, but not in the U.S.
DDT	50-29-3, 8017-34-3	Registered in some other jurisdictions, but U.S. registrations have been canceled.
Dicofol	115-32-2	Registered in some other jurisdictions, but U.S. registrations have been canceled.
Dieldrin	60-57-1	Registered in some other jurisdictions, but U.S. registrations have been canceled.
d-Verbenone (Botanical extract; multiple plants)	18309-32-5	Significantly repellent to *Ixodes ricinus* L. (Pålsson et al 2008), but PHP utility not demonstrated.

Active Ingredient & Chemical Class	CAS RN	Mode of Action & Potential Vector Control Use Pattern
		Semiochemical with significant repellent effect on bark beetles. Registered in Canada but this stereoisomer not registered in the U.S.
Endosulfan	115-29-7	Registered in other jurisdictions, but negotiated cancellation and phase out (11/10/10) of all U.S. registrations by 7/1/2016.[466]
Epoxylated Soybean Oil (Botanical derivative; Soya)	none	Registered pesticide ingredient in the E.U. and cited in patents as a useful adjuvant for ULV applications[467]. PHP utility is not clear.
Eucalyptol = 1,8-Cineole = Cajeputol (Botanical derivative; primarily Eucalyptus Oil)	470-82-6	The major constituent of Eucalyptus Oil (esp. oil from *Eucalyptus globulus*) and oil of Cajeput (*Melaleuca leucadendron*), Eucalyptol has been demonstrated to be an effective mosquito feeding and oviposition repellent.[468] The compound is also a strong repellent vs. the tick *Ixodes ricinus* L. (Pålsson et al 2008). There are many synonyms, and the compound is found in many plants[469]. It is a popular folk remedy repellent in Listerine[470], which is largely eucalyptol, but PHP utility has not been demonstrated. Mosquito larvicidal and adulticide efficacy is low (Tabanca et al 2011). Registered as a pesticide in many jurisdictions, but not in the U.S.
Fenoxycarb	72490-01-8	Registered in some other jurisdictions, but U.S. registrations have been canceled.
Fenthion (OP)	55-38-9	Registered in some other jurisdictions, but U.S. registrations have been canceled.
Flufenoxuron (Benzoylurea)	101463-69-8	Chitin synthesis inhibitor developed by BASF. Registered widely but not in the US, although import tolerances established[471]. Less current research indicates efficacy against vectors.[472]
Gaiac (Guaiac) Wood Oil (Botanical oil; *Bulnesia sarmientoi*)	9000-29-7[473]	Registered in the EU as an insecticidal AI, this plant oil has no demonstrated efficacy vs. mosquitoes in the published literature.
Garlic (*Allium sativum*)	None	Garlic is registered in many jurisdictions, and the oil is registered in the U.S., but not the whole plant or other extracts.
Isoeugenol (Botanical extract)	97-54-1	Major constituent of clove bud oil, and significant evidence of mosquito repellency, comparable or higher than citronella (Shin-Ho et al 2009). PHP utility has not been demonstrated. Registered in Australia but not in the U.S.
Ivermectic (Macrocyclic lactones)	70288-86-7	Registered in China but not in the U.S.
Jodfenphos = Iodofenphos (OP)	18181-70-9 (309700)	Insecticide with historical PHP use in many jurisdictions and current registration in the E.U. PC Code issued in U.S., but apparently no technical material nor end-use products has been registered in the U.S.[474] The WHOPES Specification for this material has been withdrawn as obsolete.
Lavender Oil (Botanical; *Lavandula angustifolia*, etc.)	8000-28-0	Used as an active ingredient in "natural" insect repellents[475], but efficacy or PHP utility has not been demonstrated. Registered in Australia but not in the U.S.
Lindane (OC)	58-89-9	Registered in some other jurisdictions, but U.S. registrations have been canceled.
Linseed Oil (Botanical; *Linum usitatissimum*)	8001-26-1	Registered in the E.U., but exempt from registration requirements in the U.S.
Malic Acid (Botanical)	6915-15-7	Registered in some jurisdictions, but exempt from registration requirements in U.S.
Marjoram Oil (Botanical Oil; *Origanum majorana*)	8015-01-8	Registered as a pesticide in the E.U. but not in the U.S., marjoram oil is used as an ingredient in "natural" insect repellents[476], and there is some evidence of dose-response insect repellency with beetles.[477] Efficacy or PHP utility has not been demonstrated.
Methoxychlor	72-43-5	Registered in some other jurisdictions, but U.S. registrations have been canceled.
Niclosamide-Olamine	1420-04-8	Registered in some jurisdictions but not in the U.S.
Peanut Oil (Botanical Oil; *Arachis hypogaea hypogaea*)	8002-03-7	Registered as a pesticide in some jurisdictions but not in the U.S., peanut oil is used as an ingredient in "natural" insecticides and insect repellents[478], but efficacy or PHP utility has not been demonstrated.
Pepper (Black) Oil (Botanical; *Piper nigrum;* Piperaceae)	8006-82-4	Registered in the E.U., but not in the U.S. White pepper is exempt from regulatory requirements in the U.S.

Active Ingredient & Chemical Class	CAS RN	Mode of Action & Potential Vector Control Use Pattern
Peppermint Oil (Botanical; *Mentha × piperita*)	8006-90-4	Registered in some jurisdictions, but exempt from registration requirements in U.S.
Phoxim	14816-18-3	Registered in some other jurisdictions, but U.S. registrations have been canceled.
Pine Tar Oil = Tall Oil = Wood Tar Distillates[8] (*Pinus spp.*)	91995-59-4	Registered in some other jurisdictions, but U.S. registrations have been canceled.
Potassium Sorbate	24634-61-5	Registered in some jurisdictions, but exempt from registration requirements in U.S.
Propoxur	114-26-1	Registered in some other jurisdictions, but U.S. registrations have been canceled.
Sodium Chloride	7647-14-5	Registered in some jurisdictions, but exempt from registration requirements in U.S.
Sodium Lauryl Sulfate	151-21-3	Registered in some jurisdictions, but exempt from registration requirements in U.S.
Sunflower Oil (Botanical Oil; *Helianthus annuus*)	8001-21-6	Used as base ingredient in "natural" insect repellents[479] and as a carrier for *Metarhizium anisopliae* fungal spores to infect adult mosquitoes (Takken and Knols 2007), but efficacy and PHP utility is uncertain. Registered in the E.U. but not in the U.S.
Tasmanone (Botanical extract; *Eucalyptus cloeziana*)	22595-52-4	Botanical insecticide compound (a β-triketone), which exhibits a unique mode of action thought to be targeting the octopermine receptor in insects. Developed and marketed in Australia as Qcide for household and agricultural pests,[480] but no literature found on screening vs. public health pests.
Transfluthrin	118712-89-3	Registered in most jurisdictions but never in the U.S.
Ylang Ylang Oil (Botanical Oil; *Cananga odorata*)	68989-25-3	Active ingredient in some "natural" insect repellents[481], but efficacy and PHP utility unclear. Registered in the E.U. but not in the U.S.

Part J: Potential PHP's not known to be registered in any major jurisdiction

Table J1 presents novel materials which are not known to be registered for any purpose in any major jurisdiction. Many of these are natural products, which may have local uses, while others are semi-synthetic analogues to natural products or purely synthetic chemicals. In all cases, chemical or botanical identifiers are included together with mode of action (if known), observations on efficacy in the lab (and field, where available), and the most likely potential PHP use patterns as indicated in the current scientific and other public access literature. Many biological pest control strategies, such as microbes or fungal spores, can be formulated and distributed in a manner identical to chemical pesticides, and these are included in this table. Table J2 is a short list of underutilized biological vector control agents which are not likely to be readily formulated and packaged as pesticides.

Table J1. Potential PHP's not known to be registered in any major jurisdiction

Active Ingredient & Chemical Class	CAS RN	Mode of Action & Potential Vector Control Use Pattern
(-)-Isolongifolenone (Botanical – sesquiterpene)	26839-52-1	A natural product with significant repellent activity against medically important ticks and mosquitoes. More effective in the lab than DEET vs. *Ae. aegypti* (L.) and *Anopheles stephensi* Listonk, and as effective vs. *Ixodes scapularis* Say and *Amblyomma americanum*.[482] Reportedly synthesized from inexpensive turpentine oil feedstock, and therefore potentially inexpensive and abundant. Limited toxicology data as a repellent, but derivatives have been used extensively as ingredients in the cosmetics industry.
1,3,3-trimethylcyclohex-1-ene-4-carboxaldehyde (Botanical extract from multiple plants)	1726-47-2	Major constituent (11%) of some batches of essential oil of tansy, a highly effective tick repellent, but not significantly repellent when tested alone (Pålsson et al 2008). Unknown if tested yet on other vector species.
4-Terpineol (Botanical extract; multiple plants)	562-74-3	Significantly repellent to *Ixodes ricinus* L. (Pålsson et al 2008), but PHP utility not demonstrated.
Aedes aegypti male pheromone	None	Experimental work taking place as U.S. military's NAMRU-3 laboratory.
Alaskan Yellow Cedar Oil (Botanical; *Callitropsis nootkatensis*, Cupressaceae)	1069136-34-0	Essential oil with significant insect and repellent effects. (Anderson and Coats 2012).
Allethrin II (Pyrethroid, Ester)	497-92-7	A synthetic analogue to Pyrethrin II and Cinerin II, insecticidal constituents of pyrethrum, with a somewhat different biological activity profile from Allethrin I (and its pyrethrum analogue Pyrethrin I).
α-Terpineol = Alpha-Terpineol (Monoterpenoid; botanical extract from multiple plants)	98-55-5 (224400)	Monoterpenoid extracted from plants with insecticidal and/or repellent properties. Molecule with good insecticidal attributes, but MOA unclear (does not demonstrate MOA through [3H]-TBOB binding or 36Cl-uptake assays; Tong and Coats 2010). Significantly repellent to *Ixodes ricinus* L. (Pålsson et al 2008), and significant repellency to nymphal lone star ticks (*Amblyomma americanum*) and adult female yellow fever mosquitoes (*Ae. aegypti*) in lab assays (Weldon et al 2010), but PHP utility not demonstrated. No U.S. product registrations.
α-Thujone = Alpha-Thujone (Botanical extract from multiple plants)	546-80-5	Major constituent (11%) of some batches of essential oil of tansy, a highly effective tick repellent; significantly repellent to *Ixodes ricinus* L. when tested with beta-thujone (Pålsson et al 2008).
American Beautyberry Oil (Botanical oil; *Callicarpa americana*)		Ethnobotanical evidence of insect repellency. Several extracts of the essential oil have significant demonstrated efficacy vs. mosquitoes (Cantrell et al 2005), but operational utility not yet demonstrated.
Azadirachtin B (Botanical extract; Neem = *Azadirachta indica*)	95507-03-2 (121700)	Insecticide, IGR, and repellent with multiple modes of action. One of the three most potent constituents of neem oil. Full utility vs. public health pests has not been defined. EPA PC Code issued, but no technical materials nor end-use products have been registered (4/5/12).
Azadirachtin H (Botanical extract; Neem = *Azadirachta indica*)	134788-15-1	Insecticide, IGR, and repellent with multiple modes of action. One of the three most potent constituents of neem oil. Full utility vs. public health pests has not been defined.
Bti Strain IPS-78 (Microbial; bacterial spores & proteins)	68038-71-1	The literature describes this Bti strain, which presumably could serve as a larvicide, but it does not appear that any materials have been registered.
Balsam Torchwood Oil = West Indian Sandalwood Oil (Botanical Oil; *Amyris balsamifera*, Rutaceae)	8015-65-4	Essential oil with significant repellent activity vs. ticks in lab (in vitro and in vivo assays). In one study, at 2 and 4 h after application to filter paper, 827 microg amyris oil/cm^2 paper repelled 80 and 55%, respectively, of host-seeking *Am. americanum* nymphs. *Ixodes scapularis* was repelled by lower concentrations of the oil than A. americanum.[483]
Beauveria amorpha (Fungus)		Entomopathogenic fungus with evidence of efficacy and potential for commercialization vs. cattle ticks (Fernandes et al 2011).
Beauveria velata (Fungus)		Entomopathogenic fungus with evidence of efficacy and potential for commercialization vs. cattle ticks (Fernandes et al 2011).

Active Ingredient & Chemical Class	CAS RN	Mode of Action & Potential Vector Control Use Pattern
Beauveria vermiconia (Fungus)		Entomopathogenic fungus with evidence of efficacy and potential for commercialization vs. cattle ticks (Fernandes et al 2011).
Beauvericin (Fungal derivative)	26048-05-5	Beauvericin and analogues with toxic properties have been isolated and described from fungi with significant insecticidal activity.[484]
β-Caryophyllene (Botanical extract)	87-44-5	Major constituents of clove oils, and significant evidence of mosquito repellency (Shin-Ho et al 2009).
β-Ionone = Beta-Ionone (Botanical extract; *Suregada zanzibariensis*, etc.)	79-77-6	Published evidence found of good repellency vs. An. gambiaea, but PHP utility not demostrated.[485]
β-Pinene = Beta-Pinene (Botanical extract from multiple plants)	127-91-3 (224300)	Major constituent (11%) of some batches of essential oil of tansy, a highly effective tick repellent; apparently not highly repellent when tested alone (Pålsson et al 2008). No U.S. registered technical materials nor end-use products (4/2012).
β-Thujone = Beta-Thujone (Botanical extract from multiple plants)	471-15-8	Major constituent (39%) of some batches of essential oil of tansy, a highly effective tick repellent; significantly repellent to *Ixodes ricinus* L. when tested with alpha-thujone (Pålsson et al 2008).
Bistrifluron = DBI-3204 (Benzoylphenyl urea)	201593-84-2	IGR active against lepidopterous pests, whitefly; acts by inhibiting chitin synthesis. Efficacy vs. public health pests unknown.
Bovidic Acid (hydroxy furanoid fatty acid) and analogues	765956-30-7 etc.	Novel fatty acid identified from the Indian bison or gaur (Bos frontalis) and analogues demonstrate topical repellency vs. *Ae. aegypti* and potential PHP utility.[486]
Butyric Acid = Butanoic Acid	107-92-6	Possible oviposition attractant for some mosquitoes at some concentrations, but strong oviposition repellent for other species or at other concentrations (Hwang et al 1980; Kramer et al 1980).
Bugleweed (Botanical; *Ajuga remota*, Lamiaceae)		Reputed to produce compounds with substantial insecticidal properties, but apparently not tested for PHP efficacy or evaluated for utility.[487]
BYI 02960		Acetylcholine receptor agonist. Controls sucking pests and some thrips. Pest spectrum still being investigated. High level of safety for honeybees. PHP uses?
Cajeput Oil (Botanical Oil; *Melaleuca leucadendron*, Myrtaceae)	none	Pronounced efficacy vs. a range of mosquitoes (An., Ae., Cx.) is some published studies (e.g. Amer & Mehlhorn 2006), but PHP utility has not been fully demonstrated.
Callicarpenal (Terpenoid, Botanical; *Callicarpa america* or *C. japonica*; also synthetic)	161105-12-0	Botanical extract with good insect (including mosquito) and tick repellency. Bite deterrency effectiveness vs. *Ae. aegypti* and *An. stephensi* comparable to the highly repellent SS-220); no knock-down toxicity was seen (Cantrell et al 2005). Efficacy vs. ticks equivalent to Deet.[488] Effect against red imported fire ants.[489] Compound can be isolated from plant source (Cantrell et al 2005) or synthesized.[490]
Carveol (Botanical extract)	99-48-9	Constituent of plants with significant insecticidal and/or repellent effects. Significant repellency to nymphal lone star ticks (*Amblyomma americanum*) and adult female yellow fever mosquitoes (*Ae. aegypti*) in lab assays (Weldon et al 2010) but PHP utility not shown.
Carvone	99-49-0	Constituent of plants with significant insecticidal and/or repellent effects. Significant repellency to nymphal lone star ticks (*Amblyomma americanum*) and adult female yellow fever mosquitoes (*Ae. aegypti*) in lab assays (Weldon et al 2010) but PHP utility not shown.
Catnip Oil (Botanical oil; *Nepeta cataria*, Lamiaceae)	8023-84-5, 84929-35-1	Listed as an active ingredient in "natural" insect repellents,[491] and pronounced spatial repellent and irritant efficacy vs. a range of mosquitoes (An., Ae., Cx.) is some published studies[492] (e.g. Amer & Mehlhorn 2006), but PHP utility has not been fully demonstrated. Refined or hydrogenated catnip/catmint oil is a registered biopesticide (PC Code 4801).
Cinerin I (Botanical; extract of pyrethrum)	25402-06-6	One of six pyrethrins (active materials in pyrethrum) ; ester of chrysanthemumic acid + cinerolone
Cinerin II (Botanical; extract of pyrethrum)	121-20-0	One of six pyrethrins (active materials in pyrethrum) ; ester of pyrethric acid + cinerolone
Citronellal (Botanical extract; Lemon	106-23-0	Volatile constituent of many plants with insecticidal and/or repellent attibutes (e.g. constitutes 32-45% of

Active Ingredient & Chemical Class	CAS RN	Mode of Action & Potential Vector Control Use Pattern
Eucalyptus, etc.)		citronella oil). Precursor to PMD in leaves of lemon eucalyptus. Shows strong responses for mosquito odor receptors, indicating potential for utility as attractant or repellent.[493] In *Anopheles gambiae*, the DEET receptor OR83b is stimulated by citronellal.[494]
Citronellyl Acetate	150-84-5	Constituent of plants with significant insecticidal and/or repellent effects. Significant repellency to nymphal lone star ticks (*Amblyomma americanum*) and adult female yellow fever mosquitoes (*Ae. aegypti*) in lab (Weldon et al 2010) but PHP utility not shown.
Coelomomyces spp. (Fungi)		Entomopathogenic fungi. Many species known to reduce mosquito populations, but apparently never commercialized to date.[495]
Conidiobolus coronatus (Fungus)		Entomopathogenic fungus known to Infect *Phlebotomus papatisi* sand flies.[496]
Culicinomyces spp. (Fungi)		Entomopathogenic fungi. Many species known to reduce mosquito populations, but apparently never commercialized to date.
Copper Nanoparticles[16]	7440-50-8	Novel approach to insect control. Evidence of significant toxicity vs. larvae of the malaria vector mosquito *Anopheles subpictus* Grassi, the filariasis vector mosquito *Culex quinquefasciatus*, Say (Diptera: Culicidae), and the cattle tick *Rhipicephalus (Boophilus) microplus*, Canestrini (Acari: Ixodidae).[497]
CuniNPV (Baculovirus)		Pathogen of *Culex nigripalpus* and perhaps other mosquitoes, with potential for PHP development if technical challenges can be met. [498]
Cyhalothrin (Pyrethroid; Ester Type II)	68085-85-8	Subsets of stereoisomers of cyhalothrin are registered in the U.S. as lambda-cyhalothrin and gamma-cyhalothrin, and cyhalothrin is a pesticide common name recognized by ISO 1750, but it does not appear that this set of stereoisomers has ever been developed as a PHP.
d-α-Pinene = d-Alpha-Pinene = d-Pinene (Botanical extract from multiple plants)	7785-70-8 (67004)	Botanical extract with significant insecticidal and repellent activity. No U.S. registrations (4/2012).
Elemol (Botanical extract; Osage orange, *Maclura pomifera*, Moraceae, etc.)	639-99-6	A principle constituent of the essential oil of osage orange (also found in , with significant repellent activity vs. ticks in lab (in vitro and in vivo assays). In one study, there was no difference between this material and DEET on repellency vs. host-seeking *Am. americanum* nymphs. *Ixodes scapularis* was repelled by lower concentrations of elemol than A. americanum.[499]
(E)-N-cyclohexyl-N-ethyl-2-hexenamide (Carboxamide)	167645-74-1	Carboxamide from the USDA archives with very high mosquito repellency (better duration vs. *Ae. aegypti* than DEET at high and low doses; Katritsky et al 2010).
Engyodontium albus = *Beauveria alba* (Fungus)	none	Entomopathogenic fungus with evidence of efficacy and potential for commercialization vs. cattle ticks (Fernandes et al 2011).
French Marigold (Botanical; *Tagetes patula*, Asteraceae)		This plant is used in companion planting for many vegetable crops. Root secretions reportedly kill nematodes in the soil and the plant is said to repel harmful insects, such as white fly amongst tomatoes.[500] Evidence of repellency vs. squash bugs and Colorado potato beetles (Eason and LaManna 2000), but PHP efficacy or utility not shown.
Geranyl Acetate	105-87-3	Volatile botanical which shows strong responses for mosquito odor receptors, indicating potential for utility as attractant or repellent.[501] Significant repellency to nymphal lone star ticks (*Amblyomma americanum*) and adult female yellow fever mosquitoes (*Ae. aegypti*) in lab assays (Weldon et al 2010) but PHP efficacy not yet shown.
Geranylacetone	3796-70-1	Volatile botanical which shows strong responses for mosquito odor receptors, indicating potential for utility as attractant or repellent.[502]
Haedoxane A		Botanical extract with very good larvicidal action (0.025 ppm) vs. early fourth instar larvae of *Culex pipiens pallens* in a lab assay (Xiao et al 2011).

Active Ingredient & Chemical Class	CAS RN	Mode of Action & Potential Vector Control Use Pattern
Haedoxane E		Botanical extract with good larvicidal action (0.15 ppm) vs. early fourth instar larvae of *Culex pipiens pallens* in a lab assay (Xiao et al 2011).
HBTX (= Homobatrachotoxin)	23509-17-3	Experimental (unregistered) bacterial metabolite with PHP potential.
Hexahydro-1-(1-oxohexyl)-1H-azepine = NSC 60374 (Carboxamide)	18494-57-0	Carboxamide from the USDA archives with very high mosquito repellency (better minimum effective dose vs. *Ae. aegypti* than DEET; Katritzky et al 2010).
Intermedeol (Terpenoid, Botanical; *Callicarpa america* or *C. japonica*)	6168-59-8	Botanical extract with good mosquito repellency vs. *Ae. aegypti* and *An. stephensi* (similar to SS-220); no knock-down toxicity was seen (Cantrell et al 2005). Operational utility not demonstrated.
Japanese Beautyberry Oil (Botanical oil; *Callicarpa japonica*)	none	Ethnobotanical evidence of insect repellency. Several extracts of the essential oil have significant demonstrated efficacy vs. mosquitoes (Cantrell et al 2005), but operational utility not proven.
Jasmolin I[14] (Botanical; extract of pyrethrum)	4466-14-2	One of six pyrethrins (active materials in pyrethrum) ; ester of chrysanthemumic acid + jasmololone
Jasmolin II[14] (Botanical; extract of pyrethrum)	1172-63-0	One of six pyrethrins (active materials in pyrethrum) ; ester of pyrethric acid + jasmololone
Juniper Berry Oil (Botanical oil; *Juniperus communis*)	73049-62-4	Significant published evidence of high repellency for mosquito species with a variety of assays (Shin-Ho et al 2009).
Lemon Oil (Botanical Oil; *Citrus limonum*, Rutaceae)	8008-56-8	Significant repellency to nymphal lone star ticks (*Amblyomma americanum*) and adult female yellow fever mosquitoes (*Ae. aegypti*) in lab assays with whole plant extract and constituents geraniol, citronellol, citral, carveol, geranyl acetate, α-terpineol, citronellyl acetate, and carvone (Weldon et al 2010).
Limonin	1180-71-8	Liminoid found in extracts of many citrus plants with insecticidal and/or repellent attributes, with moderate (ca 50-500 ppm) efficacy as a mosquito larvicide, apparently due to moult inhibition (Kawaguchi et al 1989, Jayaprakasha et al 1997, Kiproop et al 2005, Faisal et al 2011).
Linoleic Acid (Fatty Acid; botanical extract from *Jatropha curcas* etc.)		Effective spatial repellent vs. *Ae. aegypti* after semi-volitalization resulting from combustion of plant matter traditionally used for this purpose (e.g. *Jatropha curcas* in India and parts of Africa). (Cantrell et al 2011).
Lopseed extracts (Botanical; *Phryma leptostachya*, Phrymaceae)	none	Extracts of this plant show good larvicidal action vs. *Culex pipiens pallens* in a lab assay; the most active fractions have been identified as the lignins Phrymarolin-I, haedoxane A, and haedoxane E (Xiao et al 2011).
May Chang Oil (Botanical oil; *Litsea cubeba*)	68855-99-2, 90063-59-5	Used as an active ingredient in some "natural" insect repellents.[503] Pronounced efficacy vs. a range of mosquitoes (An., Ae., Cx.) is some published studies (e.g. Amer & Mehlhorn 2006), but PHP utility has not been fully demonstrated.
Menthofuran	494-90-6	Volatile with significant toxicity to mosquitoes and other dipterans. Not as toxic as DDVP (ca 1/60), but lower mammalian toxicity and appealing odor, so perhaps a good replacement in some circumstances. (Chaskopoulou et al 2009)
Methyl Cinnamate	103-26-4	Constituent of plants with significant mosquito repellency, and shown in labs to have independent efficacy vs. *Ae. aegypti*. (Dekker et al 2011)
Mugwort = Common Wormwood Oil (*Artemisia vulgaris*, Asteraceae)	68991-20-8, 68916-13-2	Evidence of repellency vs. squash bugs and Colorado potato beetles (Eason and LaManna 2000), but not apparently tested for PHP efficacy or evaluated for utility.
Myristic Acid = Tetradecanoic Acid (Fatty Acid, C14)	544-63-8	Moderately effective topical and spatial repellent vs. mosquitoes. (Jones et al 2012)
n-Butyl Formate	592-84-7	Volatile with significant toxicity to mosquitoes and other dipterans. Not as toxic as DDVP (ca 1/60), but lower mammalian toxicity and appealing odor, so perhaps a good replacement in some circumstances. (Chaskopoulou et al 2009)
Niaouli Oil (Botanical Oil; *Melaleuca quinquenervia*, *M. viridiflora*; Myrtaceae)	8014-68-4	Pronounced repellent efficacy vs. a range of mosquitoes (An., Ae., Cx.) is some published studies (e.g. Amer & Mehlhorn 2006), but PHP utility has not been fully demonstrated.
Nomilin	1063-77-0	Liminoid found in extracts of many citrus plants with insecticidal and/or repellent attributes, with moderate

Active Ingredient & Chemical Class	CAS RN	Mode of Action & Potential Vector Control Use Pattern
		(ca 50-500 ppm) efficacy as a mosquito larvicide, apparently due to moult inhibition (Kawaguchi et al 1989, Jayaprakasha et al 1997, Kiproop et al 2005, Faisal et al 2011).
Nootkatone (Sesquiterpenoid, Botanical; from Alaskan Yellow Cedar and Grapefruit.	4674-50-4	Botanical extract with significant repellent effect. Toxic MOA unclear, but not acetylcholinesterase inhibition (Anderson and Coats 2012).
Nutmeg Oil (Botanical oil; *Myristica* spp., Myristicaceae)	8008-45-5, 8007-12-3[504]	Used as an active ingredient in "natural" insect repellents[505], but efficacy or PHP utility has not been demonstrated. The primary constituent of nutmeg oil is d-camphene (60-80% by weight), but d-pinene, limonene, d-borneol, l-terpineol, geraniol, safrol, and myristicin are also found.[506]
Oleic Acid (Fatty Acid; botanical extract from *Jatropha curcas* etc.)	112-80-1	Effective spatial repellent vs. *Ae. aegypti* after semi-volitalization resulting from combustion of plant matter traditionally used for this purpose (e.g. *Jatropha curcas* in India and parts of Africa). (Cantrell et al 2011).
Osage Orange Oil (Botanical Oil; *Maclura pomifera*, Moraceae)	none	A principle constituent of this oil, elemol, showed significant repellent activity vs. ticks in lab (in vitro and in vivo assays). The fruit has been claimed to deter spiders, cockroaches, boxelder bugs, crickets, fleas, and other arthropods, but the usefulness of this practice has been challenged.[507]
Palmitic Acid = Hexadecanoic Acid (Fatty Acid, C16; botanical extract from many sources)	57-10-3	Effective spatial repellent vs. *Ae. aegypti* after semi-volitalization resulting from combustion of plant matter traditionally used for this purpose (e.g. *Jatropha curcas* in India and parts of Africa). (Cantrell et al 2011). Less effective than other fatty acids in other studies (e.g. Jones et al 2012).
Patchouli Oil (Botanical Oil; *Pogostemon cablin*)	8014-09-3	Used as an active ingredient in "natural" insect repellents[508], but efficacy or PHP utility has not been demonstrated.
P-Cymene	99-87-6	Major constituent (1-27%) of a plant with insecticidal/repellent attributes (*Achillea biebersteinii*), but showed little independed mosquito larvicide or adulticide efficacy (Tabanca et al 2011).
Phrymarolin-I (Lignin; botanical extract *Phryma leptostachya* L.)	38303-95-6	Botanical extract with moderately good larvicidal action (1.21 ppm) vs. early fourth instar larvae of *Culex pipiens pallens* in a lab assay (Xiao et al 2011).
Pillpod Sandmat Oil (Botanical oil; *Euphorbia hirta*, Euphorbiaceae)	84625-37-6	Anectodal and some laboratory evidence of mosquito larvicidal activity, apparently due to the presence of saponins (Arya et al 2011).
Pinocamphone (Botanical extract from multiple plants)	547-60-4	Major constituent (11%) of some batches of essential oil of tansy, a highly effective tick repellent; apparently not highly repellent when tested alone (Pålsson et al 2008).
Prickly Ash (*Zanthoxylum spp.*) Oils	-	Experimental (unregistered) material; some plants of this genus (e.g. Sichuan Peppers) have very good insecticidal and repellent potential vs. mosquitoes, etc.
Prodigiosin (Microbial extract; *Serratia marcescens* NMCC46)	82-89-3	Microbial pigment with moderate larvicidal activity demonstrated vs. *Ae. aegypti* (LC_{50} = 42-377 ppm) and *An. stephensi* (51-285 ppm).[509]
Pulegone (Monoterpene; Botanical derived from essential oils of catnip, peppermint, and the pennyroyals)	89-82-7	Monoterpenoid extracted from plants with insecticidal (and repellent?) properties. Toxic MOA = positive allosteric modulator at insect GABA receptors (Tong and Coats 2010). A potent mosquito larvicide in laboratory assays,[510] and a major constituent in plants with insect repellency, but high mammalian toxicity to the chemical and its metabolite menthofuran may limit utility.[511]
Pyrethrin I (Botanical; extract of pyrethrum)	121-21-1	The most abundant and most toxic of the six insecticidal components of pyrethrum; ester of chrysanthemumic acid + pyrethrolone
Pyrethrin II (Botanical; extract of pyrethrum)	121-29-9	One of six pyrethrins (active materials in pyrethrum); ester of pyrethric acid + pyrethrolone
RIDL (**R**elease of **I**nsects carrying a **D**ominant **L**ethal) genes	-	Patented genetic engineering approach to sterile male releases; now in field experiments with mosquitoes in several countries.[512]
RNAi = RNA Interference	-	Recent publications and patent action as highly specific pesticides; development activity for many pests. Potential modes of action are varied, including direct toxicity, reduction of pathogen survival or transmissivity, overcoming resistance to existing pesticides, etc.

Active Ingredient & Chemical Class	CAS RN	Mode of Action & Potential Vector Control Use Pattern
S 220	-	Consists of the better known SS 220 and another stereochemical configuration, with lower repellent efficacy,[513] but perhaps lower cost of synthesis.
Sabadilla Oil (Botanical oil; *Schoenocaulon officinale*)	84604-18-2	Cited as useful insecticide vs. lice, etc.[514], but safety has been questioned, and efficacy and PHP utility is uncertain.
Sabinene (Botanical extract; *Juniperus communis* etc.)	3387-41-5	Major constituent of Juniper Berry oil, which was highly repellent to *Cx. pipiens* in recent review (Shin-Ho et al 2009).
Saponins	8047-15-2	Demonstrates mosquito larvicidal activity (Arya et al 2011).
Sichuan or Szechuan Pepper = Timur Oil (Botanical oil; *Zanthoxylum armatum*)	none	Published evidence of high repellent efficacy vs. mosquitoes[515]. PHP utility has not been demonstrated. Primary constituents are reportedly linalool (50%), limonene, methyl cinnamate, and cineole (= eucalyptol).[516]
Serratia entomophila & *Serratia proteamaculans* (microbial)		Bacteria that produce patented insecticidal protein genes.[517] PHP utility has been suggested, but no efficacy data have been identified.
Silicon Dioxide Nanoparticles	7631-86-9	Particles of silicon dioxide of approximately 10nm size have been successfully tested as larvicides as carriers and cuticle penetrants for bound pesticides (e.g. 2 molecules deltamethrin /particle), but PHP efficacy and utility are unproven.
Silver Nanoparticles	7440-22-4	Particles of silver of approximately 10nm size have been successfully tested as larvicides due to silver toxicity, as carriers and cuticle penetrants for bound pesticides (e.g. pyrethroids), and as toxicants for pathogens carried by mosquitoes. U.S. registration pending as antimicrobial only.[518]
Spathulenol (Terpenoid, Botanical; *Callicarpa japonica*)	6750-60-3	Botanical extract with good mosquito repellency vs. *Ae. aegypti* and *An. stephensi* (Cantrell et al 2005), but operational utility not demonstrated.
Spinosyn A	131929-60-7	A bacterial biotoxin, constituting 50-95% of the registered pesticide Spinosad
Spinosyn D	131929-63-0	A bacterial biotoxin, constituting 5-50% of the registered pesticide Spinosad
SS 220 = Methanone, (1S)-3-cyclohexen-1-yl[(2S)-2-methyl-1-piperidinyl] -	298207-27-9	Recent, experimental insect and tick repellent. Efficacy vs. mosquitoes equivalent to Deet, and better than Deet against ticks.[519]
Stearic Acid (Fatty Acid; botanical extract from *Jatropha curcas* etc.)	57-11-4	Effective spatial repellent vs. *Ae. aegypti* after semi-volitalization resulting from combustion of plant matter traditionally used for this purpose (e.g. *Jatropha curcas* in India and parts of Africa). (Cantrell et al 2011).
Stinking Roger (Botanical; *Tagetes minuta*, Asteraceae)		Evidence of repellency vs. squash bugs and Colorado potato beetles (Eason and LaManna 2000), but not apparently tested for PHP efficacy or evaluated for utility.
Sweet Basil Oil (Botanical oil; *Ocimum basilicum****Error! Bookmark not defined.***)	none	Used as active ingredient in "natural" insect repellents[520], but efficacy and PHP utility is uncertain. Recent review of essential oils vs. *Culex pipiens* (Shin-Ho et al 2009) showed moderate efficacy at 0.005 g/cm^2.
SYN 131-1	n/a	Botanical analogue with very high mosquito repellency under development by USDA ARS.
Tansy Oil (Botanical Oil; *Tanacetum vulgare* L., Asteraceae)	8016-87-3	The essential oils of tansy flower heads show strong repellency vs. the tick *Ixodes ricinus* L., although different chemotypes differ in their composition; typical volatile repellent constituents include alpha-terpineol, 4-terpineol, thujone (alpha+beta), eucalyptol, verbenol, and verbenone (Pålsson et al 2008). Eucalyptol was the only volatile material noted in all chemotypes in on study (Pålsson et al 2008). Not apparently tested for mosquito repellent efficacy or evaluated for utility.
Trans-Cinnamaldehyde (Botanical extract)	14371-10-9	Trans-cinnamaldehyde is the naturally occurring stereoisomer, and the major constituent of cinnamon oil. Evidence of mosquito control efficacy, primarily as constituent of botanical oils with bioactivity, but PHP utility not demonstrated.
Transpermethrin	61949-77-7	Subset of stereoisomers of permethrin, not independently registered.
Trilinolein(Triglyceride; botanical extract from	537-40-6	Triglyceride containing linoleic acid; both the free fatty acid and triglyceride are effective spatial repellents

Active Ingredient & Chemical Class	CAS RN	Mode of Action & Potential Vector Control Use Pattern
Jatropha curcas etc.)		vs. *Ae. aegypti* after semi-volitalization resulting from combustion of plant matter (Cantrell et al 2011).
Triolein (Triglyceride; botanical extract from *Jatropha curcas* etc.)	122-32-7	Triglyceride containing oleic acid; both the free fatty acid and triglyceride are effective spatial repellents vs. *Ae. aegypti* after semi-volitalization resulting from combustion of plant matter (Cantrell et al 2011).
Tripalmitin (Triglyceride; botanical extract from *Jatropha curcas* etc.)	555-44-2	Triglyceride containing palmitic acid; both the free fatty acid and triglyceride are effective spatial repellents vs. *Ae. aegypti* after semi-volitalization resulting from combustion of plant matter (Cantrell et al 2011).
Tristearin (Triglyceride; botanical extract from *Jatropha curcas* etc.)	555-43-1	Triglyceride containing stearic acid; both the free fatty acid and triglyceride are effective spatial repellents vs. *Ae. aegypti* after semi-volitalization resulting from combustion of plant matter (Cantrell et al 2011).
Turmeric Oil (Botanical, *Curcuma longa*, Zingiberaceae)	8024-37-1	Evidence of repellency vs. mosquitoes and other insects.
Undecanoic Acid = Hendecanoic Acid	112-37-8	Has been known as an effective mosquito repellent since the 1940's. Highly effective mosquito repellent (spatial) when produced from burning plant matter; also effective topical repellent applied to skin or cloth, and larvicide, etc. (Jones et al 2012)
Verbenol (Botanical extract; multiple plants)	473-67-6	Significantly repellent to *Ixodes ricinus* L. (Pålsson et al 2008), but PHP utility not demonstrated.
Verbenone (Botanical extract; multiple plants)	80-57-9	Significantly repellent to *Ixodes ricinus* L. (Pålsson et al 2008), but PHP utility not demonstrated. Semiochemical with significant repellent effect on bark beetles.
Violet Oil (Botanical Oil; *Viola odorata*, Violaceae)	8024-07-5	Pronounced repellent efficacy vs. a range of mosquitoes (An., Ae., Cx.) is some published studies (e.g. Amer & Mehlhorn 2006), but PHP utility has not been fully demonstrated.
Wild Bergamot Oil (Botanical Oil; *Monarda fistulosa*)	97952-61-9	Reputed to repel mosquitoes[521], probably because of the presence of thymol,[522] but evidence of practical efficacy is unclear.
Wild Turmeric Oil (Botanical oil; *Curcuma aromatic*)	94349-73-2	Published evidence of high repellent efficacy vs. mosquitoes[523]. PHP utility has not been demonstrated.
Wormwood = Absinth Wormwood Oil (Botanical oil; *Artemisia absinthium*)	8008-93-3	Extracts of this perennial herb, forb, or sub-shrub act as a volatile (= short-duration) traditional insect repellent. Evidence of repellency vs. squash bugs and Colorado potato beetles (Eason and LaManna 2000). Potential source of botanical extracts useful against mosquitoes and other public health pests (Strickman et al 2009).
Zinc Oxide Nanoparticles	1314-13-2	Novel approach to insect control. Evidence of significant toxicity vs. larvae of the cattle tick *Rhipicephalus (Boophilus) microplus*, Canestrini (Acari: Ixodidae); head louse *Pediculus humanus capitis*, De Geer (Phthiraptera: Pediculidae); malaria vector mosquito, *Anopheles subpictus*, Grassi; and filariasis vector mosquito, *Culex quinquefasciatus*, Say (Diptera: Culicidae).[524]

Table J2. Potential vector control biological control agents not in routine operational use

Organism	Mode of Action & Potential Vector Control Use Pattern
Anax imperator (Insect; Odonata: Aeshnidae)	Strong evidence that presence deters oviposition by Culiseta mosquitoes, but operational utility not demonstrated.[525]
Chrysoperla carnea (Insect)	Insects (Green Lacewing) with predatory larvae useful as biological control agents, particularly vs. aphids and thrips. Developed as Kagetaro by Arysta LifeScience. PHP utility unclear, but no published evidence found of vector control efficacy.
Diplonychus indicus (Insect; Hemiptera: Belostomatidae)	Demonstrated multi-year field efficacy vs. *Ae. aegypti* in tires.[526] Operational utility not yet demonstrated.
Nematodes	Parasitic nematodes colonize and replicate inside insect until host death. Currently used for controlling garden pests, with available literature showing efficacy against ticks.

Part K: Materials with Low Apparent Potential as Vector Control Pesticides

It is impossible to comprehensively list all the materials which have been screened for vector control uses and judged to have little potential, it is helpful to comment on novel pest control technologies that have been screened for PHP potential as part of their development process. Thus, Table K presents new pesticides coming onto the market, or older ones recently reevaluated for vector control, that have little apparent utility. While none of these should be rejected out of hand, it is hoped that this list may help direct scarce research resources away from unproductive paths if these have already been adequately explored.

Table K. Materials with low apparent potential utility as vector control pesticides

Active Ingredient & Chemical Class	CAS RN (EPA PC Code)	Potential Vector Control Use Pattern
1,2,4-Trimethoxybenzene (Botanical extract)		Regulated in BPPD Floral Attractants, Repellents, and Insecticides Group.[527] No published evidence found of utility for control of public health pests.
3-Buten-2-one, 4-(2,6,6-trimethyl-2-cyclohexen-1-yl)-, (E) (Botanical extract)		Regulated in BPPD Floral Attractants, Repellents, and Insecticides Group; and in Vegetable and Flower Oils Group. Not included in Registration Review documents for Vegetable and Flower Oils Group. No published evidence found of utility for control of public health pests.
4-Allylanisole = 4-Allyl Anisole (Botanical)		Semiochemical with significant repellent effect on bark beetles, but no significant published PHP efficacy.
α-Humulene = Alpha-Humulene (terpenoid, botanical; *Callicarpa americana* and *C. japonica*)	6753-98-6	Isolate from strongly repellent plants, but did not show significant repellent / bite deterrent efficacy in assays with *Ae. aegypti* or *An. stephensi* (Cantrell et al 2005).
Amdoflumet (Sulfonylamino Benzoate)		Miticide. No efficacy data found vs. public health pests.
Caraway Seed Oil (Botanical; *Carum carvi*; Umbelliferae)	8000-42-8	Recent review of essential oils vs. *Culex pipiens* (Shin-Ho et al 2009) showed low efficacy at 0.005 g/cm2.
Cardamom Oil (Botanical; *Elettaria cardamomum*; Zingiberaceae)	8000-66-6	Recent review of essential oils vs. *Culex pipiens* (Shin-Ho et al 2009) showed low efficacy at 0.005 g/cm2.
Chlorantraniliprole (Anthranilic Diamide)	500008-45-7 (90100)	Novel mode of action = ryanodine receptor activator, which interrupts muscle contraction in insects. Developed by Dupont Crop Protection and Syngenta Crop Protection, and EPA registered 2008 as a Reduced Risk & OP-Replacement Pesticide. Sometimes coformulated w/ Thiamethoxam or lambda-cyhalothrin. Excellent activity against a broad range of lepidopterous larvae. Screening by developer indicated low activity vs. mosquitoes, ticks, and bed bugs (Pers. Comm. 2/2012). 34 U.S. product registrations (4/2012).
Chlorphoxim	14816-20-7	The most durable of the materials initially screened for use in ITN's (Darriet 2007). Unclear if ever registered in U.S. Listed by WHO as "Believed to be Obsolete or Discontinued for Use as Pesticides" (WHO 2010, Table 6).
Chromafenozide	143807-66-3	Novel Ecdysone receptor agonist, which functions as an IGR apparently specific to lepidopterous pests. Developed as Matric by Nippon Kayaku / Sankyo. Not registered in U.S. PHP utility seems unlikely from the mode of action[528], and no published accounts of vector control efficacy have been found.
Cydia pomonella granulose virus	none	Virus specifically infective vs. codling moth larvae. Unlikely to have efficacy vs. vectors.
Cyenopyrafen (Acrylonitrile)	560121-52-0	Site 1 electron transport inhibitor Inhibits mitochondrial respiration. Controls spiders and mites, but screening by the developer found no evidence of efficacy vs. mosquitoes, other vector insects, or ticks (Pers. Comm. 2/2012).
Cyhexatin		Miticide. EPA registered Cyhexatin as Stannane, tricyclohexylhydroxy- from 1972 to 1989, when the last U.S. registrations were canceled. This older material is included here for efficacy comparisons. Topical efficacy vs. adult mosquitoes poor in one study (LD50 vs. *Ae. aegypti* 1/1,000 vs. permethrin; Pridgeon et al 2008).
Diflovidazin (ISO 1750) = Flufenzine = Flutenzine	162320-67-4	Not registered with the EPA and only registered as an agricultural pesticide in other countries.[529] No evidence found of PHP efficacy in the published literature.
d-trans-beta-Cypermethrin (Pyrethroid, Ester, Type II)	66841-24-514	A unique stereoisomer of cypermethrin, sold as a discrete product in some places, but has apparently not been registered as a PHP in any jurisdiction, and there are no published reports of efficacy vs. vectors. Generally cis-stereoisomers have better efficacy against dipterans that trans- configurations[530], so there seems little need to develop this chemical for vector control, given the availability of alpha-cypermethrin (cis- molecules) and the

Active Ingredient & Chemical Class	CAS RN (EPA PC Code)	Potential Vector Control Use Pattern
		observed increase in resistance to pyrethroids generally, but it may have utility in some niche uses.
EDP = Ethoxy Dodecyl Phenol (Polymer)	9014-92-0	EPA registered AI and Inert. As an agricultural pest AI, operates with a non-toxic MOA that damages the protective coating of soft-bodied insects or foliar pathogens, making them vulnerable to dessication from secondary chemicals in the formulation. This MOA does not seem likely to result in an effective PHP.[531]
Fenpyroximate (Pyrazole; Pyridazinone)	134098-61-6 (129131)	Effective miticide registered in many EU countries, with EPA registration pending for use as an agricultural pesticide[532]. Some claims of vector control efficacy in patent claims. However, this chemical class and mode of action have been reviewed for almost 40 years with minimal evidence published in the scientific literature of significant evidence of efficacy vs. mosquitoes, ticks, or other public health pests.
Flonicamid (pyridinecarboxamide)	158062-67-0 (128016)	A recently introduced material with an apparently novel, slow-acting, and not well characterized, mode of action. No cross-resistance with any known MOA, and promoted as a resistance management tool. An anti-feedant, leading to insect starvation.[533] While an insect may take up a toxic dose within a hour of contact, death may not occur for 2-5 days.[534] To date, this product has been directed against sucking insects only (thrips, etc.)[535] and efficacy vs. arthropod vectors has not been demonstrated. Potential utiliy in sugar baits vs. mosquitoes seems possible but unlikely. Registered in the U.S. (2003?).
Fluacrypyrim (ISO) = Fluacrypyrin	229977-93-9	Miticide introduced in 2000. No published evidence of PHP efficacy. Not registered with the EPA. Manufacturer has evaluated against tick larvae and was 1000x less effective than fipronil (Pers. Comm. 2-9-12)
Flubendiamide	272451-65-7	Acts primarily against lipidopterous agricultural pests536. PH pest efficacy is unknown; as of this date there is no demonstrated efficacy against PH pests.
Flufenerim	170015-32-4	Efficacy against agricultural pests (Lepidoptera) has been established.[537] No evidence to date of PHP efficacy.
Flupyrazolos	N/A	Developed ca. 2002. Publicly available information suggests potential efficacy in control of diamondback moth.[538] No published information found indicating potential PHP utility.
Helicoverpa zea Nuclear Polyhedrosis Virus	N/A	Virus apparently specific to the bollworm Helicoverpa zea, so potential utility for PH pests is low.
Humulene Epoxide II (terpenoid, botanical; *Callicarpa americana* and *C. japonica*)		Isolate from strongly repellent plants, but did not show significant repellent / bite deterrent efficacy in assays with *Ae. aegypti* or *An. stephensi* (Cantrell et al 2005).
Kaolin Clay (Mineral)	1332-58-7 (100104)	Registered in the US as a biopesticide, but PHP efficacy unclear. Protective film repels harmful insects.
Nerolidol (Botanical extract)	7212-44-4 (128911)	EPA-registered as biochemical pesticide as a mite sex pherermone. No apparent PHP efficacy. Now marketed as Biomite by Arysta Life Science in a combination product containing citronellol, geraniol, nerolidol and narnesol.
Polyhedral Occlusion Bodies (OB) of the Nuclear Polyhedrosis Virus of *Spodoptera exigua* (Virus)		Host-specific insecticidal virus, marketed as Spod-X vs. army beetworm.
Propargite	2312-35-8 (97601)	Miticide. Very poor topical efficacy reported vs. adult mosquitoes in one study (LD50 vs. *Ae. aegypti* 1/4900 vs. permethrin; Pridgeon et al 2006). No evidence found of tick efficacy in published literature.
Putrescent Whole Egg Solids (Natural product)	none	Putrescent Whole Egg Solids are exempt from pesticide registration in the U.S., and Whole Egg Solids are registered in Canada. Widely used in repellents for deer, rabbits, and other mammals, but no published evidence found of PHP utility.
q-Cypermethrin (Pyrethroid, Ester, Type II)	None14	A racemic mixture of R-trans stereoisomers of cypermethrin. This mixture has been sold as a discrete product, but has apparently not been registered as a PHP in any jurisdiction, and there are no published reports of efficacy vs.

Active Ingredient & Chemical Class	CAS RN (EPA PC Code)	Potential Vector Control Use Pattern
		vectors. As with other cis- isomer mixtures of cypermethrin in this table, there seems little need to develop this chemical for vector control, given the availability of alpha-cypermethrin and the observed increase in resistance to pyrethroids generally, but it may have utility in some niche uses.
Sorbitol Octanoate (Ester)	108175-15-1 (35400)	Novel pesticides in IR-4 database, effective at dessicating mites and soft-bodied insects, but no evidence found of efficacy vs. mosquitoes or other PHP's.
Streptomyces galbus Strain QST 6047 (microbial)		Novel insectice under development by AgraQuest (CA), which indicates no activity vs. public health pests.
Sucrose Octanoate (Ester)	42922-74-7 58064-47-4 (35300)	Novel pesticides in IR-4 database, effective at dessicating mites and soft-bodied insects, but no evidence found of efficacy vs. mosquitoes or other PHP's.
Theta-Cypermethrin (Pyrethroid, Ester, Type II)	71697-59-114	Theta-Cypermethrin is a racemate of a trans-configuration enantiomer pair of cypermethrin isomers, and constitutes about 60% of the mixture known as Beta-Cypermethrin. Theta-Cypermethrin has been sold as a discrete product as well, but has apparently not been registered as a PHP in any jurisdiction. As with other cis-isomer mixtures of cypermethrin in this table, there seems little need to develop this chemical for mosquito control, given the availability of alpha-cypermethrin and the observed increase in resistance to pyrethroids generally, but it may have utility in some niche uses.
Thiamin		Some old studies suggesting that ingested thiamin could act as an "oral mosquito repellent," but this claim has been convincingly disproven.[539]
Ultrasonic Insect Repellents		Widely advertised, but no rigorous evidence of efficacy found, and substantial evidence of lack of efficacy, at least for mosquitoes.[540]

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References and Notes

References that provide useful information on multiple materials are presented as full citations immediately below with the most current web address found; references relevant to only one material are in the endnotes which follow afterwards.

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ISO 765 "Pesticides considered not to require common names" was published in 1976 (ISO 765-1976).

Where ISO names have not been published, authorities recognized here include the World Health Organization (WHO), Chemical Abstracts Service (CAS), U.S. Environmental Protection Agency (EPA), British Standards Institution, (BS 1831: 1969), Standards Press of China (GB 4839: 2009), and the Entomological Society of America (ESA).

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1 The R- stereoisomer of octenol is much more bioactive than the S- configuration, and both racemic and R-Octenol are registered and sold. It is not always clear which is covered in lists of approved products.

2 The avermectins are a series of complex macrocyclic lactone derivatives with potent anthelmintic and insecticidal properties (Omura & Shiomi 2007). These naturally occurring compounds are generated as fermentation products by Streptomyces avermitilis, a soil actinomycete. Eight different avermectins have been isolated in 4 pairs of homologue compounds, with the major (a-) and minor (b-) components usually observed in ratios of 80:20 to 90:10 (Pitterna et al 2009). Other anthelmintics and potential insecticides derived from the avermectins include ivermectin, selamectin, doramectin, and abamectin (en.wikipedia.org/wiki/Avermectin accessed 3/14/12). Abamectin is a specified mixture of avermectins containing more than 80% avermectin B1a and less than 20% avermectin B1b (en.wikipedia.org/wiki/Abamectin accessed 3/14/12). Ivermectin is a mixture of derivatives of avermectins B1a and B1b (22,23-dihydroavermectin B1a + 22,23-dihydroavermectin B1b; en.wikipedia.org/wiki/Ivermectin accessed 3/14/12).

3 Azadirachtin A = 1H,7H-Naphtho[1,8-bc:4,4a-c']difuran-5,10a(8H)-dicarboxylic acid, 10-(acetyloxy)octahydro-3,5-dihydroxy-4-methyl-8-[[(2E)-2-methyl-1-oxo-2-buten-1-yl]oxy]-4-[(1aR,2S,3aS, 6aS,7S,7aS)-3a,6a,7,7a-tetrahydro-6a-hydroxy-7a-methyl-2,7-methanofuro[2,3-b]oxireno[e]oxepin-1a(2H)-yl]-, 5,10a-dimethyl ester, (2aR,3S,4S,4aR,5S,7aS,8S,10R,10aS,10bR)-

4 Azadirachtin B = 7H,8H-Furo[3',4':4,4a]naphtho[1,8-bc]furan-5,10a(1H)-dicarboxylic acid, 10-(acetyloxy)octahydro-3,5-dihydroxy-4-methyl-8-[[(2E)-2-methyl-1-oxo-2-buten-1-yl]oxy]-4-[(1aR, 2S,3aS,6aS,7S,7aS)-3a,6a,7,7a-tetrahydro-6a-hydroxy-7a-methyl-2,7-methanofuro[2,3-b]oxireno[e]oxepin-1a(2H)-yl]-,5,10a-dimethyl ester, (2aR,3S,4S,4aR,5S,7aS,8R,10R,10aS, 10bR)-

5 Azadirachtin H = 7H,8H-Furo[3',4':4,4a]naphtho[1,8-bc]furan-10a(1H)-carboxylic acid, 10-(acetyloxy)octahydro-3,5-dihydroxy-4-methyl-8-[[(2E)-2-methyl-1-oxo-2-buten-1-yl]oxy]-4-[(1aR,2S, 3aS,6aS,7S,7aS)-3a,6a,7,7a-tetrahydro-6a-hydroxy-7a-methyl-2,7-methanofuro[2,3-b]oxireno[e]oxepin-1a(2H)-yl]-, methyl ester, (2aR,3S,4S,4aR,5R,7aS,8S,10R,10aS,10bR)-

6 See, e.g. ….

7 Beauvericin = Cyclo[(2*R*)-2-hydroxy-3-methylbutanoyl-*N*-methyl-L-phenylalanyl-(2*R*)-2-hydroxy-3-methylbutanoyl-*N*-methyl-L-phenylalanyl-(2*R*)-2-hydroxy-3-methylbutanoyl-*N*-methyl-L-phenylalanyl]

8 HBTX (= Homobatrachotoxin) = 1*H*-Pyrrole-3-carboxylic acid, 2-ethyl-4-methyl-, (1*S*)-1-[(5a*R*,7a*R*,9*R*,11a*S*,11b*S*,12*R*,13a*R*)-1,2,3,4,7a,8,9,10,11,11a,12,13-dodecahydro-9,12-dihydroxy-2,11a-dimethyl-7*H*-9,11b-epoxy-13a,5a-propenophenanthro[2,1-*f*][1,4]oxazepin-14-yl]ethyl ester

9 Limonin = 11*H*,13*H*-Oxireno[*d*]pyrano[4',3':3,3a]isobenzofuro[5,4-*f*][2] benzopyran-4,6,13(2*H*,5a*H*)-trione, 8-(3-furanyl)decahydro-2,2, 4a,8a-tetramethyl-, (2a*R*,4a*R*,4b*R*,5a*S*,8*S*,8a*S*,10a*R*,10b*R*,14a*S*)-

10 Proposed as one of the active fractions in bitter orange oil (mdpi.com/1420-3049/14/2/839).

11 Methyl Isoeugenol is reportedly a significant constituent (7-11%) of Ceylon-type Citronella oil (*Cymbopogon nardus*) (Chang 2007).

12 Methyl Salicylate is a specific compound while Oil of Wintergreen is a plant extract, but because of the high percentage (98-99%) of methyl salicylate in high quality oil of wintergreen (*Gaultheria procumbens*, Ericaceae), the two identifiers are often used synonymously, especially in trade. This is unfortunate for several reasons. First, the common name wintergreen has been applied to other plants in the genus *Gaultheria*, many of which have lower methyl salicylate contents (e.g. *G. yunnanensis*). Second, *G. procumbens,* the most common wintergreen plant, and the traditional source of wintergreen oil, has many common names. Also, all plant oils contain other constituents; for example, *G. procumbens* oil also contains the recently described gaulterilenes; other trace constituents, some of which may have insecticidal attributes, remain to be identified. Finally, methyl salicylate can be synthetically produced or commercially extracted from other plants, most of which have multiple common names (for example, a major commercial source of methyl salicylate is *Betula lenta* = Sweet Birch. Plants producing methyl salicylate in significant amounts (i.e. readily detected by scent) in addition to species of the genera *Gaultheria* and *Betula* (particularly those in the subgenus *Betulenta*) include most species of the family Pyrolaceae, particularly those in the genus *Pyrola*, and all species of the genus *Spiraea* (Rosaceae), also called the meadowsweets. CAS explicitly recognizes this distinction with issuance of distinct RN's.

The distinction between the chemical compound and the botanical oil is increasingly recognized in regulatory actions and documents. For example, the EPA RED for methyl salicylate (epa.gov/oppbppd1/biopesticides/ingredients/tech-docs/red-076601.pdf) clearly distinguishes between methyl salicylate and oil of wintergreen. However, PC Code 76601 is still used for both, as well as for birch bark oil, sweet birch oil, and *Betula lenta* oil (epa.gov/pesticides/chemicalsearch; accessed 3/7/12).

[13] Nomilin = Oxireno[4,4a]-2-benzopyrano[6,5-*g*][2]benzoxepin-3,5,9(3a*H*,4b*H*,6*H*)-trione, 11-(acetyloxy)-1-(3-furanyl)decahydro-4b,7,7,11a,13a-pentamethyl-, (1*S*,3a*S*,4a*R*,4b*R*,6a*R*,11*S*,11a*R*,11b*R*,13a*S*)-

[14] The composition of the two citronella taxa/chemotypes is somewhat variable, but the values shown below are typical (en.wikipedia.org/wiki/Citronella-oil):

	Ceylon Citronella	Java Citronella
Plant Species	*Cymbopogon nardus* (L.) Rendle	*Cymbopogon winterianus* Jowitt
Citronellal	5-15%	32-45%
Citronellol	6-8%	
Geraniol	18-20%	11-13%
Limonene	9-11%	1-4%
Methyl Isoeugenol	7-11%	
Geranyl Acetate		3-8%

[15] This oil reportedly contains linalool (50%), limonene, methyl cinnamate, and cineole (http://en.wikipedia.org/wiki/Sichuan_pepper, accessed 7/17/12), all of which may explain its activity vs. insects.

[16] Pyrethrum Marc is not generally considered to have any particularly active insecticidal or repellent character, but it is registered by some pesticide authorities.

[17] In 1992, EPA consolidated eight registered pesticide active ingredients (soap = sodium salts of fatty acids, oleic acid, ammonium oleate, sodium oleate, potassium laurate, potassium myristate, potassium oleate, and potassium ricinoleate) into three (ammonium, potassium, and sodium salts of fatty acids), which were reregistered in the "soap salts" group. EPA considers "all potassium salts of fatty acids and all combinations of these chemicals to be a single active ingredient. Similarly, all ammonium salts of fatty acids are treated as one active ingredient. Soap or sodium salts of fatty acids remained an active ingredient as well." (Soap Salts Summary Document Registration Review: Initial Docket (9/15/08), regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2008-0519-0003.

Earlier EPA documents and other jurisdictions use other terms. In particular, some fatty acids and soap salts are considered independently, such as Potassium laurate = CAS RN 10124-65-9, the potassium salt of dodecanoic acid, or nonanoic = pelargonic acid and its salts. CAS RN's for this group are also complex, and there is not a one-to-one correspondence of CAS usage and regulatory usage.

[18] Spinosyn A = 1*H*-*as*-Indaceno[3,2-*d*]oxacyclododecin-7,15-dione, 2-[(6-deoxy-2,3,4-tri-*O*-methyl-α-L-mannopyranosyl)oxy]-13-[[(2*R*,5*S*,6*R*)-5-(dimethylamino)tetrahydro-6-methyl-2*H*-pyran-2-yl]oxy]-9-ethyl-2,3,3a,5a,5b,6,9,10,11,12,13,14,16a,16b-tetradecahydro-14-methyl-, (2*R*,3a*S*,5a*R*,5b*S*,9*S*,13*S*,14*R*,16a*S*,16b*R*)-

[19] Spinosyn D = 1*H*-*as*-Indaceno[3,2-*d*]oxacyclododecin-7,15-dione, 2-[(6-deoxy-2,3,4-tri-*O*-methyl-α-L-mannopyranosyl)oxy]-13-[[(2*R*,5*S*,6*R*)-5-(dimethylamino)tetrahydro-6-methyl-2*H*-pyran-2-yl]oxy]-9-ethyl-2,3,3a,5a,5b,6,9,10,11,12,13,14,16a,16b-tetradecahydro-4,14-dimethyl-, (2*S*,3a*R*,5a*S*,5b*S*,9*S*,13*S*,14*R*,16a*S*,16b*S*)-

[20] The R- stereoisomer of octenol is much more bioactive than the S- configuration, and both racemic and R-Octenol are registered and sold. It is not always clear which is covered in lists of approved products.

[21] Acetaminophen is registered in the U.S. for use vs. the brown tree snake, but not apparently vs. any vector species.

[22] α-Pinene is registered in Australia only when coformulated with Anisyl Alcohol, Butyl Salicylate, D-Limonene, Eucalyptol, and Phenylacetaldehyde.

[23] *Betabaculovirus* is only registered in the E.U. vs. *Cydia Pomonella.*

[24] Dicofol is registered in Australia solely as a miticide (not as an insecticide).

[25] The U.S. is evaluating whether to withdraw registration requirements for the furanones, due to their low toxicity to insects in typical application concentrations (see Table E3).

[26] Unclear if d-Verbenone is registered in Canada as racemate or as specific stereoisomer.

[27] EPA has announced the pending cancellation of all remaining uses of Endosulfan in the U.S., effective by 2016: regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2002-0262-0188.

[28] While the Indian Pesticides Registry shows Endosulfan as a registered insecticide as of May 16, 2012 (cibrc.nic.in/ accessed 7/20/12), it notes that "Endosulfan has been banned by the Supreme Court of India w.e.f. 13-05-2011 for production, use & sale, all over India, till further orders vide ad-Interim order in the Writ Petition (Civil) No. 213 of 2011."

[29] Canada registers Fatty Acids as herbicides, but not as insecticides at this time (3/19/12).

[30] As per the EU website, Fatty acids are registered from C7-C20, so there is some overlap with the categories.

[31] There are multiple stereoisomers of HCH, but only Lindane (γ = gamma-HCH) has apparently been used specifically for vector control.

[32] Heptanoic Acid was registered is Australia as an herbicide within the last year, but not as an insecticide. Not in latest available list; no details available on reason for cancellation.

[33] U.S. registration of blastospores of P. *fumosoroseus* strain FE 9901 are pending.

[34] Lindane is currently registered as "restricted for use" in India, but is also listed as banned, with the note: "Banned vide Gazette Notification No S.O. 637(E) Dated 25/03/2011)-Banned for Manufecture,Import or Formulate w.e.f. 25th March,2011 and banned for use w.e.f. 25th March,2013." (http://cibrc.nic.in/list_pest_bann.htm accessed 7/20/12).

[35] *Metarhizium anisopliae* is registered in India, but with no specific strain identified.

[36] The strain registered in South Africa is not identified as in other jurisdictions, but it is not clear if this is a difference in taxa or in nomenclature for the same organism.

[37] These viruses registered in Canada only for vs. saw fly, tussock moth, and gypsy moth (larvae).

[38] E.U. registration pending for Pending approval for spodoptera and helicoverpa.

[39] Australia registers mustard powder rather than oil.

[40] Australia registers "Neem Seed Extract Powder".

[41] Pine Tar Oil is Registered in Australia as Tar.

[42] Tea tree oil is registered in the E.U. as "Extract of Tea Tree".

[43] Propylene Glycol Monolaurate is managed by EPA as part of the group Fatty Acid Monoesters.

[44] Pyridaben is registered in Australia solely as a miticide (not as an insecticide).

[45] USEPA has publicly announced the impending voluntary cancellation of Resmethrin, but negotiations are underway to retain U.S. registration.

[46] Tebufenpyrad is registered in Australia solely as a miticide (not as an insecticide).

[47] USEPA has publicly announced the impending voluntary cancellation of Temephos, but negotiations are underway to retain U.S. registration.

[48] IRAC MoA Classification v 7.2, February 2012: http://www.irac-online.org/wp-content/uploads/MoA-classification.pdf

[49] http://www.who.int/whopes/Insecticides_IRS_Malaria_09.pdf (October 2009)

[50] http://www.who.int/whopes/Insecticides_ITN_Malaria_ok3.pdf (Dec 2007)

[51] http://www.who.int/whopes/Long_lasting_insecticidal_nets_Jul_2011.pdf

[52] http://www.who.int/whopes/quality/en/Alphacypermethrin_WHO_specs_eval_Jan_2012.pdf

[53] http://www.who.int/whopes/quality/Alphacypermethrin_Interceptor_specs_eval_WHO_Oct_2009.pdf

[54] http://www.who.int/whopes/quality/Alpha-cypermethrin_incorporated_LN_specs_eval_WHO_Jul_2011.pdf

[55] All materials under evaluation are current as of the most recent WHOPES compilation (August 2011).

[56] http://www.who.int/whopes/Mosquito_Larvicides_sep_2011.pdf

[57] http://www.who.int/whopes/quality/Bti_eval_spec_Jun_07.pdf

[58] http://www.who.int/whopes/quality/Bendiocarb_eval_WHO_jan_2009.pdf

[59] http://www.who.int/whopes/quality/Bifenthrin_WHO_specs_eval_Jan_2012.pdf

[60] http://www.who.int/whopes/quality/Bioallethrin_%20spec_eval_May2005.pdf

[61] http://www.who.int/whopes/quality/en/Brodifacoum_Aug_09.pdf

[62] http://www.who.int/whopes/quality/Chlorpyrifos_WHO_specs_eval_Mar_2009.pdf

[63] WHO 1980. C.P. Pant and J. Pull. "Evaluation of new insecticides for use in antimalaria programmes." World Health Organization, Geneva, document WHO/VBC/80.771. Cited in FAO 2004, "FAO Specifications and Evaluations for Agricultural Pesticides: Chlorpyrifos," fao.org/ag/AGP/AGPP/Pesticid/Specs/docs/Pdf/new/chlorpyr.pdf.

[64] http://www.who.int/whopes/quality/en/Cyfluthrin_spec_eval_WHO_Nov_2004.pdf

[65] http://www.who.int/whopes/quality/en/dAllethrin_spec_eval_March_04.pdf

[66] http://www.who.int/whopes/quality/en/DDT_Aug_09.pdf

[67] http://www.who.int/whopes/Insecticides_for_space_spraying_nov_2011.pdf (November 2011)
[68] http://www.who.int/whopes/quality/en/ddtrans-cyphenothrin_Spec_Eval_Sept_2005.pdf
[69] http://www.who.int/whopes/quality/oldspecif/en/
[70] http://www.who.int/whopes/quality/Deltamethrin_eval_specs_WHO_Jan_2010.pdf
[71] http://www.who.int/whopes/quality/Deltamethrin_coated_LN_specs_eval_WHO_Sep_2010.pdf
[72] http://www.who.int/whopes/quality/Deltamethrin_LN_incorporated_into_filaments_WHO_spec_eval_Sep_2011.pdf
[73] http://www.who.int/whopes/quality/Deltamethrin_PBO_incorporated_LN_spec_eval_WHO_Dec_2010.pdf
[74] http://www.who.int/whopes/quality/en/diazinon.pdf
[75] http://www.who.int/whopes/quality/en/Dichlorvos_Aug_09.pdf
[76] http://www.who.int/whopes/quality/diflubenzuron_eval_march_2006.pdf
[77] http://www.who.int/whopes/quality/en/Dimethoate_eval_april_2006.pdf
[78] http://www.who.int/whopes/quality/en/dPhenothrin_Spec_Eval_Oct_2004.pdf
[79] http://www.who.int/whopes/quality/en/Endosulfan_eval_WHO_feb_2011.pdf
[80] who.int/whopes/quality/en/Esbiothrin_spec_eval_Oct_2004.pdf. The WHOPES Specification and EPA 2009 cite CAS RN 260359-57-5 for this mixture of allethrin stereoisomers, but CAS SciFinder cites this as an invalid CAS Registry Number (2/16/12).
[81] http://www.who.int/whopes/quality/en/Etofenprox_eval_WHO_july_2007.pdf
[82] http://www.who.int/whopes/quality/Fenitrothion_specs_eval_WHO_Jan_2010_ok.pdf
[83] http://www.who.int/whopes/quality/en/Fenthion_eval_spec_Dec2006.pdf
[84] http://www.who.int/whopes/quality/en/IR3535_eval_april_2006.pdf
[85] http://www.who.int/whopes/quality/oldspecif/en/
[86] http://www.who.int/whopes/quality/en/Lambda-cyhalothrin_eval_specs_WHO_Oct_2011.pdf
[87] http://www.who.int/whopes/quality/en/Larvicidal_Oil.pdf
[88] http://www.who.int/whopes/quality/en/Lindane_Aug_09.pdf
[89] http://www.who.int/whopes/quality/en/Malathion_july04.pdf
[90] http://www.who.int/whopes/quality/en/methoprene_evaluation_feb_2007.pdf
[91] http://www.who.int/whopes/quality/oldspecif/en/
[92] http://www.who.int/whopes/quality/en/Niclosamide.pdf (2002)
[93] http://www.who.int/whopes/quality/en/Niclosamide.pdf (2002)
[94] http://www.who.int/whopes/quality/en/Novaluron_evaluation_Dec_2004.pdf
[95] http://www.who.int/whopes/quality/en/Permethrin_specs_eval_WHO_March_2009.pdf
[96] http://www.who.int/whopes/quality/Permethrin_25_75_specs_eval_WHO_Sep_2011.pdf
[97] http://www.who.int/whopes/quality/permethrin_LN_July_2006.pdf
[98] http://www.who.int/whopes/quality/sbioallethrin_permethrin_eval_Nov2006.pdf
[99] http://www.who.int/whopes/quality/en/Phoxim_WHO_specs_March_2011.pdf
[100] http://www.who.int/whopes/quality/en/Icaridin_spec_eval_Oct_2004.pdf
[101] http://www.who.int/whopes/quality/PBO_specs_eval_WHO_Sep_2011.pdf
[102] http://www.who.int/whopes/quality/en/Pirimiphos_methyl_eval_may_06.pdf
[103] http://www.who.int/whopes/quality/en/prallethrin_spec_eval_Nov_2004.pdf
[104] http://www.who.int/whopes/quality/en/propoxur_eval_spec_WHO_October_2005.pdf
[105] http://www.who.int/whopes/quality/en/Pyrethrum_Aug_09.pdf
[106] http://www.who.int/whopes/quality/en/pyriproxyfen_eval_specs_WHO_jul2006.pdf
[107] http://www.who.int/whopes/quality/sbioallethrin_spec_eval_apr_2006.pdf
[108] http://www.who.int/whopes/quality/sbioallethrin_permethrin_eval_Nov2006.pdf
[109] http://www.who.int/whopes/quality/Spinosad_eval_only_Sep_2011.pdf

[110] http://www.who.int/whopes/quality/Temephos_eval_only_June_2011.pdf

[111] http://www.who.int/whopes/quality/Transfluthrin_eval_only_Nov2006.pdf

[112] http://www.who.int/whopes/quality/oldspecif/en/

[113] EPA has evaluated and managed many botanical extracts over the years using overlapping "chemical groups", of which three are now recognized by the Biopesticides and Pollution Prevention Division (BPPD): the Plant Oils Groups (Fact Sheet 2001 = epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_plant-oils.htm); the Floral Attractants, Repellents, and Insecticides Group (Fact Sheet 2000 = epa.gov/opp00001/chem_search/reg_actions/registration/fs_G-105_25-Sep-00.pdf); and the Vegetable and Flower Oils (Fact Sheet = epa.gov/opp00001/chem_search/reg_actions/registration/fs_G-114_01-Jul-01.pdf), which is in Reregistration (Docket EPA-HQ-OPP-2009-0904. The most recent document is the "Vegetable and Flower Oils Final Work Plan" (9/23/10): regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0904-0006), which covers 17 registered biopesticides. In addition, a number of these materials are exempt from FIFRA registrations requirements under section 25(b) of that Act.

[114] "1-Octen-3-ol (069037) Fact Sheet" (2003): epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_069037.htm

[115] Registration Review: Phenethyl Propionate (Case 3110) = Docket EPA-HQ-OPP-2010-0714, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0714-0003.

[116] http://pmep.cce.cornell.edu/profiles/insect-mite/abamectin-bufencarb/avermectin/insect-prof-avermectin.html

[117] Pesticide Fact Sheet, Name of Chemical: Acetamiprid, Reason for Issuance: Conditional Registration (3/15/02), epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-099050_15-Mar-02.pdf

[118] http://www.epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_073401.htm

[119] There is a patent on this (osdir.com/patents/Plant-compositions/Organophosphate-insecticide-synergists-fly-tick-control-07192905.html), for use vs. ticks. A possible mode of action is unclear, and the literature is inconsistent on atrazine and arthropods generally, with claims that this material both increases insect susceptibility to other pesticides (onlinelibrary.wiley.com/doi/10.1002/etc.5620210724/full) and decreases susceptibility (sciencedirect.com/science/article/pii/S0045653506002232), presumably by acting on detoxifying oxidases.

[120] The EPA jointly evaluates Neem materials as the Azadirachtin and Clarified Hydrophobic Extract of Neem Oil Group. epa.gov/opp00001/chem_search/reg_actions/registration/fs_G-127_01-Oct-01.pdf

[121] *Bacillus thuringiensis* (Bt) is registered at the species level by EPA as PC Codes 6400 and 69162, but subspecies and strains are regulated independently. PC Code 6401 applies to "*Bacillus thuringiensis* subsp. israelensis", which is frequently synonymous with *Bacillus thuringiensis israelensis* serotype H-14 in the literature.

[122] EPA chemical search shows no regulatory activity, but NPIRS shows active registrations.

[123] EPA chemical search shows no regulatory activity, but NPIRS shows active registrations.

[124] http://www.epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_006476.htm

[125] http://www.epa.gov/oppsrrd1/REDs/poly_glycol_red.pdf

[126] http://www.epa.gov/oppsrrd1/REDs/factsheets/3150fact.pdf

[127] PesticideInfo.org reports active EPA registration vs. mosquitoes, but EPA reports that no outdoors uses for this product have been registered.

[128] RED Fact Sheet: Chloropicrin (7/10/08), epa.gov/opp00001/chem_search/reg_actions/reregistration/fs_PC-081501_10-Jul-08.pdf

[129] Amended Reregistration Eligibility Decision for Chloropicrin (5/27/09). regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-0350-0396

[130] Soil Fumigants Toolbox (April 2011), http://iaspub.epa.gov/apex/pesticides/f?p=CHEMICALSEARCH:21:3944037947044872::NO:::

[131] WHO 1980. C.P. Pant and J. Pull. "Evaluation of new insecticides for use in antimalaria programmes." World Health Organization, Geneva, document WHO/VBC/80.771. Cited in FAO 2004, "FAO Specifications and Evaluations for Agricultural Pesticides: Chlorpyrifos," fao.org/ag/AGP/AGPP/Pesticid/Specs/docs/Pdf/new/chlorpyr.pdf.

[132] There does not appear to be any published literature supporting evidence of this material vs. any vector, although the 25(b) provision would currently allow its sale for this purpose.

[133] Corn Gluten Meal (100137) Fact Sheet (11/1/02), epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-100137_01-Nov-02.pdf; Biopesticides Registration Action Document: Glutens, Corn (Corn Gluten Meal) (PC Code 100137) (3/4/03), epa.gov/opp00001/chem_search/reg_actions/registration/decision_PC-100137_4-Mar-03.pdf

[134] Reregistration Eligibility Decision for Coumaphos (7/1/06), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-036501_1-Jul-06.pdf

[135] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-109702_14-Jan-08.pdf

[136] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/fs_PC-080301_1-Apr-98.pdf

[137] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/fs_PC-108201_1-Aug-97.pdf

[138] http://www.epa.gov/oppsrrd1/REDs/factsheets/3138fact.pdf

[139] http://www.epa.gov/opprd001/factsheets/dunotefuran.pdf; epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-044312_01-Sep-04.pdf

[140] http://www.epa.gov/opp00001/reregistration/REDs/mgk_326_red.pdf

[141] http://www.epa.gov/oppsrrd1/REDs/factsheets/3083fact.pdf; http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0673-0015

[142] Reregistration Eligibility Decision for d-Phenothrin (9/25/08), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-069005_25-Sep-08.pdf

[143] Dried blood was registered as a biopesticide used as a mammal (dog, rabbit, deer) repellent from 1958. RED (1991) = epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-000611_1-Sep-91.pdf; RR Final Work Plan (2007) = epa.gov/opp00001/chem_search/reg_actions/reg_review/fwp_PC-000611_27-Nov-07.pdf; Final registrations cancelled and Registration Review cancelled (Dec 2007) = epa.gov/opp00001/chem_search/reg_actions/reg_review/frn_PC-000611_12-Dec-07.pdf.

[144] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-128827_1-Jun-92.pdf

[145] Garlic oil Final Registration Review Decision(9/28/10), regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0113-0011

[146] epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-004006_01-Mar-98.pdf

[147] epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-113509_01-Jan-00.pdf

[148] Aliphatic Alcohols Facts (6/1/07), epa.gov/opp00001/chem_search/reg_actions/reregistration/fs_G-5_1-Jun-07.pdf; Reregistration Eligibility Decision for Aliphatic Alcohols (3/1/07), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_G-5_1-Mar-07.pdf

[149] Revised Reregistration Eligibility Decision for Aliphatic Solvents (11/29/07), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-063503_29-Nov-07.pdf

[150] epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-079500_02-Sep-09.pdf; epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_079500.html

[151] epa.gov/pesticides/ppdc/regisreview/implemen/july07/linalool-summary.pdf; regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2006-0356-0010

[152] http://www.epa.gov/oppbppd1/biopesticides/ingredients/tech_docs/brad_128929.pdf; L-Lactic Acid Final Registration Review Decision (6/3/09), regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2008-0383-0013

[153] Both *Bacillus sphaericus* Serotype H5a5b Strain 2362 ATCC 1170 and *Bacillus sphaericus* more broadly are regulated by EPA under the same PC Code. epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_128128.htm

[154] epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-129056_01-Sep-01.pdf

[155] http://www.epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_igr.htm

[156] epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-109709_01-Sep-06.pdf

[157] regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-1025; regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-0996; epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-025006_07-Apr-10.pdf; epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_025006.htm

[158] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-057001_26-Jun-06.pdf

[159] Pelargonic Acid (217500) Fact Sheet (4/1/00), epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-217500_01-Apr-00.pdf

[160] Permethrin Facts (8/1/09), epa.gov/opp00001/chem_search/reg_actions/reregistration/fs_PC-109701_1-Aug-09.pdf; Reregistration Eligibility Decision (RED) for Permethrin (5/11/09), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-109701_11-May-09.pdf

[161] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-070705_01-May-05.pdf

[162] http://dermatology.cdlib.org/126/reviews/lice/burkhart.html

[163] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-067501_14-Jun-06.pdf

[164] epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-011550_01-Apr-00.pdf; epa.gov/opp00001/chem_search/reg_actions/registration/related_PC-011550_1-May-00.pdf; epa.gov/opp00001/chem_search/reg_actions/registration/related_PC-011550_1-May-00.pdf

[165] Registration Review Conventional Cases Schedule - 2011-2014, epa.gov/oppsrrd1/registration_review/2011-14-conventional.pdf

[166] http://www.epa.gov/oppsrrd1/REDs/factsheets/4083fact.pdf

[167] Reregistration Eligibility Decision for Pyrethrins (6/7/06), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-069001_7-Jun-06.pdf

[168] epa.gov/oppbppd1/biopesticides/ingredients/tech_docs/brad_004801.pdf; epa.gov/opp00001/chem_search/reg_actions/registration/decision_PC-004801_25-Aug-10.pdf

[169] Reregistration Eligibility Decision for Resmethrin (6/1/06), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-097801_1-Jun-06.pdf

[170] Sesame stalks (128970) Fact Sheet (8/1/01), epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-128970_01-Aug-01.pdf

[171] http://www.epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_igr.htm

[172] EPA documents show that these products are registered for use vs. tick and mites and many insects, especially in stored grains, but not currently against mosquitoes. PesticideInfo.org shows that currently registered products may still contain mosquitoes on the label as target pests.

[173] http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-1140-0005

[174] http://www.epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_igr.htm

[175] http://www.epa.gov/oppsrrd1/REDs/factsheets/4083fact.pdf

[176] e.g. greenplanetcompany.net/ridmosq.html

[177] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-110003_19-Jul-99.pdf

[178] Reregistration Eligibility Decision for Tau-fluvalinate 9/1/05), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-109302_1-Sep-05.pdf

[179] Temephos Registration Review: Docket EPA-HQ-OPP-2008-0444. regulations.gov/#!docketDetail;dct=FR%252BPR%252BN%252BO%252BSR;rpp=10;po=0;D=EPA-HQ-OPP-2008-0444.

[180] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-069003_16-Apr-10.pdf

[181] bioportal.bioontology.org/ontologies/46567?p=terms&conceptid=MIRO%3A10000168

[182] Thiamethoxam Registration Review: Docket EPA-HQ-OPP-2011-0581: Open Pesticide Dockets and Availability of Final Work Plans = regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0581-0001. Comments due 2/21/2012.

[183] epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-083501_26-Sep-03.pdf

[184] With trifluralin we have two distinct possible PHP benefits. First, there is evidence that some of the key vector-borne pathogens, including *Leishmania* and *Plasmodia*, have plant-like tubulin in microtubules, and may be susceptible to trifluralin (and maybe other herbicides?) (Walter Reed Army Institute of Research 1994: "Antimalarial effects of the anti-tubulin herbicide trifluralin: studies with *Plasmodium falciparum*." Report Avail. NTIS. (Order No. AD-A286 439), 9 pp. From: Gov. Rep. Announce. Index (U. S.) 1995, 95(5), Abstr. No. 512,064). In addition, it looks like this material may be a potent synergist for OP's (2.4x efficacy of malathion) vs mosquitoes (e.g. Gaaboub et al 1981: "Joint action of six herbicides with malathion against mosquito larvae of *Culex pipiens*. Toxicology 20(1), 61-70.). Unfortunately, while these publications have been cited (e.g. tm.mahidol.ac.th/seameo/2010-41-2/07-4698.pdf), it does not appear that they have been followed upb, .

[185] epa.gov/opp00001/chem_search/reg_actions/reregistration/tred_PC-036101_31-Aug-04.pdf

[186] R.E.D. FACTS, Methyl Nonyl Ketone (7/1/95), epa.gov/opp00001/chem_search/reg_actions/reregistration/fs_PC-044102_1-Jul-95.pdf; Reregistration Eligibility Decision (RED) Methyl Nonyl Ketone (6/1/95), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-044102_1-Jun-95.pdf

[187] PesticideInfo.com DB indicates registration vs. ticks, but labels with this use have not been found.

[188] http://www.epa.gov/oppsrrd1/REDs/rotenone_red.pdf

[189] http://www.epa.gov/oppsrrd1/REDs/factsheets/4083fact.pdf

[190] http://www.epa.gov/oppsrrd1/REDs/tcvp_red.pdf

[191] EPA has evaluated and managed many botanical extracts over the years using overlapping "chemical groups", of which three are now recognized by the Biopesticides and Pollution Prevention Division (BPPD): the Plant Oils Groups (Fact Sheet 2001 = epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_plant-oils.htm); the Floral Attractants, Repellents, and Insecticides Group (Fact Sheet 2000 = epa.gov/opp00001/chem_search/reg_actions/registration/fs_G-105_25-Sep-00.pdf); and the Vegetable and Flower Oils (Fact Sheet = epa.gov/opp00001/chem_search/reg_actions/registration/fs_G-114_01-Jul-01.pdf), which is in Reregistration (Docket EPA-HQ-OPP-2009-0904. The most recent document is the "Vegetable and Flower Oils Final Work Plan" (9/23/10): regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0904-0006), which covers 17 registered biopesticides. In addition, a number of these materials are exempt from FIFRA registrations requirements under section 25(b) of that Act.

[192] Registration Review; Pesticide Dockets Opened for Review and Comment, Docket EPA-HQ-OPP-2010-0517, Document EPA-HQ-OPP-2010-0517-0001 (6/23/10), regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0517-0001

[193] Registration Review: Phenethyl Propionate (Case 3110) = Docket EPA-HQ-OPP-2010-0714, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0714-0003.

[194] Registration Review: Allethrin Stereoisomers (Case 0437) = Docket EPA-HQ-OPP-2010-0022, epa.gov/oppsrrd1/registration_review/allethrin-stereoisomers/index.html

[195] Registration Review: Amitraz (Case 0234) = Docket EPA-HQ-OPP-2009-1015, epa.gov/oppsrrd1/registration_review/amitraz/index.html

[196] Decision Documents for Atrazine, epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-080803_1-Apr-06.pdf. Atrazine Updates Fact Sheet (10/1/10), epa.gov/pesticides/reregistration/atrazine/atrazine_update.htm

[197] Petition Requesting Ban on Use and Production of Atrazine = Docket ID EPA-HQ-OPP-2011-0586, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0586-0001

[198] Registration Review: Azadirachtin (Case 6020) = Docket ID EPA-HQ-OPP-2008-0632, epa.gov/oppsrrd1/registration_review/azadirachtin/index.htm

[199] Registration Review: *Bacillus thuringiensis* (Case 0247) = Docket EPA-HQ-OPP-2011-0705, epa.gov/oppsrrd1/registration_review/bacillus-thuringiensis/index.html

[200] *Beauveria bassiana* Strain ATCC 74040 = PC 128818; GHA = PC 128924; 447 = PC 128815; ESC 170 = PC 128817; HF 23 = PC 090305.

[201] Registration Review: *Beauveria bassiana* (Case 6057) = Docket EPA-HQ-OPP-2010-0564, epa.gov/oppsrrd1/registration_review/beauveria_bassiana/index.html

[202] Registration Review: Cyfluthrins (Case 7405) = Docket EPA-HQ-OPP-2010-0684, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0684-0002

[203] Registration Review: Bifenthrin (Case 7402) = Docket EPA-HQ-OPP-2010-0384, epa.gov/oppsrrd1/registration_review/bifenthrin/index.html

[204] Registration Review: Boric Acid and Sodium Borate Salts (Case 0024) = Docket EPA-HQ-OPP-2009-0306, epa.gov/oppsrrd1/registration_review/boric-acid/index.html

[205] Registration Review: Carbaryl (Case 0080) = Docket EPA-HQ-OPP-2010-0230, epa.gov/oppsrrd1/registration_review/carbaryl/index.html

[206] Registration Review: Carbon, Carbon Dioxide, and Sawdust (Case 4019) = Docket EPA-HQ-OPP-2007-0705, epa.gov/oppsrrd1/registration_review/carbon/index.htm

[207] Registration Review: Wood Oils and Gums (Case 3050) = Docket EPA-HQ-OPP-2009-0258, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0258-0015

[208] Registration Review: Chlorfenapyr (Case 7419) = Docket EPA-HQ-OPP-2010-0467, epa.gov/oppsrrd1/registration_review/chlorfenapyr/index.html

[209] Registration Review: Chlorpyrifos (Case 0100) = Docket EPA-HQ-OPP-2008-0850, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2008-0850-0002

[210] Preliminary Human Health Risk Assessments; Availability: Chlorpyrifos Registration Review, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0384-0035. Draft Stipulation and Order, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-1005-0087. "There will be a 4-day meeting of the Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (FIFRA SAP) to consider and review scientific issues

concerning chlorpyrifos health effects." April 10-13, 2012, Washington, DC, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2012-0040-0001

[211] Registration Review: Citric Acid and Salts (Case 4024) = Docket EPA-HQ-OPP-2008-0855. Final Decision 11/20/2009, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2008-0855-0012

[212] Registration Review: Coumaphos (Case 0018) = Docket ID EPA-HQ-OPP-2008-0023, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2008-0023-0016

[213] Registration Review: Cyfluthrins (Case 7405) = Docket EPA-HQ-OPP-2010-0684, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0684-0002

[214] Registration Review: Cyphenothrin (Case 7412) = Docket EPA-HQ-OPP-2009-0842, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0842-0016

[215] Registration Review: DDVP/Dichlorvos (Case 0310) = Docket EPA-HQ-OPP-2009-0209, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0209-0013

[216] Registration Review: Deltamethrin (Case 7414) = Docket EPA-HQ-OPP-2009-0637, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0637-0019

[217] Registration Review: Diazinon (Case 0238) = Docket EPA-HQ-OPP-2008-0351, epa.gov/oppsrrd1/registration_review/diazinon/index.htm

[218] Registration Review: Tanol Derivs = Furanone (Case 3138) = Docket EPA-HQ-OPP-2011-0682 (9/30/11), epa.gov/oppsrrd1/registration_review/tanol/index.html

[219] Registration Review: Dimethoate (Case 0088) = Docket EPA-HQ-OPP-2009-0059, epa.gov/oppsrrd1/registration_review/dimethoate/index.htm

[220] http://www.regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2009-0629

[221] Registration Review: Dinotefuran = Docket EPA-HQ-OPP-2011-0920 (12/14/11), regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0920-0002

[222] Registration Review: Limonene (d-Limonene) = Docket ID EPA-HQ-OPP-2010-0673, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0673-0015

[223] Registration Review: d-Phenothrin (Case 0426) = Docket EPA-HQ-OPP-2011-0539 (12/21/11); regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0539-0008

[224] Registration Review: Egg Solids (Case 4079) = Docket EPA-HQ-OPP-2010-0726, epa.gov/oppsrrd1/registration_review/egg_solids/index.html

[225] Endosulfan Phase-out (11/10/10), epa.gov/pesticides/reregistration/endosulfan/endosulfan-agreement.html

[226] Registration Review: Esfenvalerate (Case 7406) = Docket EPA-HQ-OPP-2009-0301 (12/16/09), epa.gov/oppsrrd1/registration_review/esfenvalerate/index.html

[227] Registration Review: Etofenprox (Case 7407) = EPA-HQ-OPP-2007-0804, regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2007-0804

[228] Registration Review: Fipronil (Case 7423) = Docket EPA-HQ-OPP-2011-0448 (6/29/11). epa.gov/oppsrrd1/registration_review/fipronil/index.htm

[229] Registration Review: Gamma-Cyhalothrin (Case 7437) = Docket EPA-HQ-OPP-2010-0479, epa.gov/oppsrrd1/registration_review/gamma_cyhalothrin/index.html

[230] Registration Review: Imidacloprid (Case 7605). epa.gov/oppsrrd1/registration_review/imidacloprid/index.htm; Docket ID EPA-HQ-OPP-2008-0844: regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2008-0844; Amended Workplan Docket ID EPA-HQ-OPP-2010-0734, regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2010-0734

[231] Registration Review: Imiprothrin (Case 7426) = Docket EPA-HQ-OPP-2011-0692 (9/31/11), regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0692-0002

[232] Registration Review: *Lagenidium giganteum* (Case 6068) = Docket EPA-HQ-OPP-2011-0193 (3/30/11). epa.gov/oppsrrd1/registration_review/lagenidium/index.html

[233] Registration Review: Lambda-cyhalothrin (Case 7408) = Docket EPA-HQ-OPP-2010-0480, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0480-0017

[234] Registration Review: Malathion (Case 248) = Docket EPA-HQ-OPP-2009-0317 (6/24/09), http://www.epa.gov/oppsrrd1/registration_review/malathion/index.html

[235] Registration Review: *Metarhizium Anisopliae* Docket ID EPA-HQ-OPP-2009-0510. regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2009-0510

[236] Registration Review: Naled (Case 0092) = Docket ID EPA-HQ-OPP-2009-0053, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0053-0045

[237] Registration Review: Pelargonic Acid, Salts and Esters (Case 6077) = Docket EPA-HQ-OPP-2010-0424 (6/30/10), epa.gov/oppsrrd1/registration_review/pelargonic-acid/index.html

[238] Registration Review: Permethrin (Case 2510) = Docket EPA-HQ-OPP-2011-0039, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0039-0031

[239] Registration Review: Piperonyl Butoxide (Case 2525) = Docket EPA-HQ-OPP-2010-0498, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0498-0014

[240] Registration Review: Propoxur (Case 2555) = Docket EPA-HQ-OPP-2009-0806 (12/16/09), epa.gov/oppsrrd1/registration_review/propoxur/index.html

[241] Registration Review: Pyrethrins (Case 2580) = Docket EPA-HQ-OPP-2011-0885 (12/21/11), regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0885-0002

[242] Registration Review: Pyriproxyfen (Case 7424) = Docket ID EPA-HQ-OPP-2011-0677 (9/30/11). regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0677-0002

[243] Requests To Voluntarily Cancel Certain Pesticide Registrations: Resmethrin. Docket EPA-HQ-OPP-2010-0306, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0306-0003

[244] Registration Review: Thyme Herbs and Ground Sesame Plant (Case 6060), epa.gov/oppsrrd1/registration_review/thyme/index.htm ; epa.gov/fedrgstr/EPA-PEST/2008/March/Day-28/p6394.pdf. RR Case 6060 (Thyme Herbs and Ground Sesame Plant) docket not opened because final registrations cancelled 2004-2005.

[245] Registration Review: Silica and Silicates (Case 4081) = Docket EPA-HQ-OPP-2007-1140 (3/26/08), epa.gov/oppsrrd1/registration_review/silica/index.htm

[246] Registration Review: Soap Salts (Case 4083) = Docket EPA-HQ-OPP-2008-0519 (9/15/08). epa.gov/oppsrrd1/registration_review/soap_salts/index.htm

[247] Registration Review: Spinosad (Case 7421) = Docket EPA-HQ-OPP-2011-0667 (9/30/11), regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0667-0002

[248] Registration Review: Sulfur (Case 2295) = Docket EPA-HQ-OPP-2010-0915 (12/22/10); epa.gov/oppsrrd1/registration_review/sulfur/index.htm

[249] Registration Review: Tau-fluvalinate (Case 2295) = Docket EPA-HQ-OPP-2010-0915, epa.gov/oppsrrd1/registration_review/tau_fluvalinate/index.html

[250] Registration Review: Temephos (Case 0006) = Docket EPA-HQ-OPP-2008-0444. epa.gov/oppsrrd1/registration_review/temephos/index.htm; regulations.gov/#!docketDetail;dct=FR%252BPR%252BN%252BO%252BSR;rpp=10;po=0;D=EPA-HQ-OPP-2008-0444.

[251] Registration Review: Tetramethrin (Case 2660) = Docket EPA-HQ-OPP-2011-0907, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0907-0001.

[252] Registration Review: Thiamethoxam (Case 7614) = Docket EPA-HQ-OPP-2011-0581, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2011-0581-0002. Comments due 2/21/2012.

[253] Registration Review: Thyme Herbs and Ground Sesame Plant (Case 6060), epa.gov/oppsrrd1/registration_review/thyme/index.htm ; epa.gov/fedrgstr/EPA-PEST/2008/March/Day-28/p6394.pdf. Docket not opened because final registrations cancelled 2004-2005

[254] Registration Review: Tralomethrin (Case 7400) = Docket EPA-HQ-OPP-2010-0116, regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0116-0008; Requests to Voluntarily Cancel Pesticide Registrations: Tralomethrin: regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0116-0009

[255] Registration Review: Trichlorfon (Case 104) = Docket EPA-HQ-OPP-2009-0097, regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2009-0097.

[256] Registration Review: Muscalure Fly Attractant or (Z)-9-tricosene (Case 4112) = EPA-HQ-OPP-2010-0925 (12/22/10). epa.gov/oppsrrd1/registration_review/muscalure/index.html

[257] Registration Review: Nucleopolyhedroviruses and Granuloviruses (Insect Viruses) (Case 4106) = Docket EPA-HQ-OPP-2011-0694 (9/30/11). epa.gov/oppsrrd1/registration_review/nucleopoly/index.html

[258] Registration Review: Chlorpyrifo-methyl (Case 8011) = Docket EPA-HQ-OPP-2010-0119, epa.gov/oppsrrd1/registration_review/chlorpyrifos-methyl/index.html

[259] Registration Review: Cinnamaldehyde (Case 6032) = Docket EPA-HQ-OPP-2010-0918, epa.gov/oppsrrd1/registration_review/cinnamaldehyde/index.html

[260] Registration Review: Pirimiphos-methyl (Case 2353) = Docket EPA-HQ-OPP-2009-0056 (3/18/09), epa.gov/oppsrrd1/registration_review/pirimiphos-methyl/index.htm

[261] Registration Review: Propoxur (Case 2555) = Docket EPA-HQ-OPP-2009-0806 (12/16/09), epa.gov/oppsrrd1/registration_review/propoxur/index.html

[262] Registration Review: Spinetoram (Case 7448) = Docket EPA-HQ-OPP-2011-0666 (9/30/11), epa.gov/oppsrrd1/registration_review/spinetoram/index.html

[263] Registration Review: Thymol (Case 3143) = Docket EPA-HQ-OPP-2010-0002 (3/31/10). regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0002-0006

[264] In 1951 the U.S. military adopted a mixture named M-1960 (30% each of 2-butyl-2-ethyl-1,3-propanediol, N-butylacetanilide, and benzyl benzoate, and 10% TWEEN 80) as the standard fabric treatment for repellent clothing. Clothing treated with M1960 proved 100% effective against chiggers, 90% effective against mosquitoes, ticks, and fleas through more than a week of wear or until washed, but retreatment after each washing was necessary to provide good protection against fleas, ticks and mosquitoes. This product was registered in 1975 by USEPA as an insect repellent and feeding depressant treatment for human clothing vs. mosquitoes, ticks, mites, fleas, and land leeches ("Insect Repellent Clothing Application", EPA Product Reg. No. 6830-84; Octagon Process Inc.). In 1982 the AFPMB recommended replacement of M-1960 by permethrin (afpmb.org/sites/default/files/contingency/Permethrin_Treated_Uniforms.ppt), and the EPA registration lapsed on 10/10/89 for failure to pay routine registration maintenance fees (pesticideinfo.org/Detail_Product.jsp?REG_NR=00683000084&DIST_NR=006830, accessed3/25/12).

[265] EPA OPP Chemical Search shows as registered 3/8/12, but this is apparently an error. PesticideInfo.org shows that the last registration with this A.I., EPA 6830-84 = "Insect Repellent Clothing Application", with the composition of M-1960, was cancelled in 1989 (pesticideinfo.org/Detail_Product.jsp?REG_NR=00683000084&DIST_NR=006830), soon after development of Joint Service Requirements Document (JSOR) for an arthropod repellent system based on permethrin afpmb.org/sites/default/files/contingency/Permethrin_Treated_Uniforms.ppt.

[266] Reregistration Eligibility Decision (RED), Hydroxyethyl octyl sulfide (12/1/95), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-046301_1-Dec-95.pdf; R.E.D. FACTS Hydroxyethyl Octyl Sulfide (12/1995), epa.gov/oppsrrd1/REDs/factsheets/3103fact.pdf

[267] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/red_G-7_27-May-09.pdf

[268] http://news.google.com/newspapers?nid=888&dat=19281028&id=eLwwAAAAIBAJ&sjid=Z04DAAAAIBAJ&pg=4667,3185903 ; "Operational Experiences with Paris Green Pellets in Operational Mosquito Control." (1959), archive.org/details/cbarchive_114785_operationalexperienceswithpari1959

[269] http://news.google.com/newspapers?nid=888&dat=19281028&id=eLwwAAAAIBAJ&sjid=Z04DAAAAIBAJ&pg=4667,3185903 ; "Operational Experiences with Paris Green Pellets in Operational Mosquito Control." (1959), archive.org/details/cbarchive_114785_operationalexperienceswithpari1959

[270] http://news.google.com/newspapers?nid=888&dat=19281028&id=eLwwAAAAIBAJ&sjid=Z04DAAAAIBAJ&pg=4667,3185903 ; "Operational Experiences with Paris Green Pellets in Operational Mosquito Control." (1959), archive.org/details/cbarchive_114785_operationalexperienceswithpari1959

[271] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/fs_PC-105201_1-Sep-99.pdf

[272] As a public health pesticide, it was significant primarily as an insect repellent applied to clothing. Currently registered by EPA as a miticide vs. dust mites and dog mites. A mixture of wetted cellulose and benzyl benzoate is used on carpets as an acaricide. epa.gov/opp00001/chem_search/reg_actions/reregistration/red_G-13_26-Jun-07.pdf. The closely related benzoic acid is used an antimicrobial in food-grade lubricating oils: http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0692-0004.

[273] http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2005-0220-0017; http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2005-0220-0018

[274] http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2012-0167-0001

[275] Metabolite of Aldrin.

[276] http://www.epa.gov/pesticides/reregistration/dimethoate/

[277] Registration Review: Dimethoate (Case 0088) = Docket EPA-HQ-OPP-2009-0059, http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0059-0006

[278] Used as a military repellent fabric treatment ca. 1944-1950, before being superceded by M-1960. Prevented chigger attachments when applied to clothing, but formuation became ineffective after a single rinsing in cool water (AFPMB 2008).

[279] http://ppis.ceris.purdue.edu/htbin/cheminfo.com?chemcd=28002

[280] Endosulfan RED Facts. EPA-738-F-02-012 (11/2002), epa.gov/opp00001/chem_search/reg_actions/reregistration/fs_PC-079401_1-Nov-02.pdf

[281] Endosulfan Phase-out (11/10/10), epa.gov/pesticides/reregistration/endosulfan/endosulfan-agreement.html

[282] http://www.pesticideinfo.org/Detail_Product.jsp?REG_NR=01035200034&DIST_NR=010352

[283] http://pmep.cce.cornell.edu/profiles/extoxnet/dienochlor-glyphosate/fenoxycarb-ext.html

[284] http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2006-0111-0017

[285] "Onchocerciasis and Chagas' disease control: the evolution of control via applied research through changing development scenarios." Molyneux & Morel (1998), bmb.oxfordjournals.org/content/54/2/327.full.pdf

[286] Reregistration Eligibility Decision (RED) for Lindane (7/1/02); Addendum to Reregistration Eligibility Decision (RED) for Lindane (7/1/06); Lindane Voluntary Cancellation and RED Addendum Fact Sheet (7/1/06)

[287] Product Cancellation Order for LINDANE (12/13/06); EPA is not opening a docket for Lindane because this pesticide is not included in any products actively registered under FIFRA section 3 (12/22/10).

[288] Fact Sheet for Lindane (7/1/02); Lindane and Other HCH Isomers--EPA Risk Assessment Fact Sheet (PDF, 4 pp, 32K) (2/8/06)

[289] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-034001_30-Jun-04.pdf

[290] http://en.wikipedia.org/wiki/Phoxim

[291] PesticideInfo.org DB claims registrations vs. mosquitoes, ticks, bed bugs, and sand flies, but labels have not been verified.

[292] epa.gov/oppsrrd1/REDs/factsheets/2555fact.pdf; PesticideInfo.org DB shows some registrations still active with mosquitoes on the label, but this has not been verified.

[293] http://www.epa.gov/oppsrrd1/REDs/rotenone_red.pdf

[294] *Bacillus thuringiensis* (Bt) is registered at the species level by EPA as PC Codes 6400 and 69162, but subspecies and strains are regulated independently. PC Code 6401 applies to "*Bacillus thuringiensis* subsp. israelensis", which is frequently synonymous with *Bacillus thuringiensis israelensis* serotype H-14 in the literature.

[295] EPA chemical search shows no regulatory activity, but NPIRS shows active registrations.

[296] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/fs_PC-108201_1-Aug-97.pdf

[297] Revised Reregistration Eligibility Decision for Aliphatic Solvents (11/29/07), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-063503_29-Nov-07.pdf

[298] Su & Mulla 2004. "Documentation of high-level *Bacillus sphaericus* 2362 resistance in field populations of *Culex quinquefasciatus* breeding in polluted water in Thailand." http://www.ncbi.nlm.nih.gov/pubmed/15669382?dopt=Abstract

[299] Registration Review Conventional Cases Schedule - 2011-2014, epa.gov/oppsrrd1/registration_review/2011-14-conventional.pdf

[300] e.g. drsfostersmith.com/pic/article.cfm?d=161&category=596&articleid=867

[301] "Onchocerciasis and Chagas' disease control: the evolution of control via applied research through changing development scenarios." Molyneux & Morel (1998), bmb.oxfordjournals.org/content/54/2/327.full.pdf

[302] E.g. RAID EO ARK, EPA Reg 4822-534; EcoPCO ACU, EPA Reg. 67425-14.

[303] onlinelibrary.wiley.com/doi/10.1111/j.1948-7134.2011.00141.x/full

[304] Product is labeled for turf, use on pets, etc.

[305] E.g. http://www.hydroponics.net/i/136698

[306] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-069003_16-Apr-10.pdf

[307] E.g. Shoobug product = https://home.comcast.net/~klauwagie/ShooBug.htm.

[308] E.g. http://www.swansonvitamins.com/BTB077/ItemDetail?SourceCode=INTL405&CAWELAID=410184119

[309] E.g. http://www.swansonvitamins.com/BTB077/ItemDetail?SourceCode=INTL405&CAWELAID=410184119

[310] http://www.ingentaconnect.com/content/esa/jme/1999/00000036/00000005/art00014

[311] Citric Acid, and Salts Registration Review Case Docket ID EPA-HQ-OPP-2008-0855: regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2008-0855-0012

[312] E.g. http://www.swansonvitamins.com/BTB077/ItemDetail?SourceCode=INTL405&CAWELAID=410184119

[313] E.g. http://www.swansonvitamins.com/BTB077/ItemDetail?SourceCode=INTL405&CAWELAID=410184119

[314] Shin-Ho et al 2009

: "When [33] essential oils were tested at a concentration of 0.005 mg/cm^2 for 10 min, the clove bud and leaf oils showed repellencies against *C. pipiens pallens* female that exceeded 80% (Fig. 1). A previous study using the arm-in-cage method has also shown that clove oil has very high repellency against *Aedes aegypti* and *Anopheles albinmanus* [Barnard, 1999]. Moreover, in a study using human subjects under laboratory conditions, clove oils was found to be the most repellent of the 38

essential oils tested against *Ae. aegypti* [Trongtokit et al., 2005]…. Another study using a Y-tube olfactometer showed that of the five essential oils tested, thyme and clove oil repelled *Ae. aegypti* and *An. albimanus* [Barnard, 1999]… We then examined the repellency of the clove bud, clove leaf, juniperberry, and marjoram oils further.… Clove bud had the highest repellency at an ED50 value of 0.15×10^{-3} mg/cm^2 (Table 2). The clove leaf … had lower repellencies of 0.40×10^{-3} … mg/cm^2 …. Notably, the effectiveness of the clove bud and clove leaf oils was higher than that of citronella. Thus, according to the ASTM E951-94 method recommended by ASTM, the two clove oils have high mosquito repellency. Major components analysis using GC and GC-MS: "Eugenol [2-methoxy-4-(2-propenyl)phenol] was the major component of the clove bud (80.7%) and clove leaf (87.0%) oils (Table 3). Both oils also contained β-caryophyllene at similar percentages. However, only clove bud oil contained isoeugenol [(E)-2-methoxy-4-(1-propenyl)phenol; 11.8%."

[315] e.g. http://organicdatabank.info/databank-newmain-239/healthy-home/103-natural-mosquito-control/607-natural-mosquito-control-101.html

[316] E.g. amazon.com/Organics-by-Cedar-Creek-Bug/dp/B004GY0GBO

[317] regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-1025; regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-0996; epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-025006_07-Apr-10.pdf; epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_025006.htm

[318] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/related_PC-011550_1-May-00.pdf

[319] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/decision_PC-004801_25-Aug-10.pdf

[320] e.g. drsfostersmith.com/pic/article.cfm?d=161&category=596&articleid=867

[321] http://www.ingentaconnect.com/content/esa/jme/1999/00000036/00000005/art00014

[322] Citric Acid, and Salts Registration Review Case Docket ID EPA-HQ-OPP-2008-0855: regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2008-0855-0012

[323] E.g. http://www.swansonvitamins.com/BTB077/ItemDetail?SourceCode=INTL405&CAWELAID=410184119

[324] E.g. http://www.swansonvitamins.com/BTB077/ItemDetail?SourceCode=INTL405&CAWELAID=410184119

[325] Shin-Ho et al 2009

: "When [33] essential oils were tested at a concentration of 0.005 mg/cm^2 for 10 min, the clove bud and leaf oils showed repellencies against *C. pipiens pallens* female that exceeded 80% (Fig. 1). A previous study using the arm-in-cage method has also shown that clove oil has very high repellency against *Aedes aegypti* and *Anopheles albinmanus* [Barnard, 1999]. Moreover, in a study using human subjects under laboratory conditions, clove oils was found to be the most repellent of the 38

essential oils tested against *Ae. aegypti* [Trongtokit et al., 2005]…. Another study using a Y-tube olfactometer showed that of the five essential oils tested, thyme and clove oil repelled *Ae. aegypti* and *An. albimanus* [Barnard, 1999]… We then examined the repellency of the clove bud, clove leaf, juniperberry, and marjoram oils further.… Clove bud had the highest repellency at an ED50 value of 0.15×10^{-3} mg/cm^2 (Table 2). The clove leaf … had lower repellencies of 0.40×10^{-3} … mg/cm^2 …. Notably, the effectiveness of the clove bud and clove leaf oils was higher than that of citronella. Thus, according to the ASTM E951-94 method recommended by ASTM, the two clove oils have high mosquito repellency. Major components analysis using GC and GC-MS: "Eugenol [2-methoxy-4-(2-propenyl)phenol] was the major component of the clove bud (80.7%) and clove leaf (87.0%) oils (Table 3). Both oils also contained β-caryophyllene at similar percentages. However, only clove bud oil contained isoeugenol [(E)-2-methoxy-4-(1-propenyl)phenol; 11.8%."

[326] e.g. http://organicdatabank.info/databank-newmain-239/healthy-home/103-natural-mosquito-control/607-natural-mosquito-control-101.html

[327] E.g. amazon.com/Organics-by-Cedar-Creek-Bug/dp/B004GY0GBO

[328] regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-1025; regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-0996; epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-025006_07-Apr-10.pdf; epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_025006.htm

[329] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/related_PC-011550_1-May-00.pdf

[330] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/decision_PC-004801_25-Aug-10.pdf

[331] e.g. drsfostersmith.com/pic/article.cfm?d=161&category=596&articleid=867

[332] E.g. Lurex product: victorpest.com/resource/uploads/mosquito-magnet-lurex3---twin-pack-instructions.pdf

[333] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-067501_14-Jun-06.pdf

[334] epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-083501_26-Sep-03.pdf

[335] http://www.epa.gov/pesticides/reregistration/atrazine/atrazine_update.htm

[336] regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-1025; regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-0996; epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-025006_07-Apr-10.pdf; epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_025006.htm

[337] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-067501_14-Jun-06.pdf

[338] EPA documents show that these products are registered for use vs. tick and mites and many insects, especially in stored grains, but not currently against mosquitoes. PesticideInfo.org shows that currently registered products may still contain mosquitoes on the label as target pests.

[339] http://www.epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-069003_16-Apr-10.pdf

[340] epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-083501_26-Sep-03.pdf

[341] e.g. amazon.com/Organics-by-Cedar-Creek-Bug/dp/B004GY0GBO; organicdatabank.info/databank-newmain-239/healthy-home/103-natural-mosquito-control/607-natural-mosquito-control-101.html

[342] E.g. amazon.com/Organics-by-Cedar-Creek-Bug/dp/B004GY0GBO

[343] http://www.swansonvitamins.com/BTB077/ItemDetail?SourceCode=INTL405&CAWELAID=410184119

[344] E.g. http://www.swansonvitamins.com/BTB077/ItemDetail?SourceCode=INTL405&CAWELAID=410184119

[345] regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-1025; regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-0996; epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-025006_07-Apr-10.pdf; epa.gov/oppbppd1/biopesticides/ingredients/factsheets/factsheet_025006.htm

[346] E.g. http://www.swansonvitamins.com/BTB077/ItemDetail?SourceCode=INTL405&CAWELAID=410184119

[347] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/related_PC-011550_1-May-00.pdf

[348] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/decision_PC-004801_25-Aug-10.pdf

[349] E.g. http://www.swansonvitamins.com/BTB077/ItemDetail?SourceCode=INTL405&CAWELAID=410184119

[350] E.g. amazon.com/FRESH-Natural-Biodegradable-Insect-Repellent/dp/B00309S4RE

[351] http://pmep.cce.cornell.edu/profiles/insect-mite/abamectin-bufencarb/avermectin/insect-prof-avermectin.html

[352] Mo et al 2008. "Lethal and Sublethal Effects of Acetamiprid on the Larvae of Culex pipiens pallens." onlinelibrary.wiley.com/doi/10.1111/j.1744-7917.2002.tb00153.x/abstract

[353] faqs.org/patents/app/20080319029

[354] pesticides1.com/supplier/nanjing-essence-finechemical-co-ltd-2/acetamiprid-betacypermethrin-wp.html

[355] http://www.epa.gov/pesticides/reregistration/atrazine/atrazine_update.htm

[356] anorganicwonder.com/bed_bugs/faq.html

[357] According to EPA OPP ChemicalSearch (accessed Dec. 2011), Azardirachtin has been registered as both a biochemical and conventional chemical since 1994. This material is now undergoing Registration Review. Azadirachtin B, Dihydroazadirachtin, and Clarified hydrophobic neem oil are also registered in the U.S.

[358] eurojournals.com/EJSR_57_2_05.pdf

[359] sciencedirect.com/science/article/pii/0022191088901837; sciencedirect.com/science/article/pii/0022191088900832; ncbi.nlm.nih.gov/pubmed/14620053; springerlink.com/content/q334631048732071/

[360] ajol.info/index.php/sajas/article/viewfile/3784/11788

[361] Registration Review: Bacillus thuringiensis (BT). epa.gov/oppsrrd1/registration_review/bacillus-thuringiensis/index.html

[362] Raghavendra 2011. "Chlorfenapyr: a new insecticide with novel mode of action can control pyrethroid resistant malaria vectors." malariajournal.com/content/10/1/16

[363] Reregistration Eligibility Decision for Coumaphos (7/1/06), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-036501_1-Jul-06.pdf

[364] http://esa.confex.com/esa/2003/techprogram/paper_12381.htm

[365] http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2008-0168-0006

[366] http://citebank.org/node/117967

[367] http://www.springerlink.com/content/m1t0634762376721/

[368] http://www.ncbi.nlm.nih.gov/pubmed/20618668

[369] EPA documents show that these products are registered for use vs. tick and mites and many insects, especially in stored grains, but not currently against mosquitoes. PesticideInfo.org shows that currently registered products may still contain mosquitoes on the label as target pests.

[370] http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-1140-0005

[371] E.g. Labeled products vs. bed bugs include RESULTS INDOOR INSECT CONTROL, EPA Reg. 42850-1; Ticks, fleas, and lice on dogs and cats include RESULTS PET POWDER, EPA Reg. 42850-3;

[372] http://esa.confex.com/esa/2003/techprogram/paper_12381.htm

[373] e.g. ehow.com/how_5665976_eat-sulfur-mosquito-repellent.html

[374] Siju et al 2010. "Influence of blood meal on the responsiveness of olfactory receptor neurons in antennal sensilla trichodea of the yellow fever mosquito, *Aedes aegypti*." J. Insect Physiology (2010), 56(6), 659-665.

[375] Reregistration Eligibility Decision (RED) Methyl Nonyl Ketone (6/1/95), epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-044102_1-Jun-95.pdf; R.E.D. FACTS, Methyl Nonyl Ketone (7/1/95), epa.gov/opp00001/chem_search/reg_actions/reregistration/fs_PC-044102_1-Jul-95.pdf

[376] http://onlinelibrary.wiley.com/doi/10.1002/ps.994/full

[377] freepatentsonline.com/y2010/0249173.html

[378] http://bioportal.bioontology.org/ontologies/44686/?p=terms&conceptid=CHEBI%3A38592

[379] Li et al 2009. "Effects of water color and chemical compounds on the oviposition behavior of gravid *Culex pipiens pallens* females under laboratory conditions." J Ag and Urban Entomol, 26(1), 23-30.; Siju et al 2010. "Influence of blood meal on the responsiveness of olfactory receptor neurons in antennal sensilla trichodea of the yellow fever mosquito, *Aedes aegypti*." J. Insect Physiology (2010), 56(6), 659-665.

[380] http://www.insectscience.org/10.57/i1536-2442-10-57.pdf

[381] Qui et al 2006. "Olfactory Coding in Antennal Neurons of the Malaria Mosquito, *Anopheles gambiae*." Chemical Senses (2006), 31(9), 845-863.

[382] http://edis.ifas.ufl.edu/ig142

[383] Cheng et al. 2004. "Chemical composition and mosquito larvicidal activity of essential oils from leaves of different *Cinnamomum osmophloeum* provenances". *J. Agric. Food Chem.* **52** (14): 4395–400.doi:10.1021/jf0497152. PMID 15237942; Morais et al 2006. "Larvicidal activity of essential oils from Brazilian *Croton* species against *Aedes aegypti* L". *J. Am. Mosq. Control Assoc.* **22** (1): 161–4. doi:10.2987/8756-971X(2006)22[161:LAOEOF]2.0.CO;2. PMID 16646345; Park et al. 2006. "Fumigant activity of plant essential oils and components from horseradish (*Armoracia rusticana*), anise (*Pimpinella anisum*) and garlic (*Allium sativum*) oils against *Lycoriella ingenua* (Diptera: Sciaridae)". *Pest Manag. Sci.* **62** (8): 723–8. doi:10.1002/ps.1228.PMID 16786497.

[384] http://www.epa.gov/oppbppd1/biopesticides/ingredients/tech_docs/brad_129035.pdf

[385] ncbi.nlm.nih.gov/pmc/articles/PMC528879/pdf/i1536-2442-004-19-0001.pdf

[386] sciencedirect.com/science/article/pii/0022201168900475

[387] http://www.bioone.org/doi/abs/10.1603/0022-2585(2007)44%5B799:OAOEHO%5D2.0.CO%3B2

[388] springerlink.com/content/jvv2875nxr4m15q6/

[389] agris.fao.org/agris-search/search/display.do?f=1996/BE/BE96002.xml;BE9600329; bioone.org/doi/abs/10.1603/0022-2585-41.4.705; bioone.org/doi/abs/10.1603/ME10019; springerlink.com/content/t4014314164800g2/fulltext.pdf; sciencedirect.com/science/article/pii/S0304401711004158

[390] tandfonline.com/doi/abs/10.1080/09583150120093077

[391] sciencedirect.com/science/article/pii/S0022201185710956

[392] pubs.acs.org/doi/abs/10.1021/np50119a012

[393] The plant *Mondarda fistulosa* is sometimes called Wild Bergamot (http://www.plants.usda.gov/java/profile?symbol=MOFI), and it is reputed to repel mosquitoes.

[394] E.g. bonanza.com/listings/insect-repellant-natural-aromatherapy-for-bugs-Bug-Off-2-3-oz/18865625

[395] onlinelibrary.wiley.com/doi/10.1002/ps.994/full

[396] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-000586_01-Jun-99.pdf

[397] onlinelibrary.wiley.com/doi/10.1002/ps.994/full

[398] http://pubs.acs.org/doi/pdfplus/10.1021/ed005p1067.2

[399] E.g. http://electroherbalism.com/Naturopathy/Therapies/Toxins/ToxinAvoidance/InsectControlandYardCare.htm

[400] Canola oil is commonly associated with the rape seed plant *Brassica napus*, but it also can be obtained under EPA standards from *Brassica juncea*, *Brassica rapa*, and *Brassica campestris* (all in the Cruciferea or mustard family). regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0904-0005

[401] Canola Oil (011332) Fact Sheet (11/25/09), epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-011332_25-Nov-09.pdf; Canola Oil (011332) Technical Fact Sheet (10/1/98), epa.gov/opp00001/chem_search/reg_actions/registration/related_PC-011332_1-Oct-98.pdf

[402] Eiras and Roque 1970

[403] Strong evidence against acetylcholinesterase inhibition is shown by Anderson and Coats 2012.

[404] bioone.org/doi/abs/10.1603/029.102.0638

[405] Gillij, Gleiser, and Zygadlo 2007. "Mosquito repellent activity of essential oils of aromatic plants growing in Argentina." ncbi.nlm.nih.gov/pubmed/17583499

[406] Soares et a 2010. "Repellent activity of plant-derived compounds against Amblyomma cajennense (Acari: Ixodidae) nymphs." ncbi.nlm.nih.gov/pubmed/19897309

[407] "Methods of Inhibiting, Preventing, Killing and/or Repelling Insects using Simulated Blends of Chenopodium Extracts." freepatentsonline.com/y2010/0316738.html

[408] http://www.ncbi.nlm.nih.gov/pubmed/2402025

[409] Darriet 2007. "Oxidases are naturally present in mosquitoes, but their activity is even more important when the level of mosquito resistance to insecticides is high. Chlorpyrifos-methyl is a thiophosphate, which means that in its molecule a sulfur atom is linked to the phosphorus atom (P = S). In the process of desulfurization of thiophosphates by oxidases, the sulfur atom is replaced by an oxygen atom (P = S to P = O) (Hassall, 1982). However, the molecule generated (oxon forms) is 3000 times more toxic to the insect than the original. Consequently, this oxidation reaction does not involve disabling the insecticide but its activation. Reaction of anti-resistance in a way that makes chlorpyrifos-methyl prove to be a candidate for the desired synergy between the actions of insecticides."

[410] http://www.epa.gov/oppsrrd1/REDs/factsheets/cpm_fs.htm

[411] RR Case 8011 = Docket EPA-HQ-OPP-2010-0119 (3/31/10); Final Work Plan 7/16/10. epa.gov/oppsrrd1/registration_review/chlorpyrifos-methyl/index.html

[237] Cinnamaldehyde Preliminary Work Plan and Summary Document. Docket ID: EPA-HQ-OPP-2010-0918. regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2010-0918-0003

[413] E.g. http://www.lessmosquito.com/incognito/what-is-incognito-mosquito-repellent/

[414] Notice of Receipt of Application for a New Active Ingredient (Citral) Docket ID EPA-HQ-OPP-2010-0804: regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2010-0804

[415] Weldon et al 2011. "Anointing Chemicals and Hematophagous Arthropods: Responses by Ticks and Mosquitoes to Citrus (Rutaceae) Peel Exudates and Monoterpene Components." J Chem Ecol (2011) 37:348–359 DOI 10.1007/s10886-011-9922-. ncbi.nlm.nih.gov/pubmed/21409496; afpmb.org/sites/default/files/pubs/dwfp/publications/FY11/Weldon,Carroll,Kramer,Bedoukian,Coleman,Bernier,2011.pdf

[416] E.g. avoidmosquitobites.com/insect-repellent/avon-skin-so-soft-original-dry-oil-body-spray.asp

[417] epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-167004_22-Apr-04.pdf; epa.gov/opp00001/chem_search/reg_actions/registration/decision_PC-167004_11-May-04.pdf

[418] e.g. http://www.springerlink.com/content/dm684505w3576016/fulltext.pdf).

[419] http://www.epa.gov/oppsrrd1/REDs/0087.pdf

[420] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-107091_22-Aug-02.pdf

[421] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-044501_01-Aug-07.pdf

[422] Brun & Sales, 1976, cited in Darriet 2007 (p42).

[423] http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0172-0003

[424] http://iaspub.epa.gov/apex/pesticides/f?p=CHEMICALSEARCH:31:733470794163530:::::

[425] E.g. http://www.bugbog.com/travel_health/malaria.html

[426] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-214900_01-Apr-05.pdf

[427] http://www.afpmb.org/sites/default/files/pubs/dwfp/publications/FY09/Chaskopoulou&4al,2009.pdf

[428] http://www.bioone.org/doi/full/10.1603/0022-2585%282007%2944%5B718%3AREOFAA%5D2.0.CO%3B2

[429] http://www.epa.gov/opp00001/chem_search/reg_actions/registration/fs_PC-214900_01-Apr-05.pdf

[430] Ayesa et al 2006. "Evaluation of Novel Insecticides for Control of Dengue Vector Aedes aegypti (Diptera: Culicidae)" bioone.org/doi/abs/10.1603/0022-2585(2006)043%5B0055:EONIFC%5D2.0.CO%3B2; esa.confex.com/esa/2003/techprogram/paper_12381.htm

[431] R.E.D. FACTS Hydramethylnon (12/98), epa.gov/opp00001/chem_search/reg_actions/reregistration/fs_PC-118401_1-Sep-98.pdf; _Reregistration Eligibility Decision (RED): Hydramethylnon (12/98) epa.gov/opp00001/chem_search/reg_actions/reregistration/red_PC-118401_1-Sep-98.pdf

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