

Table 4. Active ingredients of commonly used pesticides and their effect on bees in California, Idaho, Oregon, and Washington

Active Ingredient	Highly Toxic to Bees (RT)	Toxic to Bees (RT)	No Bee Precautionary Statement (PS) on Label	Common Product Names	Notes and Special Precautions
Abamectin (Avermectin) Fermentation products derived from soil bacterium, affects nerve and muscle action of insects and mites	X 0.025 lb ai/acre 1-3 days ERT , ≤ 0.025 lb ai/acre 8 hours RT [1] Can vary with formulation and application rate			Abacide, Abacus, Abba, Agmectin, Agri-Mek, Ardent, Avert, Avicta, Avid, Epi-Mek, Reaper, Solera, Solero, Temprano, Timectin, Zoro	ERT to bumble bees [2], short RT to alfalfa leafcutting bees and alkali bees at 0.025 lb ai/acre [1].
Acephate Organophosphate insecticide	X > 3 days ERT [1] Can vary with formulation and application rate			Bracket, Orthene, Orthonex	Incompatible with bumble bees [2], ERT to alfalfa leafcutting bees and alkali bees [1].
Acequinocyl Quindone insecticide/miticide, metabolic poison			X	Kanemite, Shuttle	
Acetamiprid Neonicotinoid insecticide (cyano group)		X Yes		Assail, Tristar, Transport	Length of residual toxicity to honey bees is unknown. ERT to alfalfa leafcutting bees and alkali bees [3]. 2 day ERT to bumble bees [2].  Cyano group neonicotinoids exhibit lower toxicity to bees than nitro group neonicotinoids [4].
Aldicarb Systemic carbamate insecticide and nematocide	X			Temik Only available as granular formulation [5]	Not hazardous to bees when applied at least 4 weeks prior to bloom [1]. May be a persistent contaminant of beeswax [6].
Alpha-cypermethrin Pyrethroid insecticide	X Yes			Fastac	Length of residual toxicity to bees unknown.
Aluminum tris O-ethyl phosphonate Systemic organophosphate fungicide			X	Aliette, Fosetyl-Al, Chipco, Flanker, Linebacker, Legion	
Azadirachtin Insecticidal extract of neem oil Ecdysone antagonist		X < 2 hours RT [1] Can vary with formulation and application rate		Neemix, Amazin, Azera, Aza, Ecozin, Ornazin	Must be ingested to be toxic [7].
Azinphos-methyl Organophosphate insecticide	X 4 days ERT [1] 5 days ERT [8] Can vary with formulation and application rate			Guthion is being phased out	ERT to alfalfa leafcutting bees and alkali bees [1].
Azoxystrobin β-methoxyacrylate fungicide			X	Abound, Dynasty, Heritage, Quadris	
Bacillus subtilis Fungicide derived from naturally occurring soil bacterium			X	Kodiak, Rhapsody, Serenade, Optiva, Companion, Cease	Laboratory tests suggest potential effects on bumble bees [9].

Active Ingredient	Highly Toxic to Bees (RT)	Toxic to Bees (RT)	No Bee Precautionary Statement (PS) on Label	Common Product Names	Notes and Special Precautions
<b>Bacillus thuringiensis</b> Bacterium that produces a number of chemicals toxic to butterfly and moth digestive systems			X	BT, Agree, Jackpot, Thuricide, Condor, Vault	
<b>Beauveria bassiana</b> Soil fungus that infects and kills insects		X		Mycotrol, Botaniguard	Potentially pathogenic to honey bees (per Mycotrol label), and laboratory studies suggest effects on bumble bees [9].
<b>Beta-cyfluthrin</b> Pyrethroid insecticide	X > 1 day ERT [10] Can vary with formulation and application rate			Baythroid, Leverage, Tempo	
<b>Bifenazate</b> Carbazate acaricide, metabolic poison		X Yes		Acramite, Floramite, Vigilant	Length of residual toxicity to bees unknown.
<b>Bifenthrin</b> Pyrethroid insecticide	X > 0.06 lb ai/acre > 1 day ERT, ≤ 0.04 lb ai/acre 4-6 hours RT [1] Can vary with formulation and application rate			Brigade, Capture, Discipline, Shiper, Talstar	> 0.032 lb ai/acre: > 1 day ERT for alfalfa leafcutting bees, ≤ 0.32 lb ai/acre: 4-6 hours RT toxicity for alfalfa leafcutting bees and alkali bees [1]. Incompatible with bumble bees [2].
<b>Boscalid</b> Carboxamide fungicide			X	Endura, Pristine	
<b>Buprofezin</b> Insect growth regulator, chitin synthesis inhibitor			X	Applaud, Centaur, Courier, Talus,	
<b>Calcium Polysulfide</b> Inorganic fungicide			X	Lime Sulfur, Sulfurix	
<b>Capsaicin</b> Insect and animal repellant derived from hot peppers		X [7]		Hot pepper wax	
<b>Captan</b> Dicarboximide fungicide			X?	Captan, Merpan, Captec, Captevate	Up to 7 day ERT for mason bees [1]. Effects on honey bee brood in laboratory, but not in field tests [11-13].
<b>Carbaryl</b> Carbamate insecticide	X Carbaryl D (Sevin): 2-14 days ERT. Carbaryl 4F (Sevin) 2 lb ai/acre & Carbaryl WP (Sevin): 3-7 days ERT. Carbaryl XLR (Sevin) > 1.5 lb/acre: > 1 day ERT. Carbaryl 4F (Sevin) ≤ 1 lb ai/acre & Carbaryl XLR (Sevin) ≤ 1.5 ai/acre not > 1:19 dilution: 8 hours RT. [1] Can vary with formulation and application rate			Sevin Bees are unlikely to be exposed to granular and bait formulations	Hazardous if applied to blooming trees as a blossom-thinning agent [1]. Carbaryl has ERT to alfalfa leafcutting bees [1], alkali bees [1], and bumble bees [2].

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<b>Chenopodium ambrosioides extract</b> Antifeedant insecticide			X	Requiem	
<b>Chlorantraniliprole</b> Anthranilic diamide insecticide: Insect neurotoxin affecting muscle regulation, causing paralysis and death			X	Altacor, Acelepryn, Coragen, Grubex	No impact on bumble bees [14].
<b>Chlorfenapyr</b> Pyrrole insecticide/acaricide, metabolic poison		X < 4 hours RT [1] Foraging behavior may be affected > 2 days [10] Can vary with formulation and application rate		Phantom, Pylon	8 hour ERT for alfalfa leafcutting bees[1]. Incompatible with bumble bees [2].
<b>Chlorothalonil</b> Chloronitrile fungicide			X?	Bravo, Echo, Daconil, Equus, Legend	Tentatively associated with "entombed pollen" [15]. Common contaminant of beeswax [6].
<b>Chlorpyrifos</b> Organophosphate insecticide	X EC 4-6 days ERT, ULV 0.05 lb ai/acre or less < 2 hours RT [1] Can vary with formulation and application rate			Dursban, Cobalt, Lorsban Bees unlikely to be exposed to granular formulations	Up to 7 day ERT for alfalfa leafcutting bees, 3-6 days ERT for alkali bees [1]. Common contaminant of beeswax [6]. Incompatible with bumble bees [2].
<b>Chromobacterium subtsugae</b> Insecticide derived from bacteria, acts through complex mechanism of action		X Yes		Grandevo	Length of residual toxicity to bees unknown.
<b>Cinnamaldehyde</b> Cinnamon flavoring, insecticide, miticide, fungicide			X	Cinnacure	
<b>Clofentezine</b> Tetrazine oxide/miticide, mite growth inhibitor			X	Apollo	
<b>Clothianidin</b> Systemic neonicotinoid insecticide (nitro group)	X [5] > 5 days ERT (per Clutch label) Can vary with formulation and application rate			Arena, Belay, Clutch, Poncho, Sepresto	Dust from planting seeds coated with neonicotinoids have been associated with colony losses [16]. Incompatible with bumble bees [2].
<b>Copper Hydroxide</b> Inorganic fungicide/bactericide		X [17]		Badge, Champ, Kocide, Nu-Cop	
<b>Copper Sulfate + lime</b> Inorganic fungicide/bactericide	X [17]			Bordeaux Mixture	Other sources indicate that this pesticide can be applied at any time with reasonable safety to bees [18].
<b>Cryolite</b> (aka Sodium aluminofluoride) Inorganic insecticide			X	Kryocide, Prokil	
<b>Cydia pomonella granulosis virus</b> Naturally occurring virus that infects codling moth			X	Carpovirusine, Cyd-X	

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Cyflufenamid Phenylacetamide fungicide			X	Miltrex, Torino	
Cyfluthrin Pyrethroid insecticide	X > 1 day ERT [1] Can vary with formulation and application rate			Baythroid, Tombstone, Tempo	Incompatible with bumble bees [2].
Cymoxanil Cyanoacetamide oxime fungicide			X	Curzate, Tanos	
Cypermethrin Pyrethroid insecticide	X > 0.025 lb ai/acre, > 3 days ERT < 0.025 lb ai/acre, < 2 hours RT [1] Can vary with formulation and application rate			Up-Cyde, Tenkoz	Incompatible with bumble bees [2].
Cyprodinil Anilino-pyrimidine fungicide			X	Palladium, Switch, Vangard	No impact on bumble bees [14].
Cyromazine Insect growth regulator, chitin synthesis inhibitor		X < 2 hours RT [1] Can vary with formulation and application rate		Trigard	> 1 day ERT for alfalfa leafcutting bees and alkali bees [1], short RT for bumble bees [2].
Deltamethrin Pyrethroid insecticide	X < 4 hours RT [1] Can vary with formulation and application rate			Battalion, Grim Reaper	< 8 hours RT for alfalfa leafcutting bees and alkali bees [1]. Formulated products may have a repellent effect lasting 2-3 hours [7]. 2 days ERT for bumble bees [2].
Diatomaceous earth Naturally occurring silicon dioxide, abrasive, fossilized remains of diatoms, used as insecticide		X [1] < 2 hours RT [1] Can vary with formulation and application rate			Although no PS on label, some toxicity observed in field studies [1, 17]
Diazinon Organophosphate insecticide	X 2 days ERT [1] Can vary with formulation and application rate				Incompatible with bumble bees [2], ERT for alfalfa leafcutting bees and alkali bees [1].
Dichloran Aromatic hydrocarbon fungicide			X	Botran	
Dicofol Organochlorine miticide			X		Mixing with insecticides increases hazard to bees [1].
Difenoconazole Triazole fungicide			X?	Dividend, Inspire, Quadrus, Revus	Potential effects on learning in honey bees [19]
Diflubenzuron Benzoylurea insect growth regulator, chitin synthesis inhibitor			X?	Dimilin	Laboratory studies suggest effects on larval development [20], while field studies do not indicate any effects to honey bees [1, 21]. Toxic to bumble bee larvae [21] and alfalfa leafcutting bees [1].
Dimethoate Organophosphate insecticide	X Up to 3 days ERT [1] 1-3.5 days ERT [8] Can vary with formulation and application rate			Dimate	ERT to alfalfa leafcutting bees and alkali bees [1]. Do not place alfalfa leafcutting bee nest shelters into fields until at least 1 week after treatment. Incompatible with bumble bees [2].

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<b>Dinotefuran</b> Neonicotinoid insecticide (nitro group)	<b>X</b> 39 hours ERT [5] Can vary with formulation and application rate			Venom, Safari, Scorpion	Reported residual toxicity to honey bees tentative [5]. Incompatible with bumble bees [2].
<b>Disulfoton</b> Organophosphate insecticide		<b>X</b> ≥ 1 lb ai/acre 7 hours RT, ≥ 0.5 lb ai/acre 2 hours RT [1]		Di-Syston is being discontinued	
<b>Dodine</b> Guanidine fungicide			<b>X</b>	Syllit	
<b>Emamectin benzoate</b> Avermectin class insecticide, affects nerve and muscle action	<b>X</b> > 24 hours ERT [5] Can vary with formulation and application rate			Denim, Proclaim	1 day ERT for bumble bees [2].
<b>Endosulfan</b> Organochlorine insecticide		<b>X</b> > 0.5 lb ai/acre 8 hours RT, 0.5 lb ai/acre or less 2-3 hours RT [1] Can vary with formulation and application rate		Thionex Is being discontinued	1-3 days ERT for alfalfa leafcutting bees, 14 hours ERT for alkali bees [1].
<b>Esfenvalerate</b> Pyrethroid insecticide	<b>X</b> Up to 1 day ERT [1] Can vary with formulation and application rate			Asana	Incompatible with bumble bees [2].
<b>Ethoprop</b> Organophosphate insecticide		<b>X</b>		Mocap	
<b>Etoxazole</b> Oxazoline insecticide/acaricide, growth regulator likely to affect chitin synthesis			<b>X ?</b>	Beethoven, Tetrasan, Zeal	3 days ERT for bumble bees [2].
<b>Famoxadone</b> Oxazolidine dione fungicide			<b>X</b>	Tanos	
<b>Fenarimol</b> Pyrimidine fungicide			<b>X</b>	Rubigan, Vintage	
<b>Fenbuconazole</b> Triazole fungicide			<b>X</b>	Enable, Indar	
<b>Fenbutatin-oxide</b> Organotin acaricide			<b>X</b>	Vendex	
<b>Fenhexamid</b> Hydroxylanilidine fungicide			<b>X</b>	Decree, Elevate, Judge	
<b>Fenpropathrin</b> Pyrethroid insecticide/acaricide	<b>X</b> 1 day ERT [1] Can vary with formulation and application rate			Danitol, Tame	> 1 day ERT for alfalfa leafcutting bees and alkali bees [1]. Incompatible with bumble bees [2].
<b>Fenpyroximate</b> Pyrazole acaricide, metabolic poison			<b>X</b>	Fujimite, Akari	

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<b>Fipronil</b> Phenylpyrazole insecticide	<b>X</b> < 8 hours ERT [1] to 7-28 days ERT [10] Can vary with formulation and application rate			Regent	> 1 day ERT for alfalfa leafcutting bees [1]. Incompatible with bumble bees [2].
<b>Flonicamid</b> Pyridinecarboxamide insecticide, antifeedant			<b>X ?</b>	Beleaf, Carbine	Possible effects on honey bees, further research needed [22]. Short RT for alfalfa leafcutting bees and alkali bees [3]. Short RT for bumble bees [2].
<b>Flubendiamide</b> Diamide insecticide, affects nerve and muscle action			<b>X ?</b>	Belt, Synapse, Turismo, Vetica	Possible effects on honey bee larval development, further research needed [23].
<b>Fludioxonil</b> Phenylpyrrole fungicide			<b>X</b>	Graduate, Maxim, Scholar, Switch	No impact on bumble bees [14].
<b>Fluopicolide</b> Benzamide fungicide			<b>X</b>	Adorn, Presidio	
<b>Fluopyram</b> Pyridinyl-ethyl-benzamide fungicide			<b>X</b>	Luna, Propulse	
<b>Flutriafol</b> Triazole fungicide			<b>X</b>	Topguard	
<b>Fluvalinate</b> Pyrethroid insecticide		<b>X</b> < 2 hours RT [1] ½ day ERT [8] Can vary with formulation and application rate		Mavrik, Zoecon	Ubiquitous contaminant of beeswax [6].
<b>Formetanate</b> Formamidine insecticide/acaricide, affects nerve action		<b>X</b> < 8 hours RT [1] Can vary with formulation and application rate		Carzol	> 14 hours ERT for alfalfa leafcutting and 9 hour ERT for alkali bees [1]. Incompatible with bumble bees [2].
<b>Gamma-cyhalothrin</b> Pyrethroid insecticide	<b>X</b> Yes			Bolton, Cobalt, Declare, Proaxis	Length of residual toxicity to honey bees unknown. > 1 day ERT for alfalfa leafcutting bees [1].
<b>Hexythiazox</b> Thiazolidine acaricide, growth regulator			<b>X ?</b>	Onager, Savey	> 2 hours RT for alfalfa leafcutting and alkali bees [1].
<b>Horticultural oil</b> Refined paraffinic oils used as insecticide		<b>X</b> [1] < 3 hours RT [1] Can vary with formulation and application rate		Superior, Supreme, Dormant, Summer	Although no PS on label, some toxicity observed in field studies.
<b>Imidacloprid</b> Neonicotinoid insecticide (nitro group)	<b>X</b> 0.25 lb ai/acre > 1 day ERT, 0.1 lb ai/acre < 8 hours RT [2] Can vary with formulation and application rate			Admire, Alias, Benefit, Brigadier, Couraze, Dominion, Gaucho, Macho, Merit, Nuprid, Pasada, Provado, Premise, Widow	Imidacloprid is often used as a systemic insecticide, and has been found in pollen and nectar of plants [4, 24]. Whether these concentrations represent a hazard to bees is under scrutiny [4]. Bumble bees may be more sensitive to imidacloprid than honey bees [25]. Incompatible with bumble bees [2].

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<b>Indoxacarb</b> Oxadiazine insecticide, affects nerve action	X Yes			Avaunt, Steward	Short RT for honey bees [1], 3 days ERT for bumble bees [2].
<b>Iprodione</b> Dicarboximide fungicide			X ?	Rovral, Dovetail, Nevado, Tazz	Laboratory studies suggest effects on honey bee larval development [12], field studies needed.
<b>Kaolin clay</b> Naturally occurring clay			X	Surround	
<b>Kresoxim methyl</b> Oximino acetate fungicide			X	Cygnus, Sovran	
<b>Lambda-cyhalothrin</b> Pyrethroid insecticide	X > 1 day ERT [1], > 7 days ERT [10] (encapsulated) Can vary with formulation and application rate			Warrior, Cyzmic, Demand, Voliam	May be more toxic to bees when mixed with propiconazole. > 1 day ERT for alfalfa leafcutting bees [1]. Incompatible with bumble bees [2].
<b>Lime Sulfur</b> Calcium polysulfides			X <sub>[17]</sub>		
<b>Malathion</b> Organophosphate insecticide	X Malathion ULV, ≥8 fl oz ai/acre 5.5 days ERT, ≤ 3 fl oz ai/acre 3 hours RT, Malathion WP 2 days ERT, Malathion EC 2-6 hours RT [1] Can vary with formulation and application rate			Fyfanon	Up to 7 days ERT for alkali bees and alfalfa leafcutting bees [1]. Incompatible with bumble bees [2].
<b>Mancozeb</b> Dithio-carbamate fungicide			X	Dithane, Fore, Gavel, Manzate, Mankocide, Penncozeb, Ridomil	
<b>Mandipropamid</b> Mandelic acid amide fungicide			X	Micora	
<b>Mefenoxam</b> Acylalanine fungicide			X	Apron, Maxim, Ridomil, Ultra Flourish	
<b>Metaxyl</b> Acylalanine fungicide			X	Acquire, Allegiance, Belmont, Metastar, Sebring, Vireo	
<b>Metalddehyde bait</b> Molluscicide			X	Deadline, Sug-fest, Snail & Slug Killer	
<b>Metarhizium anisopliae</b> Soil fungus that parasitizes insects			X	Met52	

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<b>Metconazole</b> Triazole fungicide			X	Quash, Caramba	
<b>Methidathion</b> Organophosphate insecticide	X 1-3 days ERT [1] Can vary with formulation and application rate			Supracide	Do not place alfalfa leafcutting bee nest shelters into fields until at least 1 week after treatment [1]. Incompatible with bumble bees [2].
<b>Methomyl</b> Carbamate insecticide	X 2 hours RT [1] 1.5 days ERT [8] Can vary with formulation and application rate			Lannate, Nudrin	Up to 15 hours ERT for alfalfa leafcutting bees and 1 day ERT for alkali bees, depending on application rate. More hazardous to bees in a humid climate [1]. 3 days ERT for bumble bees [2].
<b>Methoxyfenozide</b> Insect growth regulator, ecdysone receptor agonist			X	Intrepid	
<b>Metrafenone</b> Benzophenone fungicide			X	Vivando	
<b>Milbemectin</b> Milbemycin acaricide, affects nerve and muscle action	X Yes			Ultiflora	Length of residual toxicity to honey bees unknown. 3 days ERT for bumble bees [2].
<b>Myclobutanil</b> Triazole fungicide			X	Laredo, Rally, Sonoma, Spera, Stride, Systhane	No impact on bumble bees [14].
<b>Naled</b> Organophosphate insecticide	X 1 lb ai/acre 12-20 hours ERT, 0.5 ai/acre 2 hours RT [1] 1-1.5 days ERT [8] Can vary with formulation and application rate			Dibrom, Trumpet	Up to 4.5 days ERT for alfalfa leafcutting bees and 2 days ERT for alkali bees [1].
<b>Neem oil</b> Insecticide from seeds of neem tree			X	Turbo, Trilogy	Must be ingested to be toxic [7].
<b>Novaluron</b> Benzoylurea insect growth regulator, chitin synthesis inhibitor		X Yes		Diamond, Mayhem, Pedestal, Rimon, Shackle	Length of residual toxicity to honey bees unknown. Effects on egg hatch and larval development in alfalfa leafcutting bees [26]. Effects on brood development and colony strength in honey bees [27]. 3 days ERT for bumble bees [2].
<b>Oil: cottonseed, clove, garlic</b> Contact fungicide, miticide and insecticide			X	Pest Out, GC-mite	
<b>Oxamyl</b> Carbamate insecticide	X ≥ 1 lb ai/acre 8 hours RT, ≤ 0.5 lb ai/acre 3 hours RT [1] 3-4 days ERT [8] Can vary with formulation and application rate			Vydate	> 1 day ERT for alfalfa leafcutting bees and 2 days ERT for alkali bees [1]. Incompatible with bumble bees [2].





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Oxydemeton-methyl Organophosphate insecticide		X < 2 hours RT [1] Can vary with formulation and application rate		Metasystox-R, MSR	Up to 8 hours ERT for alfalfa leafcutting bees [1]. Incompatible with bumble bees [2].
Paraquat Bipyridium herbicide			X?		Although no PS on label, laboratory studies suggest effects on honey bee larvae [28], and paraquat has been associated with colony losses [29].
Penthiopyrad Pyrazole-4-carboxamide fungicide			X	Fontelis, Velista	
Permethrin Pyrethroid insecticide	X 0.5 to 2 days ERT [1] > 5 days ERT [8] Can vary with formulation and application rate			Ambush, Bee Gone, Pounce, Permatar	Up to 3 days ERT for alfalfa leafcutting bees. May be repellent in arid conditions [1]. Incompatible with bumble bees [2].
Petroleum/Paraffinic Oil Refined paraffinic oils used as insecticides		X [1] < 3 hours RT [1] Can vary with formulation and application rate		Biocover, SunSpray, JMS	
Phorate Organophosphate insecticide	X			Thimet (granular formulations may not result in honey bee exposures)	< 2 hours RT for alfalfa leafcutting bees and alkali bees. Possible fumigation hazard [1].
Phosmet Organophosphate insecticide	X > 3 days ERT Can vary with formulation and application rate			Imidan	Up to 5 days ERT for alfalfa leafcutting bees and alkali bees [1]. 2-3 days ERT for bumble bees [2].
Phosphorous acid, mono and di-potassium salts Inorganic fungicide			X	Fosphite, Kphos, Organocide, Prophyt	
Piperonyl butoxide Synergist for insecticides			X	Exponent May be tank mixed, or active ingredient included in insecticide formulations	Low toxicity alone, increases the toxicity of insecticides by blocking cytochrome P450 activity.
Pirimicarb Carbamate insecticide		X [1] < 2 hours RT [1] Can vary with formulation and application rate		Primor	Although no PS on label, some toxicity observed in field studies. 1 day ERT for bumble bees [2].
Polyoxin D zinc salt Metabolite of Streptomyces bacteria, broad spectrum fungicide			X	Endorse, Oso, Ph-D, Tavano, Veggieturbo	
Potassium bicarbonate Naturally occurring mineral salt used as a fungicide			X	Armicarb, Greencure, Kaligreen	No impact on bumble bees [14].
Potassium salts of fatty acids aka insecticidal soap			X	M-Pede, Safer's Soap	
Propargite Miticide			X	Omite, Comite	Mixing with insecticides increases hazard to bees [1].

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<b>Propiconazole</b> Triazole fungicide			X	Banner Maxx, Bumper, Dorado, Kestrel, Propicure, Protocol, Quilt, Tilt	Mason bees more sensitive than honey bees [30]. If mixed with lambda-cyhalothrin, may increase toxicity.
<b>Propylene glycol monolaurate</b> Miticide based on fatty acids			X	Acaritouch	
<b>Pymetrozine</b> Pyridine Azomethine insecticide, antifeedant		X [1] < 2 hours RT [1] Can vary with formulation and application rate		Endeavor, Fulfill	Although no PS on label, some toxicity observed in field studies [1].
<b>Pyraclostrobin</b> Methoxy-carbamate fungicide			X	Cabrio, Coronet, Headline, Insignia, Pristine, Stamina	
<b>Pyrethrin</b> Insecticidal compounds occurring in specific chrysanthemums	X < 2 hours RT [1] Can vary with formulation and application rate			Azera, Natria, Pyganic, Pyrenone, Pyrocid	Commonly formulated with piperonyl butoxide (PBO), a synergist. 1.5 days ERT for bumble bees when formulated with PBO [2].
<b>Pyridaben</b> Pyridazine miticide/insecticide, metabolic poison	X < 2 hours RT [1] Can vary with formulation and application rate			Nexter, Pyramite, Sanmite	> 8 hours ERT for alfalfa leafcutting bees and alkali bees [1]. 1 day ERT for bumble bees [2].
<b>Pyrimethanil</b> Anilino-pyrimidine fungicide			X	Penbotec, Luna, Philabuster, Scala	
<b>Pyriproxyfen</b> Insect growth regulator, juvenile hormone agonist			X?	Esteem, Distance, Knack, Nyguard, Pitch, Seize, Terva,	< 2 hours RT for alfalfa leafcutting and alkali bees [1]. May be toxic to bumble bee larvae [31]. Avoid direct application or spray drift to honey bee hives (per label).
<b>Quinoxifen</b> Aza-naphthalene fungicide			X	Quintec	
<b>Reynoutria sachaliensis</b> Biofungicide, plant extract			X	Regalia	
<b>Rotenone</b> Plant-derived insecticide and piscicide		X [1] < 2 hours RT [1] Can vary with formulation and application rate		Only piscicidal (fish-killing) uses registered	
<b>Sabadilla</b> Plant derived insecticide, affects nerve and muscle action	X [17] ≥ 1 day ERT [17] Can vary with formulation and application rate			Veratran-D	No PS on label, other sources suggest ERT to bees.

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<b>Sodium tetraborohydrate decahydrate</b> Borax®, used as insecticide and fungicide			X	Borax, Prev-am	
<b>Spinetoram</b> Spinosyn insecticide, affects nerve action		X 3 hours RT [1] Can vary with formulation and application rate		Assurity, Delegate, Radiant	
<b>Spinosad</b> Spinosyn insecticide, affects nerve action		X 3 hours RT [1] to 1 day ERT [10] Can vary with formulation and application rate		Bull's Eye, Entrust, Natular, Protector Pro, Success	> 1 day ERT for alfalfa leafcutting bees, short RT for alkali bees [1].
<b>Spirodiclofen</b> Mite/insect growth regulator, lipid biosynthesis inhibitor		X		Envidor	Toxic to honey bee larvae through direct contamination of pollen and nectar (per Envidor label). Incompatible with bumble bees [2].
<b>Spiromesifen</b> Mite/insect growth regulator, lipid biosynthesis inhibitor			X?	Forbid, Judo, Oberon	Structure and mechanism of action similar to spiroadiclofen and spirotetramat, which are potentially toxic to honey bee larvae.
<b>Spirotetramat</b> Mite/insect growth regulator, lipid biosynthesis inhibitor		X Yes		Kontos, Movento	Practically nontoxic to adult bees, but residues in pollen and nectar potentially toxic to larvae (per Movento label). Length of residual toxicity to honey bees unknown. 1 day ERT for bumble bees [2].
<b>Streptomyces lydicus</b> Biological fungicide			X	Actino-Iron, Actinovate	
<b>Sucrose octanoate esters</b> Sucrose fatty acid ester insecticide/miticide			X	Sucrashield, Sucrocid	
<b>Sulfoxaflor</b> Nicotinic acetylcholine receptor agonist, affects nerve action	X 3 hrs RT Can vary with formulation and application rate			Closer, Transform	Label instructions include crop-specific restrictions and advisory statements to protect pollinators.
<b>Sulfur</b> Naturally occurring element			X?	Sulfur	See also lime sulfur. While most sources say sulfur poses little risk for bees, other sources suggest sulfur may cause toxicity for bees for up to a day and a half [17].
<b>Tebuconazole</b> Triazole fungicide			X?	Adament, Amtide, Buzz Ultra, Luna, Monsoon, Orius, Unicorn	2 days ERT for bumble bees [2].
<b>Tebufenozide</b> Insect growth regulator, ecdysone agonist			X	Confirm, Mimic	
<b>Tetraconazole</b> Triazole fungicide			X?	Eminent, Mettle	1 day ERT for bumble bees [2].
<b>Thiacloprid</b> Neonicotinoid insecticide (cyano group)			X?	Calypso	Less toxic to bees than most other neonicotinoids [4]. 1-2 days ERT for bumble bees [2].

Active Ingredient	Highly Toxic to Bees (RT)	Toxic to Bees (RT)	No Bee Precautionary Statement (PS) on Label	Common Product Names	Notes and Special Precautions
<b>Thiamethoxam</b> Neonicotinoid insecticide (nitro group)	<b>X</b> 7-14 days ERT [1] Can vary with formulation and application rate			Actara, Adage, Agri-flex, Centric, Cruiser, Durivo, Endigo, Flagship, Helix XTra, Meridian, Platinum, Voliam	Thiamethoxam is often used as a systemic insecticide, and has been found in pollen and nectar of plants [4, 24]. Thiamethoxam may also be used in seed coatings. Whether these applications represent a hazard to bees is under scrutiny [16, 24]. Bumble bees may be more sensitive to neonicotinoids than honey bees [25]. Incompatible with bumble bees [2].
<b>Thiodicarb</b> Carbamate insecticide		<b>X</b> < 2 hours RT [1] Can vary with formulation and application rate		Larvin	> 8 hours ERT for alfalfa leafcutting bees and alkali bees.
<b>Thiophanate-methyl</b> Thiophanate fungicide			<b>X</b>	Incognito, Topsin	
<b>Tolfenpyrad</b> Pyrazole insecticide, metabolic poison			<b>X</b>	Hachi-hachi, Torac	Greenhouse use only, no PS on label. ERT to alfalfa leafcutting bees and alkali bees [3].
<b>Triadimefon</b> Triazole fungicide			<b>X</b>	Armada	
<b>Triflumizole</b> Imidazole fungicide			<b>X</b>	Procure	May increase toxicity of certain neonicotinoids [32].
<b>Zeta-cypermethrin</b> Pyrethroid insecticide	<b>X</b> > 1 day ERT [1] Can vary with formulation and application rate			Mustang, Hero, Stallion, Mustang Maxx	
<b>Ziram</b> Dithiocarbamate fungicide			<b>X?</b>	Ziram	Laboratory studies suggest effects on honey bee larval development [12], field studies needed.

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