

Characteristics of Insecticides

Navneet Kaur

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Pesticides discussed in this manual are presented below, along with information on the chemical class, mode of action, the toxicity class, the oral and dermal LD₅₀ values and the chemicals' primary uses.

Mode of action (MoA) refers to the IRAC MoA classification system. Rotating pesticides with different MoA is a critical practice to limit the development of insecticide resistance.

Toxicity classes are as follows:

I = high; II = medium; III = low; and IV = very low.

Note that classification into toxicity class is both approximate and relative. The LD₅₀ values refer to the amount of the chemical that is required to kill 50 percent of the test animals; thus, the lower figures are associated with the most toxic compounds. LD₅₀ values listed were established by the chemical manufacturers. It should be kept in mind that LD₅₀ values vary with testing factors such as test species, sex, age, degree of fasting and other test protocols. Thus, estimates of toxic hazard based on these figures may not be exact. LD₅₀ values are based on technical grade products unless otherwise noted.

The primary use of the chemical is listed, but it should be noted that some chemicals may have other uses. Some or all formulations of the chemical may be classified as a restricted-use pesticide (RUP).

Table 1. Acute toxicity and modes of action of insecticides and acaricides

Compound	Chemical class	MoA ¹	Toxicity class	LD ₅₀ (mg/kg)		Use
				Rat oral	Rabbit dermal	
abamectin (Avermectin, Avid)	acyclic lactone	6	IV	10	>2,000	insecticide (RUP)
acephate (Orthene)	organophosphate	1B	III	1,030–1,447	>10,000	insecticide
acequinocyl (Katemite)	quinoline	20B	IV	>5,000	2,000	insecticide
acetamiprid (Assail)	neonicotinoid	4A	II	146-217	—	insecticide
allethrin (Pynamin)	pyrethroid	3A	III	900–2,150	—	insecticide
aluminum phosphide (Phostoxin)	inorganic	24	I	8.7	—	fumigant (RUP)
amitraz (Taktic)	amidine	19	III	650	>200	insecticide, acaricide (RUP)
azadirachtin (neem, Margosan-O)	botanical: IGR	UN	II	>5,000	>2,000	insecticide
azinphos-methyl (Guthion, Sniper)	organophosphate	1B	I	9	150–220	insecticide (RUP)
<i>Bacillus sphaericus</i>	microbial	11B	IV	5,000	—	insecticide

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				Rat oral	Rabbit dermal	
<i>Bacillus thuringiensis</i>	microbial	11A	II, III, IV	>5,000	>2,000	insecticide
<i>Beauveria bassiana</i> (Mycotrol)	microbial	UN	IV	non-toxic	non-toxic	insecticide
bendiocarb (Ficam, Turcam)	carbamate	1A	II	40-156	566-800 (rat)	insecticide (RUP)
bifenazate (Floramite)	carbamate	UN		>5,000	>2,000 (rat)	acaricide
bifenthrin (Brigade, Capture)	pyrethroid	3A	II	55	>2,000	insecticide (RUP)
borax (disodium tetraborohydrate decahydrate)	inorganic	8D	III	4,500–6,000	>10,000	insecticide
boric acid	inorganic	8D	III	3,500	>10,000 (rat)	insecticide
buprofezin (Applaud)	thiadiazine ; IGR	16	III	2,355	non-irritating	insecticide
carbaryl (Sevin)	carbamate	1A	I, II, III, IV	500-850	>4,000 (rat)	insecticide
chlorantraniliprole (Coragen)	anthranilic diamide	28	IV	>5,000	>5,000	insecticide
chlorfenapyr (Alert, Pirate)	pyrrole	13	II	1,152	>2,000	insecticide; acaricide
chlorethoxyfos (Fortress)	organophosphate	1B	I, II	1.8–4.8	12.5–18.5	soil insecticide (RUP)
chloropicrin (Telone C17)	unclassified	8B	I	250		fumigant (RUP)
chlorpyrifos (Dursban, Lorsban)	organophosphate	1B	II, III	135-163	>5,000	insecticide (RUP)
chlorpyrifos-methyl (Reldan)	organophosphate	1B	III	3,000	>2,000	insecticide
clothianidin (Clutch)	neonicotinoid	4A	III	>5,000	>5,000	insecticide
clofentezine (Apollo)	tetrazine	UN	III	>5,200	>2,100 (rat)	acaricide (RUP)
coumaphos (Co-Ral)	organophosphate	1B	III	16-41	860 (rat)	insecticide (RUP)
cryolite (Kryocide)	inorganic	UN	III	>5,000	>2,000	insecticide
cyantraniliprole (Exirel)	anthranilic diamide	28	IV	>5,000	>5,000 (rat)	insecticide
cyflumetofen (Sultan)	benzoylacetone nitrile	25A	IV	>2,000	non-irritating	acaricide
cyfluthrin (Baythroid, Tempo)	pyrethroid	3A	I, II	500	>5,000 (rat)	insecticide (RUP)

Table 1. Acute toxicity and modes of action of insecticides and acaricides

Compound	Chemical class	MoA ¹	Toxicity class	LD ₅₀ (mg/kg)		Use
				Rat oral	Rabbit dermal	
cypermethrin (Ammo, Demon)	pyrethroid	3A	II,III	250-4,150	>2,460	insecticide (RUP)
cyromazine (Larvadex, Trigard)	triazine; IGR	17	III	3,387	>3,100 (rat)	insecticide
deltamethrin (Decis)	pyrethroid	3A	II	135–5,000	>2,000	insecticide (RUP)
diatomaceous earth	inorganic		IV	—	—	insecticide
diazinon	organophosphate	1B	II, III	1,250	540-650	insecticide (RUP)
diazinon (encapsulated) (Knox Out)	organophosphate	1B	IV	>21,000	>10,000	insecticide (RUP)
dichlofenthion (VC-13 Nemacide)	organophosphate	1B	II	270	—	nematicide, insecticide
dichloropropene (Telone II)	halogenated organic		III	150	333	fumigant (RUP)
dichlorvos (DDVP, Vapona)	organophosphate	1B	I	50	90 (rat)	insecticide
dicrotophos (Bidrin)	organophosphate	1B	I	17–22	224	insecticide (RUP)
diflubenzuron (Adept, Dimilin)	benzoylphenylurea	15	III	>4,640	>2,000	insecticide (RUP)
dimethoate (Cygon, Rogor)	organophosphate	1B	II	387	>2,000	acaricide, insecticide
dinocap (Karathane)	dinitrophenol		III	980	>4,700	acaricide
dinotefuran (Venom)	neonicotinoid	4A	III	2804	>2,000 (rat)	insecticide
d-trans allethrin (bioallethrin)	pyrethroid	3A	II, III	709	>3,000	insecticide
emamectin benzoate (Proclaim)	botanical	6	III	76-89	>2,000	insecticide (RUP)
esfenvalerate (Asana)	pyrethroid	3A	II	458	>2,000	insecticide (RUP)
ethoprop (Mocap)	organophosphate	1B	I	62		soil insecticide (RUP)
etoxazole (TetraSan)	oxazoline	10B	III	>5,000	>2,000 (rat)	acaricide
fenamiphos (Nemacur)	organophosphate	1B	I	3	80 (rat)	nematicide (RUP)
fenbutatin-oxide (Hexakis, Vendex)	organotin	12B	I, III	2,631	>2,000	acaricide (RUP)
fenoxycarb (Comply, Eclipse)	carbamate; IGR	7B	IV	>10,000	>2,000 (rat)	insecticide
fenpropathrin (Danitol, Tame)	pyrethroid	3A	I	71	>2,000	insecticide (RUP)
fenpyroximate (Akari)	phenoxypyrazole	21A	II	245-400	>2,000 (rat)	acaricide (RUP)

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Compound	Chemical class	MoA ¹	Toxicity class	LD ₅₀ (mg/kg)		Use
				Rat oral	Rabbit dermal	
fipronil (Termador)	phenylpyrazole	2B	II	97	354	insecticide (RUP)
flonicamid (Beleaf)	pyridinecarboxamide	9C	III, IV	>2,000	>2,000 (rat)	insecticide
flubendiamide (Synapse)	phthalic acid diamide	28	III	>2,000	>2,000 (rat)	insecticide
flucythrinate (Cybolt, Pay-Off)	pyrethroid	3A	I	67	>1,000	insecticide (RUP)
flupyradifurone (Sivanto)	butenolide	4D	III	2000	>2,000 (rat)	insecticide
fluvalinate (Spur)	pyrethroid	3A	II	261–282	>20,000	insecticide
formetanate hydrochloride (Carzol)	carbamate	1A	I	14-26	>10,200	insecticide, acaricide (RUP)
gamma cyhalothrin (Cobalt)	pyrethroid	3A	I	50	>2,500	insecticide (RUP)
hexythiazox (Savey)	organosulfur	10A	IV	>5,000	>5,000	acaricide
hydramethylnon (Amdro)	amidinohydrazone	20A	III	1,131	>5,000	insecticide
hydroprene (Gencor, Gentrol)	botanical; IGR	7A	IV	>5,000	5,100	insecticide
imidacloprid (Admire, Gaucho, Merit)	neonicotinoid	4A	II, III	450	>5,000 (rat)	insecticide
indoxacarb (Avaunt)	carbamate	22A	IV	5,000	>5,000	insecticide
insecticidal soaps (see potassium salts of fatty acids)						
iron phosphate	inorganic		IV	practically nontoxic	practically nontoxic	molluscicide
Isocloseram (Various names)	Isoxazoline insecticide	30	III, IV	>2000	>2000	insecticide
kaolin (Surround)	inorganic		IV	practically nontoxic		insecticide
kinoprene (Enstar)	juvenile hormone analog; IGR	7A	II	4,900	9,000	insecticide
lambda-cyhalothrin (Karate, Warrior)	pyrethroid	3A	II	56–79	>2,500	insecticide (RUP)
lime sulfur (calcium polysulfide)	inorganic	UN	I	400–500	—	insecticide, fungicide, acaricide

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Compound	Chemical class	MoA ¹	Toxicity class	LD ₅₀ (mg/kg)		Use
				Rat oral	Rabbit dermal	
magnesium phosphide (Magtoxin)	inorganic		I	11.2	—	fumigant (RUP)
malathion (Cythion)	organophosphate	1B	III	1,375-2,800	4,100 (rat)	insecticide
metaldehyde	aldehyde		II, III	283	>5,000	molluscicide
metam potassium (K-Pam)	carbamate		I	500	>2,000	fumigant (RUP)
metam-sodium (Vapam, VPM)	carbamate		II	1,800	1,300	fumigant (RUP)
<i>Metarhizium anisopliae</i>	microbial		IV	>2,000	>2,000	insecticide
methidathion	organophosphate	1B	I	24-54	200	insecticide (RUP)
methiocarb (Mesural)	organophosphate	1A	I	20	>5,000 (rat)	insecticide, molluscicide, repellent (RUP)
methomyl (Lannate)	carbamate	1A	<i>I</i>	13-34	>2,000	insecticide (RUP)
methoprene (Altosid, Precor)	unclassified; IGR	7A	IV	>5,000	>2,000	insecticide
methoxy-fenozide (Intrepid)	diacylhydrazine; IGR	18	IV	5,000	>5,000 (rat)	insecticide
methyl bromide	Inorganic	8A	I	214	—	fumigant (RUP)
methyl isothiocyanate (Vorlex)	unclassified	8F	I	72-220	263	soil fumigant (RUP)
MGK 264			III	4,980	—	synergist
milbemectin (Ultiflora)	macrocylic lactone	6	II	313	>5,000 (rat)	acaricide, insecticide (RUP)
naled (Dibrom)	organophosphate	1B	I	430	1,100	insecticide
naphthalene	unclassified		IV	—	—	insecticide, fumigant
nicotine	botanical	4B	I	50–60	—	insecticide (RUP)
nithiazine	neonicotinoid	4A	II	303	>2,000	insecticide
<i>Nosema locustae</i>	microbial		—	—	—	microbial insecticide
novaluron	diflubenzoylurea; IGR	15	II	>5,000	>2,000 (rat)	insecticide (RUP)
oxamyl (Vydate)	carbamate	1A	I	3.1	2,960	insecticide (RUP)

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Compound	Chemical class	MoA ¹	Toxicity class	LD ₅₀ (mg/kg)		Use
				Rat oral	Rabbit dermal	
oxydemeton-methyl (Metasystox R)	organophosphate	1B	II	50	250 (rat)	insecticide (RUP)
oxythioquinox (Morestan)	quinoxaline		I, II, III	1,500	>5,000 (rat)	acaricide, fungicide
paradichlorobenzene	halogenated organic		II	500	—	insecticide, repellent, rodenticide, fungicide
PCP (pentachlorophenol)	chlorinated phenol		II	210	105	wood preservative (RUP)
permethrin (Ambush, Permanone, Pounce)	pyrethroid	3A	II, III	430–4,000	>2,000	insecticide (RUP)
phenothrin (Sumithrin)	pyrethroid	3A	IV	>5,000	>2,000 (rat)	insecticide
<i>phorate (Tenax, Thimet)</i>	organophosphate	1B	I	3.5	2.5	insecticide (RUP)
phosmet (Imidan, Prolate)	organophosphate	1B	II	113	>5,000	insecticide
piperonyl butoxide (PBO)			IV	>7,500	1,880	synergist (RUP)
potassium salts of fatty acids (M-pede)	soap		III	>5,000	>5,000	insecticide
propargite (Comite, Omite)	organosulfur	12C	I	2,800	4,000	acaricide
propoxur (Baygon)	carbamate	1A	I, II, III	50	>5,000 (rat)	insecticide
pymetrozine (Fulfill)	triazine	9B	IV	>820	>2,000 (rat)	insecticide
pyrethrum	botanical	3A	III	1,030	>5,000 (rat)	insecticide
pyridaben (Oracle, Sanmite)	chlorinated hydrocarbon	21A	III	820	>2,000	acaricide, insecticide (RUP)
pyridalyl	unclassified	UN	IV	>5,000	sensitizer	insecticide
pyrifluquinazon	quinazalone	UN	II	300-2000	non-irritant	insecticide
pyriproxyfen	unclassified; IGR	7C	III	>5,000	>2,000 (rat)	insecticide
refined petroleum distillate			III, IV	>15,000	>2,000	acaricide, insecticide
resmethrin (Synthrin)	pyrethroid	3A	III	>2,500	>3,000 (rat)	insecticide (RUP)
rotenone	botanical	21B	I, III	132–1,500	>5,000 (rat)	insecticide (RUP)
ryania (Ryanodine)	botanical		III	1,200	—	insecticide

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Compound	Chemical class	MoA ¹	Toxicity class	LD ₅₀ (mg/kg)		Use
				Rat oral	Rabbit dermal	
sabadilla	botanical		III	>7,500	>5,500	insecticide
sodium tetraborohydrate decahydrate (Borax, Pre-Am)	boric acid	8D	I	>2,260	>2,000	insecticide
sorbitol octanoate (SorbiShield 90)	octanate ester		II	>5,000	5000	insecticide
spinetoram (Radiant, Delegate)	spinosyn	5	III	>5,000	irritant	insecticide
spinosad (Success)	spinosyn (non-synthetic)	5	III	3,738	>2,000	insecticide
spiroticlofen (Envidor)	tetranic acid	23	III/IV	>2,500	>2,000 (rat)	acaricide (RUP)
spiromesifen (Forbid)	ketoenole	23	III/IV	>2,500	>2,000 (rat)	acaricide, insecticide (RUP)
spirotetramat (Movento)	ketoenole	23	III	>2,000	>2,000 (rat)	insecticide
<i>Spodoptera exigua multicapsid</i> (Spod-X)	virus		—	—	—	viral insecticide
<i>Steinernema carpocapsae</i> (Bio-Safe-N, BioVector, Exhibit)	nematode	—	—	—	—	insect pathogenic nematode
sucrose octanoate (Sucrashield)	sugar ester		IV	10,080	>5,000	insecticide
sucrose octanoate (SucraShield 90)	octanate ester		II	>5,000	20,000	insecticide
sulfoxaflor	sulfoximine	4	III	1,000 oral	>5,000 dermal	insecticide
sulfur	inorganic	UN	IV	>5,000	>5,000 (rat)	acaricide, fungicide
tebufenozide (Confirm, Mimic)	diacylhydrazine;	18	III	>5,000	>5,000	insecticide (RUP)
tebupiriphos	organophosphate	1B	I	1.3–3.6	9.4–31 (rat)	insecticide
tefluthrin (Force)	pyrethroid	3A	III	22-35	177 (rat)	insecticide
temephos (Abate)	organophosphate	1B	III	4,204–10,000	2,181	insecticide
terbufos (Counter)	organophosphate	1B	I	1.6	1.0	insecticide (RUP)
tetrachlorvinphos (Gardona, Rabon, Stirifos)	organophosphate	1B	III	>4,000	>2,500	insecticide

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				Rat oral	Rabbit dermal	
tetramethrin (Neo-Pynamin)	pyrethroid	3A	IV	>5,000	—	insecticide
thiacloprid (Calypso)	neonicotinoid	4A	II,III	621	2,000 (rat)	insecticide
thiamethoxam (Actara)	neonicotinoid	4A	II	1,563	>2,000	insecticide
thiodicarb (Larvin)	carbamate	1A	II	66	>2,000	insecticide
tolfenpyrad (Torac)	pyrazole	21A	II	83	>2,000 (rat)	insecticide
tralomethrin (Scout X-tra)	pyrethroid	3A	I	99-3,000	>2,000	insecticide (RUP)
triazamate	carbamate	1B	I	50-200	>5,000	insecticide
trichlorfon (Dipterex, Dylox)	organophosphate	1B	II	250	>5,000 (rat)	insecticide

Much of the information for this table was taken from The Pesticide Manual, PCPC Publications, Hampshire England.

Additional information on pesticide impacts can be found at USDA NRCS Windows Pesticide Screening Tool WIN-PST 3.0 <http://www.wsi.nrcs.usda.gov/products/W2Q/pest/winpst.html> and at the Extension Toxicology Network, <https://extoxnet.orst.edu/>

1 IRAC mode of action classification: 1 acetylcholinesterase inhibitor; 2 gaba-gated chloride channel blockers; 3 sodium channel modulators; 4 nicotinic acetylcholine receptor competitive modulators; 5 nicotinic acetylcholine receptor allosteric modulators; 6 glutamate-gated chloride channel allosteric modulators; 7 juvenile hormone mimics; 8 misc. non-specific multi-site inhibitors; 9 modulators of chordotonal organs; 10 mite growth inhibitors; 11 microbial disruptors of insect midgut membranes; 12 inhibitors of mitochondrial ATP synthase; 13 uncouplers of oxidative phosphorylation via disruption of the proton gradient; 14 nicotinic acetylcholine receptor channel blockers; 15 inhibitors of chitin biosynthesis, type O; 16 inhibitors of chitin biosynthesis; 17 moulting disruptor; 18 ecdysone receptor agonists; 19 octopamine receptor agonists; 20 mitochondrial complex III electron transport inhibitor; 21 mitochondrial complex I electron transport inhibitor; 22 voltage-dependent sodium channel blockers; 23 inhibitors of acetyl coa carboxylase; 24 mitochondrial complex IV electron transport inhibitor; 25 mitochondrial complex II electron transport inhibitor; 28 ryanodine receptor modulator; UN compounds of unknown or uncertain MOA.

For further explanations, see: <https://irac-online.org/mode-of-action/classification-online/>