

LEAST TOXIC AND ORGANIC PESTICIDES FOR GARDENERS

*Least toxic pesticides that are labeled as natural or organic are not necessarily harmless to humans or the environment. Many are quite safe to use. Some have hazards associated with them. **Always read the label very carefully and follow label directions.** Wear protective clothing whenever you use any pesticide. Even those products that are nontoxic can be irritating to skin, eyes and mucous membranes.*

These descriptions are not recommendations for use. For current OSU recommendations, consult the most recent Pacific Northwest Plant Disease Management, Insect Management and Weed Management Handbooks.

The products listed for each active pesticide are examples only. The lists do not include all products that may be currently available.

Insecticides

Botanical insecticides

Rotenone

Source: derived from the roots of several tropical legumes

Mode of action: broad spectrum contact and stomach poison, inhibits cell respiration, causes cessation of feeding and death

Uses: broad spectrum, particularly effective against leaf-feeding beetles and certain caterpillars

Toxicity: most formulations have low mammalian toxicity, emulsifiable concentrate is highly toxic (and restricted use), extremely toxic to fish, keep away from water

Notes: often found in combination with pyrethrins for general pest control, degrades quickly under warm, sunny conditions

Pyrethrum and pyrethrins

Source: derived from *Chrysanthemum cinerariaefolium*, pyrethrum is crude flower dust itself, pyrethrins are insecticidal compounds that occur naturally in the crude material

Mode of action: contact poison, causes an immediate "knockdown" paralysis in insects

Uses: often formulated with other botanicals for general garden use, on pets and livestock for flea, fly and mosquito control, against indoor insect pests

Toxicity: low mammalian toxicity, toxic to bees and aquatic life, can cause an allergic reaction in humans and cats

Notes: degrades rapidly in sunlight, often formulated with synergist, PBO, which is not allowed in certified organic programs PBO= It is a synthetic synergist that gives the basic insecticide more killing power by blocking the animal's power to detox the primary poison.

Neem (azadirachtin)

Source: neem tree (*Azadirachta indica*), grows in arid tropical and subtropical regions

Mode of action: contains 25 active compounds that act as feeding deterrents, repellants, growth regulators, toxins and sterilants, has both contact and systemic action in plants, blocks hormones that control metamorphosis

Uses: broad spectrum against many garden and household pests, may be useful against hard-to-control leaf-feeders like cucumber beetle and adult root weevil, may require repeat applications

Toxicity: low to very low mammalian toxicity, most beneficials unaffected because neem must be directly ingested

Products: Bioneem, Neemix, Neem Away

Ryania (ryanodine)

Source: woody stems of *Ryania speciosa*, a South American shrub

Mode of action: slow-acting stomach poison, insect stops feeding soon after ingesting

Uses: effective against some caterpillars, used mostly for codling moth, Oriental fruit moth, and corn earworm

Toxicity: low to moderate mammalian toxicity

Products: Ryan 50

Notes: most effective in hot weather, sometimes mixed with diatomaceous earth, persists for approximately 1 week

Sabadilla

Source: ripe seeds of *Schoenocaulon officinale*, a tropical lily from Central and South America

Mode of action: broad spectrum contact poison, some activity as a stomach poison
Uses: Effective against some true bugs, i.e. stink bugs, squash bugs, also cucumber beetles, leafhoppers, loopers
Toxicity: Low mammalian toxicity, toxic to bees
Products: Red Devil Dust, Natural Guard
Notes: degrades rapidly in air and sunlight, highly toxic to honeybees, do not use on blooming plants or when honeybees are active

Nicotine

Source: simple alkaloid derived from tobacco, *Nicotiana tabacum*
Mode of action: fast-acting nerve toxin, contact poison and fumigant activity
Uses: effective against sucking pests such as aphids, thrips, mites
Toxicity: **High mammalian toxicity!**
Products: Black Leaf 40
Notes: degrades in 24 hours

Citrus oil (limonene)

Source: citrus peels and citrus peel oil
Mode of action: contact poison
Uses: combine with soap against fleas, ticks, mites, and aphids
Toxicity: low mammalian toxicity, mild irritant to skin, nose, eyes
Products: Orange Guard, Bug Ban, Duel, Sharpshooter
Notes: evaporates quickly after application, also used in solvents and cleaning products

Inorganic insecticides

Sulfur

Source: elemental sulfur, naturally occurring mineral
Mode of action: disrupts mite and insect metabolism
Uses: most effective as a miticide, also useful against aphids and thrips, on fruits, vegetables, flowers, ornamentals
Toxicity: very low mammalian toxicity, can be irritating to eyes, ears and nose
Notes: abrasive to metal, use plastic spray equipment, can burn plants at temperatures above 90 degrees F., no not use within one month of oil spray, also acts as a fungicide

Kaolin clay

Source: naturally occurring mineral
Mode of action: particle film acts as a physical barrier between pest and plant, also irritates and repels insect feeding and egg-laying
Uses: used primarily on orchard crops and berries as a broad spectrum crop protectant, used against codling moth, apple maggot and spider mite
Toxicity: no mammalian toxicity, also used as a food additive
Products: Surround
Notes: full coverage important, repeat applications necessary, also protects fruit against sunburn and heat stress

Iron phosphate

Source: naturally occurring mineral
Mode of action: stomach poison for slugs and snails
Uses: against slugs and snails throughout the garden and landscape
Toxicity: very low mammalian toxicity (used as nutritional supplement), safe for wildlife, including earthworms and ground beetles
Products: Sluggo, Escar-Go, WorryFree
Notes: applied as a pellet whose inert ingredients serve as bait for slugs and snails, remains effective even in rain

Boric acid

Source: naturally occurring mineral

Mode of action: stomach poison, also desiccation due to abrasion of exoskeleton, causes death in 3-10 days

Uses: used indoors against cockroaches, ants, silverfish, termites, fleas, some weevils and beetles

Toxicity: low mammalian toxicity, may act as an irritant by inhalation

Products: Roach Kill, Flea Stoppers, Drax Ant Bait, Boracare

Notes: long residual life if kept dry, use away from continual human contact

Insecticidal dusts

Diatomaceous earth

Source: mined from fossilized shell remains of diatoms

Mode of action: absorbs waxy cuticle layer on surface of insect skins, causes insect to desiccate, also abrades and ruptures cuticle

Uses: dust on plants as a nonselective insecticide, use as a thick border for ants, slugs, snails (1/4" deep, 2" wide) and indoors for crawling insects

Toxicity: very low mammalian toxicity, irritating to eyes, lungs

Products: DE, Dia-Secticide, Insect Stop

Notes: rain and irrigation water substantially decreases effectiveness, keep as dry as possible, use goggles and dust mask when applying, use only natural grade, not chemically treated swimming pool grade, sometimes formulated with selected baits and/or pyrethrins

Insecticidal soaps

Source: potassium salts of fatty acids

Mode of action: contact insecticide that includes physical disruption of insect cuticle, smothers and desiccates insects

Uses: against soft-bodied insects such as aphids, thrips, whitefly, mites and other slow-moving, flightless insects

Toxicity: low mammalian toxicity

Products: many

Notes: requires excellent coverage, may require repeat applications, biodegrades rapidly, only effective until it dries, may kill immature beneficials, use according to label directions - can be phytotoxic

Horticultural oils

Source: may be petroleum based, vegetable based (mint, rosemary), fish

Mode of action: smothers insect and mite eggs, blocks breathing apparatus of immature and adult insects and mites

Uses: against broad spectrum of insects and mites, especially aphids, mites, caterpillars and other soft-bodied insects

Toxicity: low to very low mammalian toxicity, may irritate eyes and skin

Products: many

Notes: degrades rapidly, dormant oils are generally heavier and used on woody plants during the dormant season, lighter oils can be used on most plants during the growing season, avoid spraying in the heat of the day, do not use on drought-stressed plants

Biological Insecticides

Bt (*Bacillus thuringiensis*)

Source: naturally occurring bacterium produced en masse in the lab

Mode of action: bacterial stomach poison that must be ingested by insect to be toxic, initial poisoning causes cessation of eating, insect dies in a few days

Uses: Bt kurstaki used against plant-eating caterpillars, Bt israelensis used against mosquitoes and fungus gnats, Bt san diego used against elm leaf beetle and Colorado potato beetle

Toxicity: mammalian toxicity varies from low to very low toxicity depending on product

Products: Caterpillar Killer, Dipel, Gnatrol, Bactimos, Potato Shield

Notes: biodegrades quickly in sunlight, spray late in day or on a cloudy day, need full plant coverage, Bt kurstaki works best when caterpillars are still small

Beauveria bassiana

Source: common soilborne fungus

Mode of action: fungus infects through contact with insect, does not need to be ingested, kills in 3-7 days

Uses: used against a wide range of foliar-feeding insects including whiteflies, aphids, thrips, mealybugs, beetles, weevils, mites and caterpillars, indoor and outdoors throughout garden and landscape

Toxicity: nontoxic to humans and wildlife, *may be harmful to bees*, avoid spraying when bees are present

Products: Naturalis, Mycotrol, Botanigard

Notes: thorough coverage needed, repeat applications may be necessary, do not apply fungicides within 24 hours, works best under moist, humid conditions

Spinosad

Source: fermentation product of soil-dwelling actinomycete, *Saccharopolyspora spinosa*

Mode of action: kills insect mainly by ingestion, some contact, kills by excitation of insect nervous system, insects die 1-2 days after ingestion

Uses: effective against a broad range of insects including fruit flies, caterpillars, leafminers, thrips, sawflies, leaf beetles

Toxicity: low mammalian toxicity, conserves most beneficial insects, use care on blooming plants, can affect bees

Products: Garden Insect Spray, Conserve, Entrust, Bulls-Eye

Notes: useful against insects that have been traditionally hard to control without commercial pesticides such as fruit flies, leafminers, and corn earworm

Entomopathogenic nematodes

Source: naturally occurring, reared en masse in the laboratory

Mode of action: juvenile stage of nematode infects through insect body openings, multiplies, kills host by infecting with symbiotic bacteria

Uses: against soil-dwelling larvae and pupae of a variety of insects, most effective at or near soil surface, useful in western Oregon in late summer against root weevil larvae

Toxicity: very low mammalian toxicity

Notes: will not survive dry conditions - soil should be moist, soil temperature must be above 55 degrees F. If conditions are favorable, nematodes will complete their life cycle in host, then new juveniles will migrate out in search of a new host. Two species, *Steinernema carpocapsae* and *Heterorhabditis sp.*, are used, depending on host preference.

Miscellaneous

Garlic

Source: garlic bulbs

Mode of action: primarily a repellent

Uses: as a preventative treatment against leaf-feeding and sucking insects, also has fungicidal properties

Toxicity: non-toxic

Products: Garlic Barrier

Notes: repeat sprays on a weekly basis, odorless shortly after application, use oil as a sticker-spreader and additional insecticide, nonselective

Hot pepper wax (capsaicin)

Source: hot peppers

Mode of action: contact and repellent, metabolic stimulant for soft-bodied insects

Uses: used as a general purpose insecticide/repellent for soft-bodied insects on wide variety of garden plants

Toxicity: nontoxic

Notes: formulated with paraffin wax, watch for leaf damage, requires repeat applications, nonselective

Fungicides

Copper (basic copper sulfate, copper hydroxide, tribasic copper sulfate)

Uses: as a broad spectrum protectant fungicide and bactericide in fruits, vegetables and ornamentals against mildew, brown rot, leaf spots, blights, scab, anthracnose and rusts, primarily used with spreader/sticker during dormant season

Mode of action: kills spores by disrupting function of enzymes

Products: Microcop and others

Toxicity: **highly toxic** to humans through ingestion and inhalation, irritating to skin and eyes, highly toxic to fish and other aquatic organisms

Notes: discoloration of flowers and foliage can occur

Lime sulfur (calcium polysulfide)

Uses: as a broad spectrum protectant fungicide and insecticide against peach leaf curl, brown rot, leaf spot, powdery mildew, scab, anthracnose, and overwintering mites, scales and aphids, use as dormant or delayed dormant spray on fruit trees and many ornamentals

Mode of action: contact poison

Products: Polysul

Toxicity: low mammalian toxicity, significant irritant to skin, eyes, lungs

Notes: do not mix with other pesticides, can mix with oil, very alkaline, will react with acids to produce toxic gas

Sulfur

Uses: broad-spectrum fungicide/miticide used on fruits, vegetables, and ornamentals against rusts, leaf spots, powdery mildew, scab, mites

Mode of action: prevents germination of spores, contact poison

Products: Garden Fungicide

Toxicity: Low mammalian toxicity, toxic to fish, irritating to skin, eyes, nose and throat

Notes: do not use within two weeks of an oil spray, some plants sensitive to sulfur, check product label

Horticultural oil (petroleum based, mineral, fish, jojoba, mint)

Uses: as a protectant and sometimes eradicator against certain ecto-parasitic fungi, especially powdery mildew, on wide variety of garden plants

Mode of action: physical disruption of fungi, interferes with attachment to host, destroys fungal cell walls

Products: many (Sunspray Ultra-fine Oil, E-Rase, Fungastop, JMS Stylet etc.)

Toxicity: very low

Notes: use superior or summer weight oils during growing season, do not use on drought-stressed plants, need excellent coverage for adequate control, helps control viruses by controlling aphid vectors

Potassium bicarbonate

Uses: as a protectant fungicide used against powdery mildew in a wide variety of vegetable crops (particularly cucurbits) and ornamental plants

Mode of action: bicarbonate ion inhibits growth in some fungi and bacteria

Products: Kaligreen, Remedy, FirstStep

Toxicity: very low

Notes: does not protect against black spot on roses, direct contact with fungus necessary, including oil as a sticker/spreader greatly increases effectiveness, use every 7-10 days for season-long protection, will provide some K fertilization

Neem oil (azadirachtin)

Uses: preventative broad spectrum fungicide on ornamentals, vegetables, fruits and nuts, and landscape plants both indoors and out for mildew, scab, rusts, and black spot

Mode of action: prevents adhesion of fungal spores to plant surface

Products: Shield-All II, Garden Safe Fungicide 3, Bioneem

Toxicity: low to very low

Notes: thorough coverage necessary, do not apply to drought-stressed plants, also acts as a broad spectrum insecticide/miticide

Biological

Gliocladium virens GL-21

Uses: naturally occurring soil fungus used to suppress soil-borne plant pathogens such as *Pythium*, *Rhizoctonia*, *Sclerotinia* and *Fusarium* that cause damping-off and root rots in greenhouse ornamentals and food crops

Mode of action: fungus parasitizes, competes with, and excludes plant pathogens

Products: Soil Gard

Toxicity: nontoxic, nonpathogenic, noninfective

Notes: can be used in soil or in soilless potting mixes

Streptomyces griseoviridis K61

Uses: soil bacterium that prevents certain plant pathogenic fungi from infecting plants, helps prevent seed rot, root rot, damping off and wilt, used on greenhouse ornamentals, herbs and vegetables

Mode of action: several modes of action including earlier colonization of plant roots and production of chemicals that may actively attack harmful fungi

Products: Mycostop

Toxicity: nontoxic, may cause irritation to eyes, skin and lungs

Notes: use at seeding or transplanting, do not mix with pesticides or fertilizers

Antitranspirants

Uses: to prevent fungal diseases such as powdery mildew, gray mold, and blackspot on a variety of garden and landscape plants

Mode of action: waxes, silicones and other plastic coatings increase thickness and integrity of leaf cuticle, results in significant physical barrier to fungal penetration of leaf, also repels water needed for fungal spore germination

Products: Wilt Pruf, Vapor Gard

Toxicity: low toxicity, biodegradable

Notes: reapply regularly to protect new growth

Herbicides **Note: (Because a product is listed here does not necessarily mean that it has scientifically been proven to be effective through research based credible experimentation. Vinegar products and corn gluten fall into the “not proven to be effective” category).**

Vinegar (acetic acid)

Uses: 5-20% concentration of acetic acid will kill selected annual weeds and tops of certain perennial weeds

Mode of action: contact, acetic acid damages plant cells, plant dries out

Products: Burn-Out

Toxicity: non-toxic, biodegradable, acetic acid concentrations of this level can cause dermatitis and serious eye damage if splashed in eyes

Notes: spray young actively growing weeds in spring, weeds should dry out in 6-24 hours, will not kill underground portion of plant, homemade vinegar solutions not registered as pesticides - do not recommend

Herbicidal soap (potassium salts of fatty acids)

Uses: used to control annual weeds, aerial portions of perennial weeds, moss, and algae

Mode of action: soap penetrates waxy cuticle, plant dries out

Products: Superfast Weed and Grass Killer, Weed-Aside

Toxicity: very low mammalian toxicity, biodegradable

Notes: non-selective, keep off of desirable vegetation, apply in spring when plants are small and actively growing, less effective on grasses and older weeds

Corn gluten meal

Uses: prevents growth of certain weed seedlings, used primarily in turf plantings, but can be used anywhere

Mode of action: inhibits root formation of germinating seeds

Products: WOW!, Bio-Weed, Weed Prevention Plus, WeedBan

Toxicity: nontoxic, biodegradable

Notes: time application to coincide with seed germination, also effective as a fertilizer due to 10% nitrogen content