DELTAMETHRIN
TECHNICAL FACT SHEET

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NPIC Technical Fact Sheets provide information that is complex and intended for individuals with a scientific background and/or familiarity with toxicology and risk assessment. This document is intended to promote informed decision-making. Please refer to the General Fact Sheet for less technical information.

Chemical Class and Type:

- Deltamethrin is in the chemical class of pyrethroids.[1] Pyrethroids are synthetic chemicals modeled after the pyrethrin components of pyrethrum.[2] Unlike other pyrethroids, deltamethrin consists of one pure compound.[3]
- Other names for deltamethrin include (S)-α-cyano-3-phenoxybenzyl (1*R*,3*R*)-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropanecarboxylate and the former, rejected name decamethrin. The Chemical Abstracts Service (CAS) registry number for deltamethrin is 52918-63-5.[4,5]

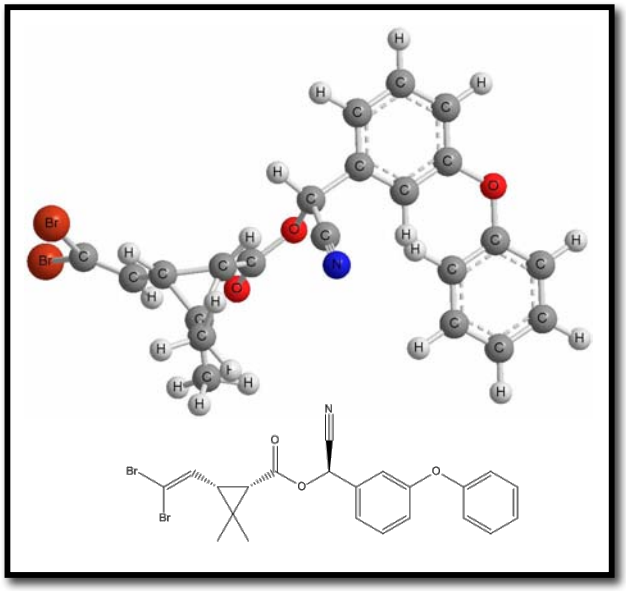
Laboratory Testing: Before pesticides are registered by the U.S. EPA, they must undergo laboratory testing for short-term (acute) and long-term (chronic) health effects. Laboratory animals are purposely given high enough doses to cause toxic effects. These tests help scientists judge how these chemicals might affect humans, domestic animals, and wildlife in cases of overexposure.

- Researchers first described deltamethrin in 1974.[6] The year of initial registration with the United States Environmental Protection Agency (U.S. EPA) was 1994.[7] See the text box on **Laboratory Testing**.

Physical / Chemical Properties:

- Technical grade deltamethrin (≥98% pure) consists of odorless crystals that are non-corrosive and colorless or white to light beige.[1,4,8]
- Vapor pressure[3]: 1.5 x 10^{-8} mmHg at 25 °C
- Octanol-Water Partition Coefficient (log K_{ow})[3]: 6.1
- Henry's constant[3,9]: Henry's constant may be determined by estimation or experimentally derived. Reported values include 1.2 x 10^{-4} atm·m³/mol at 25 °C and 5.0 x 10^{-5} atm·m³/mol, depending on the technique used.
- Molecular weight[3]: 505.2 g/mol
- Solubility (water)[3,9]: ranges from 0.002-0.0002 mg/L
- Soil Sorption Coefficient (K_{oc})[9]: adsorption ranges from 7.05 x 10^5 to 3.14 x 10^6; desorption ranges from 1.14 x 10^6 to 4.54 x 10^6

Molecular Structure - Deltamethrin



Uses:

- Deltamethrin is a broad-spectrum insecticide.[5]
- Deltamethrin has been registered for use on areas such as golf courses, ornamental gardens, lawns, outdoor perimeter treatments, indoors as spot and crack and crevice treatments, and pet collars.[10] Uses for individual deltamethrin products vary widely. Always read and follow the label when applying pesticide products.
- Deltamethrin is registered for use on various crops including cotton, corn, cereals, soybeans, and vegetables for pests such as mites, ants, weevils, and beetles.[3,11]
- The illegal, unregistered product known as "Chinese Chalk" or "Miraculous Chalk" can contain deltamethrin as the active ingredient.[12]

- Signal words for products containing deltamethrin may range from Caution to Danger. The signal word reflects the combined toxicity of the active ingredient and other ingredients in the product. See the pesticide label on the product and refer to the NPIC fact sheets on ***Signal Words*** and ***Inert or "Other" Ingredients***.
- To find a list of products containing deltamethrin which are registered in your state, visit the website http://npic.orst.edu/reg/state_agencies.html and search by "active ingredient."

Mode of Action:

Target Organisms

- Deltamethrin is effective against insects via ingestion and direct contact.[5]
- Pyrethroids, in general, interfere with normal production and conduction of nerve signals in the nervous system. Pyrethroids act on nerve membranes by delaying the closing of the activation gate for the sodium ion channel.[1]
- Researchers distinguish between two classes of pyrethroids based on electrophysiological studies with nerves and symptoms of toxicity.[1] Type II pyrethroids, including deltamethrin, have an α-cyano group that induces "long-lasting" inhibition of the sodium channel activation gate. This results in prolonged permeability of the nerve to sodium and produces a series of repetitive nerve signals in sensory organs, sensory nerves, and muscles.[1,13]
- Researchers observed that deltamethrin and other Type II pyrethroids may also affect ion channels in the nervous system other than sodium channels, possibly due to their phosphorylation state.[14,15]

Non-target Organisms

- The mechanism of action of pyrethroids, including deltamethrin, is the same for target and non-target organisms.[16]
- Pyrethroids are less toxic to mammals compared to insects due to mammals' higher body temperature, larger body size, and decreased sensitivity of the ion channel sites.[15,17]

Acute Toxicity:

Oral

- Reported LD_{50} values for rats range from 30 mg/kg (with an oily vehicle) to greater than 5000 mg/kg (in an aqueous vehicle).[18] The substance used to administer deltamethrin can influence the LD_{50} for the oral route most likely by affecting absorption.[1,5] See the text boxes on **Toxicity Classification** and **LD_{50}/LC_{50}**.

LD_{50}/LC_{50}: A common measure of acute toxicity is the lethal dose (LD_{50}) or lethal concentration (LC_{50}) that causes death (resulting from a single or limited exposure) in 50 percent of the treated animals. LD_{50} is generally expressed as the dose in milligrams (mg) of chemical per kilogram (kg) of body weight. LC_{50} is often expressed as mg of chemical per volume (e.g., liter (L)) of medium (i.e., air or water) the organism is exposed to. Chemicals are considered highly toxic when the LD_{50}/LC_{50} is small and practically non-toxic when the value is large. However, the LD_{50}/LC_{50} does not reflect any effects from long-term exposure (i.e., cancer, birth defects or reproductive toxicity) that may occur at levels below those that cause death.

Dermal

- Technical grade deltamethrin is low in toxicity when applied to the skin of rabbits. The dermal LD_{50} is greater than 2000 mg/kg for rabbits.[19]
- The dermal LD_{50} for rats ranges from 700 mg/kg to greater than 2940 mg/kg. The substance used to administer deltamethrin can potentially influence the dermal LD_{50} most likely by affecting absorption.[1]
- Technical grade deltamethrin did not cause irritation of intact, shaved, or abraded skin of rabbits.[18] Formulated deltamethrin products have the potential to cause slight to moderate skin irritation. One study reported that the other ingredients in the product influenced the degree of irritation.[1]
- Technical grade deltamethrin caused transient irritation when applied to the eyes of rabbits. The effects resolved within 72 hours.[18]

TOXICITY CLASSIFICATION - DELTAMETHRIN

	High Toxicity	Moderate Toxicity	Low Toxicity	Very Low Toxicity
Acute Oral LD_{50}	Up to and including 50 mg/kg (≤ 50 mg/kg) (*oily vehicle*)	Greater than 50 through 500 mg/kg (> 50 – 500 mg/kg)	Greater than 500 through 5000 mg/kg (> 500 – 5000 mg/kg)	Greater than 5000 mg/kg (> 5000 mg/kg) (*aqueous vehicle*)
Inhalation LC_{50}	Up to and including 0.05 mg/L (≤ 0.05 mg/L)	Greater than 0.05 through 0.5 mg/L (>0.05 – 0.5 mg/L)	Greater than 0.5 through 2.0 mg/L (> 0.5 – 2.0 mg/L)	Greater than 2.0 mg/L (> 2.0 mg/L)
Dermal LD_{50}	Up to and including 200 mg/kg (≤ 200 mg/kg)	Greater than 200 through 2000 mg/kg (> 200 - 2000 mg/kg)	Greater than 2000 through 5000 mg/kg (>2000 – 5000 mg/kg)	Greater than 5000 mg/kg (> 5000 mg/kg)
Primary Eye Irritation	Corrosive (irreversible destruction of ocular tissue) or corneal involvement or irritation persisting for more than 21 days	Corneal involvement or other eye irritation clearing in 8 – 21 days	Corneal involvement or other eye irritation clearing in 7 days or less	Minimal effects clearing in less than 24 hours
Primary Skin Irritation	Corrosive (tissue destruction into the dermis and/or scarring)	Severe irritation at 72 hours (severe erythema or edema)	Moderate irritation at 72 hours (moderate erythema)	Mild or slight irritation at 72 hours (no irritation or erythema)

The highlighted boxes relfect the values in the "Acute Toxicity" section of this fact sheet. Modeled after the U.S. EPA, Office of Pesticide Programs, Label Review Manual, Chapter 7: Precautionary Labeling. http://www.epa.gov/oppfead1/labeling/lrm/chap-07.pdf

- Deltamethrin did not cause skin sensitization in guinea pigs.[18]

Inhalation

- Deltamethrin is considered low in toxicity by inhalation with a 4-hour LC_{50} of 2.2 mg/L and a 1-hour LC_{50} of greater than 4.6 mg/L in rats.[5]

Signs of Toxicity - Animals

- Type II pyrethroids, including deltamethrin, produce characteristic effects of choreoathetosis (sinuous writhing) and salivation, also known as CS Syndrome.[17] In rats, this presents as pawing and burrowing behavior followed by salivation and tremors, progressing to choreoathetosis. Clonic seizures may occur in the final stage.[18]
- Rats exhibited motor incoordination, salivation, respiratory defects, spasms involving the limbs and tail, and clonic seizures when administered deltamethrin orally.[1]
- Dogs exhibited vomiting, hyperexcitibility, stiffness in the hind legs, and impaired body movement when 100 mg/kg of deltamethrin was orally administered.[1]
- Guinea pigs exhibited an increase in signs of biting, scratching, and licking within 1 hour of a dermal application of deltamethrin.[20]
- Symptoms from inhalation of deltamethrin in rats include grooming, hyperactivity, uncoordinated movements, and hypersensitivity to noise and touch.[1]

Signs of Toxicity - Humans

- Paresthesia was the most commonly reported symptom from dermal exposure in occupational studies involving pyrethroids. Skin sensations were characterized as tingling, itching, burning, and numbness of the skin after dermal exposure. The paresthesia was reported to be transient and reversible in a period of hours, sometimes lasting up to 48 hours.[15,20]
- Paresthesia is considered to occur only at the site of dermal exposure and is not associated with systemic intoxication.[20]
- A 25-year-old female, diagnosed with severe occupational poisoning from contact and inhalation exposure after spraying deltamethrin in cotton fields, exhibited dizziness, nausea, headache, fatigue, blurred vision, loss of appetite, sensations

of burning and tingling in the face, vomiting, vertigo, disrupted sleep, twitching of muscles in arms and legs, convulsions, sensitivity to light, loss of bladder control, and loss of consciousness.[21]

- A 31-year-old male, diagnosed with mild occupational poisoning from heavy dermal exposure after spraying deltamethrin in cotton fields, experienced dizziness, nausea, headache, fatigue, blurred vision, loss of appetite, sensations of burning and itching in the face, and tightness in the chest.[21]
- A 21-year-old female, diagnosed with severe oral poisoning from a suicide attempt, developed abdominal pain, convulsions, muscle twitching in hands and feet, headache, and delirium.[21]
- No signs or symptoms were noted after three human volunteers ingested a single dose of 3 mg of deltamethrin.[1]
- Always follow label instructions. If unintended exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 1-800-222-1222. If you wish to report an incident, please call 1-800-858-7378.

Chronic Toxicity:

Animals

- Researchers fed mice deltamethrin for 24 months at doses of 0, 1, 5, 25, or 100 mg/kg/day. The NOAEL was 100 mg/kg/day because no treatment-related effects were observed at any dose.[1] See the text box on **NOAEL**, **NOEL**, **LOAEL**, and **LOEL**.
- Deltamethrin was fed to beagle dogs for 24 months at 0, 1, 10, or 40 ppm. The NOEL was 1.1 mg/kg/day because no treatment-related effects were observed at any dose. In another study with dogs, the LOAEL was 10 mg/kg/day due to chewing and scratching of extremities, tremors, abnormal gait, liquid feces, and changes in blood chemistry.[10,19]

NOAEL: No Observable Adverse Effect Level

NOEL: No Observed Effect Level

LOAEL: Lowest Observable Adverse Effect Level

LOEL: Lowest Observed Effect Level

- Rats administered oral doses of 5 or 10 mg/kg/day for 28 days had enhanced natural killer cell activity and increased antibody-forming cells in the spleen at both doses.[22]
- Female rats fed deltamethrin daily for 84 or 14 days at doses of 6 mg/kg or 15 mg/kg, respectively, exhibited immunosuppression of the humoral immune response, decreased lymphocyte enzyme activity, splenic plaque-forming cells, and rosette-forming lymphocytes.[3]

Humans

- No human data were found on the chronic health effects of deltamethrin. See the text box on **Exposure**.

Exposure: Effects of deltamethrin on human health and the environment depend on how much deltamethrin is present and the length and frequency of exposure. Effects also depend on the health of a person and/or certain environmental factors.

Endocrine Disruption:

- Male rats were administered deltamethrin orally for 65 days at a dose of 1 or 2 mg/kg/day. Plasma testosterone levels were reduced as early as day 14 and continued to be low 21 days post-treatment.[3]
- The potential for significant endocrine effects from deltamethrin exposure is considered to be minimal.[19]

- No human data was found on the endocrine-disrupting effects of deltamethrin.

Carcinogenicity:

Animals

- Deltamethrin did not increase tumor incidence in mice fed technical grade deltamethrin at daily doses of 0, 1, 5, 25, or 100 ppm for two years.[18]
- No carcinogenic effects were found in rats fed technical grade deltamethrin at daily doses of 0, 2, 20, or 50 mg/kg for two years.[18]
- One study showed that deltamethrin had tumor initiating, but not tumor promoting, potential in Swiss albino mice.[23]
- The U.S. EPA does not consider deltamethrin to be a mutagen based on negative results from a bacterial DNA assay, an Unscheduled DNA Synthesis (UDS) assay in primary rat hepatocytes, and an *in vitro* chromosome aberration study.[10]
- No genotoxic properties were observed in studies testing for DNA damage and repair in bacteria and cultures of rat hepatocytes, mitotic recombination in yeast, gene mutation in bacteria and hamster lung cell cultures, chromosomal aberrations in hamster ovary cell cultures, or *in vivo* chromosomal aberrations and micronuclei in male mouse bone-marrow cells.[1]

Humans

- The U.S. EPA classified deltamethrin as "not likely to be a human carcinogen" by all routes of exposure.[10] See the text box on **Cancer**.

> **Cancer: Government agencies in the United States and abroad have developed programs to evaluate the potential for a chemical to cause cancer. Testing guidelines and classification systems vary. To learn more about the meaning of various cancer classification descriptors listed in this fact sheet, please visit the appropriate reference, or call NPIC.**

- The International Agency for Research on Cancer (IARC) classified deltamethrin as Group 3, "not classifiable as to its carcinogenicity to humans".[24]
- No human data were found on carcinogenic effects of deltamethrin.

Reproductive or Teratogenic Effects:

Animals

- Male rats administered deltamethrin orally for 65 days at doses of 1 or 2 mg/kg showed significantly lower testicular, prostate gland, and seminal vesicle weight. The mating success of treated rats was reduced by 50% during the study and for two months afterwards at both doses.[3]
- The offspring of rabbits fed 0, 10, 25, or 100 mg/kg of technical grade deltamethrin on days 6-19 of gestation did not exhibit teratogenic effects.[1,18,25]
- Rats were fed deltamethrin on days 7-20 of gestation at doses of 0, 1.2, 2.5, or 5.0 mg/kg/day. The NOAEL for developmental toxicity was at the highest dose tested due to the absence of malformations or developmental variations.[18]
- Young rats (11- and 21- days old) were approximately 16 and 7 times more sensitive to orally administered deltamethrin than adult rats, respectively.[3]

Humans

- No human data were found on the reproductive, developmental, or teratogenic effects of deltamethrin.

Fate in the Body:

Absorption

- Deltamethrin is considered to be readily absorbed when administered orally. The carrier or solvent can affect the rate of absorption.[1]
- Pyrethroids are lipophilic. Absorption in the gastrointestinal tract and respiratory tract is higher compared to absorption through the skin.[20]
- Rats absorbed 3.6% of the deltamethrin applied to their skin, which was then excreted within 24 hours. Since human skin is less permeable than rat skin, the absorption of deltamethrin through human skin is expected to be relatively weak.[1]
- Deltamethrin was poorly absorbed from the gastrointestinal tract of lactating cows fed 10 mg/kg for three days.[18]
- Deltamethrin was absorbed by rats after they were fed plant material containing bound residues of the chemical.[3]

Distribution

- Deltamethrin reached peak plasma concentrations in rats at 2.1 hours after a single oral dose. Deltamethrin distributed to nerve tissues and all regions of the brain tested.[26]
- There is little tendency for deltamethrin to accumulate in tissues.[18] Studies with rats observed that orally administered deltamethrin was recovered in fat at slightly higher concentrations compared to other tissues.[1]
- In rats, deltamethrin had a half-life in blood of 5.5 hours.[18]
- One study found little accumulation in the major edible tissues when lactating cows were fed deltamethrin for three days at a rate of 10 mg/kg/day.[18]

Metabolism

- Mammals generally metabolize pyrethroids through ester hydrolysis, oxidation, and conjugation.[1] Ester cleavage is the main route of degradation in the body.[18,27]
- Thiocyanate was the primary metabolite after rats were administered deltamethrin orally or intraperitoneally. Other metabolites include PBA (3-phenoxybenzoic acid), 4'-OH-PB acid sulfate (4'-hydroxy-3-phenoxybenzoic acid sulfate), Br_2CA (3-(2,2-dibromoethenyl)-2,2-dimethylcyclopropanecarboxylic acid) and its glucuronide conjugate.[18]
- Only the parent compound, deltamethrin, is considered to be toxicologically significant.[18]

Excretion

- In one study, excretion of deltamethrin fed to rats was almost complete in 48 hours. Approximately the same amount of the applied dose (36-59%) was found in the feces and the urine.[10]
- In other studies, the elimination half-life of orally-administered deltamethrin was 38.5 hours, and 33.0 hours when administered intravenously to rats.[26]
- A study in lactating cows indicated that deltamethrin was excreted in milk in low amounts (0.42-1.60%) after exposure to a single oral dose.[18] In another study, concentrations in the milk of cows peaked 7 days after dermal application of deltamethrin.[3]
- One study found that Leghorn hen eggs contained low concentrations of deltamethrin residues after hens were fed 7.5 mg each day for three days. Residues in the eggs were detected within the first 24 hours after dosing. Peak residues were detected within 48 hours after the last dose.[18]
- Deltamethrin and its metabolites were detected in the urine of workers within 12 hours of occupational exposure, and for up to 48 hours post-application.[17]

- Human volunteers ingested a single dose of 3 mg deltamethrin and researchers tested urine, feces, saliva, and blood samples. The highest levels in the blood were observed within one to two hours after the exposure. The elimination half-life ranged from 10.0-11.5 hours in plasma and 10.0-13.5 hours in urine. The majority of ingested deltamethrin (64-77%) was excreted in feces and urine within four days of exposure.[1]

Medical Tests and Monitoring:

- Biomarkers of human exposure to deltamethrin have been reported in the scientific literature. Scientists used gas chromatography and mass spectrometry to detect and quantify deltamethrin, its primary metabolite Br_2CA, and other metabolites, in urine.[28] The methods of testing for exposure to deltamethrin and its metabolites have not been well studied in humans, and the clinical significance of these tests is unknown.
- The deltamethrin metabolites *cis*-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid and 3-PBA have been measured in urine samples in national exposure assessments. The metabolite 3-PBA is also a metabolite of other pyrethroids and its presence does not necessarily imply exposure to deltamethrin. Finding a measurable amount in the blood or urine does not mean the level will result in adverse health effects.[3,29]

Environmental Fate:

Soil

- Reported half-lives under aerobic laboratory conditions for deltamethrin in sandy loam or silt loam soil ranges from 11-72 days.[1,5,9] See the text box on **Half-life**.
- In anaerobic soil conditions, the half-life of deltamethrin ranges from 31-36 days.[5]
- The half-life of deltamethrin ranged from 5.7-209.0 days in four terrestrial field dissipation studies.[9]
- Deltamethrin degrades via hydrolysis, photolysis, and microbial action. It is not susceptible to photo-oxidation, and is more persistent in soils with a high clay or organic matter content.[3,5,9,27]
- Hydrolysis of deltamethrin results in the formation of Br_2CA and PBA.[9]

The "half-life" is the time required for half of the compound to break down in the environment.

1 half-life = 50% remaining
2 half-lives = 25% remaining
3 half-lives = 12% remaining
4 half-lives = 6% remaining
5 half-lives = 3% remaining

Half-lives can vary widely based on environmental factors. The amount of chemical remaining after a half-life will always depend on the amount of the chemical originally applied. It should be noted that some chemicals may degrade into compounds of toxicological significance.

- Deltamethrin is considered relatively immobile in soils, while its two major degradation products, Br_2CA and PBA are more mobile.[3,9] Deltamethrin adsorbs to soil organic matter so strongly that biodegradation can be stalled.[27]
- Deltamethrin has little potential to leach into groundwater due to its strong tendency to bind to soil organic matter.[5]
- In a field study, approximately 24% of deltamethrin volatilized from the soil surface within 24 hours of application.[30]

Water

- In one study, the aquatic half-life of deltamethrin ranged from 8-48 hours, where the primary metabolite was Br_2CA. Variations of the half-life were due to the method of application.[31] Other reported aquatic half-lives range from one to four hours.[32]
- Deltamethrin was stable to hydrolysis in solutions of pH 5 and 7. In a pH 9 solution, the average half-life was 2.5 days. Deltamethrin was stable to direct aqueous photolysis in a 30 day study.[9]

- Due to its Henry's law constant (1.2 x 10^{-4} atm·m^3/mol at 25 °C), deltamethrin has a higher potential to volatilize from water compared with other pyrethroids.[3] In a field study, researchers detected maximum levels in air 14 hours after a pond was sprayed with deltamethrin.[32]
- Maximum levels in sediment were reached at 48 hours after treatment of two ponds with deltamethrin, which was still detectable in the pond sediment at 306 days after application.[32]
- Pyrethroids, including deltamethrin, have been found in aquatic sediment. In one study, 15 creeks in California were tested for the presence of pyrethroids in sediment. Of seven creeks sampled, deltamethrin was typically detected at levels less than 10 ng/g. In the same study, researchers detected pyrethroids, including deltamethrin, in seven other creeks at lower concentrations and less frequently than the first seven creeks. Reported concentrations were rarely greater than 20 ng/g for any pyrethroid. One sample from the remaining creek in the study contained deltamethrin at a concentration of 57 ng/g.[33]
- In the same study, 12 creeks in Tennessee were also sampled to detect pyrethroids in the sediment. Of the 14 sites sampled, five contained no pyrethroids at concentrations above 1 ng/g. Seven other sites detected one pyrethroids present per sample, with reported concentrations just above detection levels.[33]
- In another study, 30 creeks in California were sampled for pyrethroids in sediment. Deltamethrin was reported to be detected infrequently from 90 samples tested.[34]

Air

- Due to its vapor pressure (1.5 x 10^{-8} mmHg at 25 °C), deltamethrin has a low potential to volatilize.[3]

Plants

- The half-life of deltamethrin on vegetative surfaces ranges from 5.9-17.0 days, depending on the plant species.[35]
- Deltamethrin is not likely to adsorb as strongly to leafy components of vegetation, so volatilization from these surfaces may be higher compared to soil. In one field study, 12-72% of deltamethrin volatilized from plant leaves 24 hours after application, depending on the plant species.[30]
- Deltamethrin is unlikely to be taken up by terrestrial plants due to its tendency to bind to soils and rapid degradation.[3] Uptake was not observed through leaves or roots of most plants and therefore it is considered a non-systemic compound.[5]
- In field studies, aquatic plants including duckweed and pondweed accumulated deltamethrin taken up from water.[31,32]
- Deltamethrin metabolites in plants and animals are very similar and only vary in their conjugated forms.[18]
- Deltamethrin is not considered toxic to plants when formulated products are used according to label directions.[24]

Indoor

- Under indoor laboratory conditions, soil treated with deltamethrin had a half-life of 4.8 weeks.[3]
- Pyrethroids have a higher rate of volatilization from floor or glass surfaces than from soils since they are not as likely to adsorb to these surfaces.[3]

Food Residue

- In 2006, the United States Department of Agriculture (USDA) Pesticide Data Program (PDP) analyzed 9030 samples of fruits and vegetables for deltamethrin and its parent compound, tralomethrin. Of the samples tested, only one sample had detectable residues and the amount detected was eight times less than the U.S. EPA tolerance level.[36]
- In the same study, 133 finished water samples, 133 untreated water samples, 734 peanut butter samples, and 655 samples of poultry breast and thigh were analyzed for deltamethrin and tralomethrin. No samples had detectable residues.[36]

Ecotoxicity Studies:

Birds

- Deltamethrin is practically non-toxic to birds when ingested with a reported acute oral LD_{50} for mallard ducks (*Anas platyrhynchos*) of greater than 4640 mg/kg. The 8-day dietary LC_{50} is greater than 8039 mg/kg for mallard ducks and greater than 5620 mg/kg for quail.[5]
- Deltamethrin did not affect the reproduction of female Japanese quail (*Coturnix japonica*) when fed daily doses of 0, 0.2, or 1.0 mg for 34 days.[1] In other studies, the NOEL established for mallard ducks and bobwhite quail (*Colinus* sp.) were greater than 70 mg/kg and greater than 55 mg/kg, respectively, for reproduction.[5]

Fish and Aquatic Life

- Under laboratory conditions, technical grade deltamethrin is moderately to highly toxic to fish. The 96-hour LC_{50} ranges from 0.91-3.50 µg/L depending on the fish species.[1,5]
- In field applications, deltamethrin is not expected to affect fish when used properly because it binds tightly to soil and breaks down quickly.[1]
- In laboratory tests, deltamethrin was dissolved in water containing clean artificial or natural sediment. Deltamethrin spiked water with artificial sediment was highly toxic to larvae of the midge *Chironomus riparius* with a 28-day LC_{50} of 16 pg/L. Deltamethrin spiked water with natural sediment had no effect on larval survival or development rate. Differences in toxicity were attributed to the bioavailability of deltamethrin.[37]
- In the same study, artificial and natural sediments were spiked with deltamethrin and sediment toxicity was assessed for the midge larvae, *Chironomus riparius*. The 28-day LC_{50} in artificial sediment was 11µg/kg. However, natural sediment spiked with deltamethrin had no effect on survival. Dissolved organic matter concentration, calcium concentration, pH, clay content, and the quantity and quality of particulate organic matter can affect the bioavailability and therefore toxicity of deltamethrin in sediment.[37]

Terrestrial Invertebrates

- Deltamethrin is highly toxic to honeybees (*Apis* sp.) under laboratory conditions. One study reported an oral LD_{50} of 51 ng/bee and a contact LD_{50} of 51 ng/bee.[5] In field studies, deltamethrin did not harm bees at rates up to 12.5 g a.i./ha and formulated products had a repellant effect lasting for 2-3 hours.[1]

Reference Dose (RfD): The RfD is an estimate of the quantity of chemical that a person could be exposed to every day for the rest of their life with no appreciable risk of adverse health effects. The reference dose is typically measured in milligrams (mg) of chemical per kilogram (kg) of body weight per day.

U.S. Environmental Protection Agency. Office of Water. 2002 Edition of the Drinking Water Standards and Health Advisories. EPA 822-R-02-038. http://www.epa.gov/ost/drinking/standards/dwstandards.pdf

- Researches observed no effects on earthworms when the soil was treated with 12.5 g/ha of deltamethrin for 28 days.[1]

Regulatory Guidelines:

- The reference dose (RfD) for deltamethrin is 0.01 mg/kg/day.[10] See the text box on **Reference Dose (RfD)**.
- The U.S. EPA has classified deltamethrin as "Group D - not classifiable as to human carcinogenicity" by all routes of exposure.[10] See the text box on **Cancer** (page 5).
- The acute Population Adjusted Dose (aPAD) is 0.0033 mg/kg/day based on a NOAEL of 1.0 mg/kg/day.[10]
- The chronic Population Adjusted Dose (cPAD) was determined to be 0.0033 mg/kg/day based on a NOAEL of 1.0 mg/kg/day.[10]
- The Acceptable Daily Intake (ADI) for deltamethrin is 0.01 mg/kg.[5]

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