BIFENTHRIN
TECHNICAL FACT SHEET

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NATIONAL PESTICIDE INFORMATION CENTER
1.800.858.7378

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:

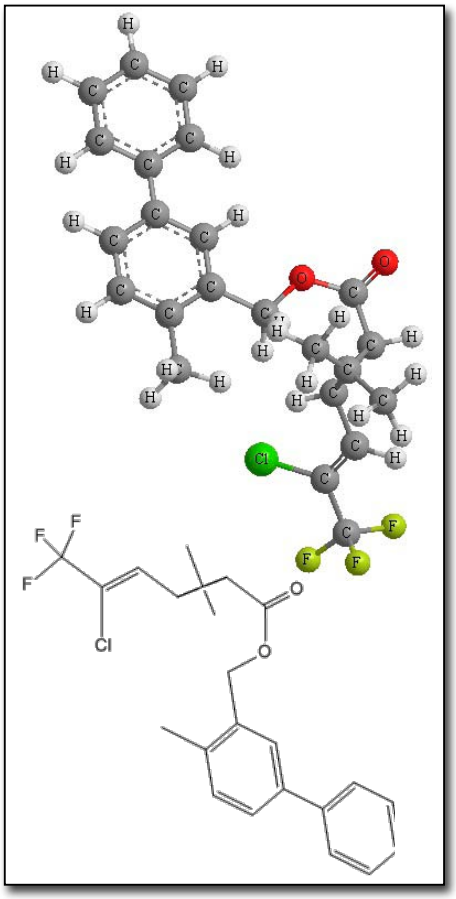
- Bifenthrin is an insecticide and a member of the pyrethroid family of chemicals.[1] It is considered a Type I, non-cyano pyrethroid with isomeric enrichment. The stereoisomers 1S, 3S and 1R, 3R are found in commercial products.[2]
- The technical International Union of Pure and Applied Chemistry (IUPAC) name for bifenthrin is 2-methylbiphenyl-3-ylmethyl (Z)-(1RS,3RS)-3-(2-chloro-3,3,3-trifluoroprop-l-enyl)- 2,2-dimethylcyclopropanecarboxylate and the Chemical Abstracts Service (CAS) registry number is 82657-4-3.[3]
- Bifenthrin was first registered for use by the United States Environmental Protection Agency (U.S. EPA) in 1985.[1] See the text box on **Laboratory Testing**.

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.

Physical / Chemical Properties:

- Bifenthrin is pale tan to off-white in color. It can be crystalline, waxy solid or viscous liquid. It has a weak, aromatic odor.[1,3]
- Vapor pressure[4]: 1.81 x 10^{-7} mmHg at 25° C
- Octanol-Water Partition Coefficient (K_{ow})[5]: 1.0 x 10^{6}
- Henry's constant[4]: 7.2 x 10^{-3} atm·m^3/mol
- Molecular weight[3]: 422.9 g/mol
- Solubility (water)[3]: <1 µg/L
- Soil Sorption Coefficient (K_{oc})[5]: 1.31 x 10^{5} – 3.02 x 10^{5}

Molecular Structure - Bifenthrin



Uses:

- Products containing bifenthrin are used on cereals, cotton, corn, alfalfa, hay, grass seed, some fruits, ornamentals, and vegetables.[3,6] Uses for individual bifenthrin products vary widely. Always read and follow the label when applying pesticide products.
- Products containing bifenthrin are used against a wide range of insects and mites.[3]
- Signal words for products containing bifenthrin 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 bifenthrin which are registered in your state, visit the website http://npic.orst.edu/state1.htm and search by "active ingredient."

Mode of Action:

Target Organisms

- Bifenthrin is designed to be effective by contact or ingestion.[3]
- Bifenthrin is a Type I pyrethroid that affects the central and peripheral nervous system by interfering with sodium channel gating. Pyrethroids delay the closure of the sodium channel. Type I pyrethroids such as bifenthrin tend to hold the channel open for shorter times compared to type II pyrethroids.[7]

Non-target Organisms

- The mechanism of action of pyrethroids, including bifenthrin, is the same for mammals and invertebrates.[7]
- Pyrethroids are less toxic to mammals compared to insects because of mammals' higher body temperature, larger body size, and lower sensitivity of the ion channel sites.[7]
- Pyrethroids other than bifenthrin have shown that they may affect fish and gill-breathing aquatic insects by inhibiting ATP. This disrupts ionic balances and osmoregulation making these organisms more susceptible to the toxic effects of pyrethroids.[8,9,10]

Acute Toxicity:

Oral

- Bifenthrin is highly toxic to mice when ingested, with an acute oral LD_{50} of 43 mg/kg.[11] See the text boxes on **Toxicity Classification** and **LD_{50}/LC_{50}**.
- Bifenthrin is moderately toxic to rats when ingested, with an acute oral LD_{50} ranging from 53.4 mg/kg to 210.4 mg/kg.[12]
- Bifenthrin was fed to rats at doses of 10, 35 or 75 mg/kg. Signs of toxicity were only observed at the highest dose tested and occurred within 6-8 hours. Observed signs included tremors, clonic convulsions, twitching, incoordination, staggered gait, splayed hind limbs, atypical posture and abdominogenital staining.[13]

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.

- In another study, researchers fed bifenthrin to male rats in doses of up to 20 or 26 mg/kg, which were given in volumes of either 1 or 5 mL/kg. The researchers used corn oil as the vehicle to test how dose volumes affected bifenthrin neurotoxicity. Observed signs were more severe at the 1 mL/kg than 5 mL/kg delivery volume and this difference was most evident 4 hours after dosing. The rats exhibited fine tremors, increased head shaking, pawing, elevated body temperature, increased click response, and decreased grip strength and motor activity. Within 24-48 hours after dosing, the rats were reported to have fully recovered.[14]

Dermal

- Bifenthrin is low in toxicity when applied to the skin of rats and rabbits. The acute dermal LD_{50} was greater than 2000 mg/kg after a 24 hour exposure to bifenthrin.[3]
- Bifenthrin was non-irritating when applied to the skin of rabbits and practically non-irritating to the eyes of rabbits.[3]
- Bifenthrin did not cause skin sensitization when applied to the skin of guinea pigs according to the Buehler method. When bifenthrin was administered to guinea pigs according to the maximization method, skin sensitization occurred.[12]

Inhalation

- Bifenthrin is low in toxicity to rats when inhaled, with an acute inhalation LD_{50} ranging from 0.8 mg/L to 1.10 mg/L.[12]

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TOXICITY CLASSIFICATION - BIFENTHRIN

	High Toxicity	Moderate Toxicity	Low Toxicity	Very Low Toxicity
Acute Oral LD_{50}	**Up to and including 50 mg/kg (≤ 50 mg/kg)**	**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)
Inhalation LC_{50}	Up to and including 0.05 mg/L (≤ 0.05 mg/L) (aerosol)	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) (dust)
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 reflect 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/hap-07.pdf

Signs of Toxicity - Animals

- Signs of exposure in rats included tremors, twitching, clonic convulsions, atypical posture, incoordination and staggering gait.[15] Head shaking, pawing, and decreased grip strength have also been observed.[14]
- Veterinary observations of acute exposures in cats and dogs to pyrethroids indicated that signs start with hyper-excitability followed by incoordination, diarrhea, depression, and dilated pupils. Some cases reported additional signs such as chewing, head bobbing, paresis, and whole-body tremors.[2]
- Clinical signs reported after pets were exposed to pyrethroids include single-episode vomiting or diarrhea, reduced activity, twitching of the ear, paw flicking and hypersalivation. These signs are typically self-limiting and considered minor.[16]

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 temporary and reversible in a period of hours, sometimes lasting up to 48 hours.[15]
- Paresthesia is typically reported only at the site of dermal exposure and is not associated with systemic intoxication.[15]
- Respiratory and nasal irritation may be caused by the inhalation of aerosol droplets or dust of pyrethroids.[7]
- Ingestion of pyrethroids may cause a sore throat, nausea, abdominal pain and vomiting almost immediately after ingestion. Other reported symptoms included increased oral secretions, ulcerations in the mouth, difficulty swallowing, headache, dizziness and fatigue. Symptoms less frequently reported include blurred vision, heart palpitations and tightness in the chest.[7]
- Always follow label instructions and take steps to avoid exposure. If any 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 rats technical-grade bifenthrin for a minimum of 90 days at doses of 0, 12, 50, 100, or 200 ppm. The NOAEL was 5 mg/kg/day (100 ppm) due to tremors observed in all animals at 200 ppm.[17] See the text box on **NOAEL, NOEL, LOAEL**, and **LOEL**.

NOAEL: No Observable Adverse Effect Level
NOEL: No Observed Effect Level
LOAEL: Lowest Observable Adverse Effect Level
LOEL: Lowest Observed Effect Level

- Technical-grade bifenthrin (88.4% purity) was fed to dogs daily for 13 weeks at doses of 0, 2.5, 5.0, 10.0, or 20.0 mg/kg. The NOAEL was established at 2.5 mg/kg due to tremors observed in animals dosed at 5.0 mg/kg and above.[18]
- Researchers applied technical-grade bifenthrin to the shaved skin of rabbits for at least 6 hours per day for 21 days at doses of 0, 25, 50, 100, or 500 mg/kg. The NOAEL was established at 100 mg/kg due to loss of muscle control and tremors at the highest dose.[18]

Humans

- No human data were found on chronic effects of bifenthrin.

Endocrine Disruption:

- In one study, researchers observed differences in the estrogenic potential of two bifenthrin enantiomers, 1S-*cis*-bifenthrin and 1R-*cis*-bifenthrin. Using the *in vitro* human breast carcinoma MCF-7 cell proliferation assay, the relative proliferative effect ratios were 20.9% for 1R-*cis*-bifenthrin and 74.2% for 1S-*cis*-bifenthrin.[19]
- In the same study, Japanese medaka (*Oryzias latipes*) were exposed to 1S-*cis*-bifenthrin or 1R-*cis*-bifenthrin at 10 ng/mL for 10 days to measure the induction of vitellogenin. Both bifenthrin isomers induced vitellogenin, which is involved in egg production. Average levels of vitellogenin for fish exposed to the 1R-*cis*-bifenthrin were measured at 12.45 ng/mg, while those exposed to1S-*cis*-bifenthrin measured levels of vitellogenin at 1532 ng/mg.[19]
- Bifenthrin is included in the draft list of initial chemicals for screening under the U.S. EPA Endocrine Disruptor Screening Program (EDSP). The list of chemicals was generated based on exposure potential, not based on whether the pesticide is a known or likely potential cause of endocrine effects.[20]
- No data were found on endocrine disruption effects of bifenthrin in humans.

Carcinogenicity:

Animals

- Researchers fed mice technical-grade bifenthrin for at least 20 months at doses of 0, 50, 200, 500, or 600 ppm. They observed an increased prevalence of liver carcinoma, adenoma, and/or hyperplasia in some male rats at 200, 500 and 600 ppm.[21]
- In the same study, researchers observed an increased rate of sub-mucosal tumors in the bladder in males at the highest dose. A statistical analysis of these data conducted by reviewers found that the results "do not provide persuasive evidence of a compound-related effect." Lesions of the type found in the mice have not been reported in humans.[21,22]
- Bifenthrin did not show any potential to cause tumors when rats were fed concentrations of 0, 12, 50, 100, or 200 ppm of technical bifenthrin for 2 years.[23]
- No mutagenic properties were observed in mutagenicity assays including the Ames test, *in vivo* rat bone marrow cells, Chinese hamster ovary (CHO) cells, and unscheduled DNA synthesis (UDS) at concentrations of bifenthrin up to 2.5 µl/mL.[1] However, bifenthrin showed mutagenic properties in a mouse lymphoma assay.[1]

Humans

- The U.S. EPA classified bifenthrin as a Category C, possible human carcinogen. This rating is based on an increased rate of urinary bladder tumors in mice, adenoma and adenocarcinoma of the liver in male mice, and bronchioalveolar adenomas and adenocarcinomas of the lung in some female mice.[24] See the text box on **Cancer**.
- No human data were found on carcinogenic effects of bifenthrin.

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.

Reproductive or Teratogenic Effects:

Animals

- Researchers fed rats technical grade bifenthrin at concentrations of 0, 30, 60, or 100 ppm for 2 generations. On days 7 and 14 of the lactation period, females of the first generation showed reduced body weight gain. No effects on the litter size, litter weight, survival of the pups, or reproductive performance were noted. The NOAEL was established at 3 mg/kg/day (60 ppm/day) due to tremors in the lactating dams of both generations at the highest dose.[18] See the text box on Cancer.
- Rats were orally administered bifenthrin at doses of 0, 0.5, 1.0, or 2.0 mg/kg on days 6 through 15 of gestation. No treatment-related reproductive effects occurred. At the highest dose, tremors were observed in the mother rats, but no treatment-related effects were noted in the embryos or fetuses.[18]
- In a teratogenicity study, rabbits were fed bifenthrin at doses of 0, 2.7, 4.0, or 8.0 mg/kg on days 7 through 19 of gestation. No indications for the potential of birth defects were observed. The NOAEL for maternal toxicity was 2.7 mg/kg/day due to head and forelimb twitching at higher doses tested. No treatment-related effects were noted in the embryos or fetuses at the highest dose tested.[18]

Humans

- No human data were found on the teratogenic or reproductive effects of bifenthrin.

Fate in the Body:

Absorption

- In general, pyrethroids are poorly absorbed through the skin of humans.[7]
- Rats were treated dermally with 36 µg bifenthrin. The bifenthrin was left on the shaved skin for 24 hours, and then washed away. Less than 4% was excreted in the urine or feces within 24 hours of treatment, indicating that dermal absorption is low.[25]
- In a study observing *in vitro* dermal absorption, radio-labeled bifenthrin in acetone was applied to dermatomed skin from human cadavers. When the skin was washed with soap and water 24 hours into the exposure, 71-83% of the applied dose was removed.[26]
- Bifenthrin was absorbed slowly from the gastrointestinal tract of rats with an absorption half-life of 1.5 hours.[24]

Distribution

- When rats were fed one dose of 5 mg/kg of bifenthrin, they had low residues in their tissues. The highest residues were found in fat (up to 1.7 ppm), skin (up to 0.4 ppm) and liver (up to 0.1 ppm). Other tissues tested contained residues of less than 0.1 ppm.[18]

- Bifenthrin was fed to female rats for 70 days at 0.5 mg/kg/day. The highest residue concentrations averaged 9.6 ppm and were found in fat. Residues consisted of 65%-85% bifenthrin. Three unspecified metabolites made up the rest. Residues were also detected in the sciatic nerve (3.2 ppm), skin (1.7 ppm), ovaries (1.7 ppm), liver (0.4 ppm), kidney (0.3 ppm), blood (0.06 ppm), and plasma (0.06 ppm).[27]

Metabolism

- Metabolism of bifenthrin in rats mainly occurs by hydrolysis of the ester linkage and oxidation of the resultant alcohol to the acid.[24] Pyrethroids, such as bifenthrin, are rapidly metabolized in the liver to a number of metabolites. Metabolism can occur by hydrolysis of the ester linkage, oxidation of aromatic rings and methyl groups and by conjugation reactions.[7]
- In addition to the parent compound, major metabolites of bifenthrin detected in rat plasma were the hydrolysis product 2-methyl-3-phenylbenzylalcohol, and the oxidation product 2-methly-3-phenylbenzoic acid (MPA).[28]
- In a study where female rats were fed 0.5 mg/kg/day of bifenthrin for 70 days, clearance half-lives were estimated after dosing was discontinued. Half-lives were 51 days in fat, 50 days in skin, 40 days in the ovaries and sciatic nerve, 28 days in the kidney, and 19 days in the liver.[27]

Excretion

- In several studies, rats that were fed bifenthrin eliminated the majority of it within 72 hours in the urine (13%-25%) and feces (66%-83%), with little or no change in the original compound.[18,24]
- In another study, rats that ate one dose of 5 mg/kg excreted most of the bifenthrin in the urine (6%-7%) and feces (76%-79%) within 48 hours. Approximately 90% of the administered dose was eliminated within 7 days.[18]
- In three studies involving lactating goats, researchers fed the goats 2 mg/kg/day for 7 days. Residues of unchanged bifenthrin were found in milk at concentrations ranging from 0.8 to 1.5 ppm. Bifenthrin accounted for 75%-98% of the residue found in the milk.[29,30,31]
- In one of the these studies, the metabolite biphenyl acid was found in goat liver and kidney at concentrations of 0.6 ppm (31%) and 0.2 ppm (42%) respectively and was also detected as a minor metabolite in milk.[30]
- Laying hens were orally administered 40 ppm of bifenthrin for 10 days. Maximum bifenthrin residues were found in the egg whites at 0.04 ppm, egg yolks at 3 ppm, and in both the fat and liver at 2 ppm. Elimination was primarily through excreta.[32]

Medical Tests and Monitoring:

- Biomarkers of human exposure to bifenthrin have been reported in the scientific literature. Scientists used HPLC-UV to detect and quantify bifenthrin and its primary metabolite 2-methyl-3-phenylbenzoic acid (MPA) in urine.[33] This method for evaluating exposure to bifenthrin and its metabolite has not been well-studied in humans, and its clinical significance is unknown.

Environmental Fate:

Soil

- The aerobic half-life of bifenthrin in soil ranges from 97-250 days, depending on soil type.[5] See the text box on **Half-life** (page 7).
- The soil half-life of bifenthrin ranged from 106 to 147 days when the soil was exposed to sunlight.[5]
- In field dissipation studies, bifenthrin half-lives ranged from 122 to 345 days in a variety of soils.[4]

- Bifenthrin is immobile in soil containing high amounts of silt, clay, and organic matter and has low mobility in sandy soil containing small amounts of organic matter.[1]
- In aerobic soil studies and flooded soil tests, breakdown of bifenthrin yielded minor degradation products in small quantities. The degradate with the highest concentration was 4'-hydroxy bifenthrin, which accounted for 3%-5.6% of the total amount applied.[34]

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

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.

Water

- Bifenthrin has a low potential to contaminate ground water due to its tendency to bind to soil and its low water solubility. However, bifenthrin that is soil-bound has the potential to contaminate surface waters through runoff.[5]
- Bifenthrin is considered photo-stable with aqueous photolysis half-lives ranging from 276 to 416 days.[5]
- At 20° C, bifenthrin has an aerobic half-life in sediment ranging from 12 to 16 months. The half-life range was 25-65 months at 4° C.[35]
- Under anaerobic conditions, bifenthrin has a half-life in sediment ranging from 8 to 16 months at 20° C and 4° C.[35] After 30 days of anaerobic conditions, the metabolite 4'-hydroxy bifenthrin accounted for 4.5% of the total amount of bifenthrin applied.[4]
- Over a 30-day period, bifenthrin was stable to abiotic hydrolysis in 25° C water at pH 5, 7, and 9.[5] Due to its tendency to tightly bind to soil particles, bifenthrin degradation can be inhibited in sediment.[5,35]
- In a study that monitored pyrethroids in water and sediments from urban creeks near Sacramento, CA, bifenthrin was detected in 23 of 24 water samples. Over the course of 10 months, median concentrations of bifenthrin in water ranged from 5 to 17 ng/L with a maximum concentration measured at 73 ng/L.[36]
- Bifenthrin was detected in 94% of sediment samples in a study of residential stream sediments in central Texas. The mean concentration of bifenthrin was 0.74 µg/g organic content (OC), with a maximum concentration found at 2.9 µg/g OC.[37]
- Of 14 creek sites sampled in Nashville, Tennessee, half detected only one pyrethroid in each sample, most at concentrations barely above detection. Five other sample sites did not detect pyrethroids above the 1 ng/g reporting limit.[38]
- A study in California examined sediments in a mixed land use setting during the wet and dry seasons. Bifenthrin was detected at maximum concentrations of 122 µg/kg in dry season samples (n=19) and 542 µg/kg in the wet season samples (n=18). Bifenthrin was one of the most frequently detected pyrethroids and found in 95-100% of the samples.[39]
- Several studies of urban creek sediments in California have detected bifenthrin in the sediment. In one study, bifenthrin was detected in all 30 samples collected in concentrations ranging from 2.19 to 219 ng/g dry weight. In another study of suspended sediment discharged from urban storm water drains, bifenthrin was detected at concentrations ranging from 252 to 1211 ng/g dry weight.[36,40]

Air

- Bifenthrin has a low potential to volatilize after being applied to dry soil, based on its low vapor pressure (1.81×10^{-7} mmHg at 25° C) and Henry's law constant (7.2×10^{-3} atm·m^3/mol).[5]

- Bifenthrin's physical properties suggest that it is unlikely to volatilize from soil. However, it is slightly more likely to volatilize when applied to wet soil compared to dry soil. Soil sorption may vary depending on soil types.[34,41]

Plants
- Bifenthrin is not absorbed by foliage or translocated throughout plants.[1]
- Bifenthrin was not metabolized in apples 21 days after the last of three applications.[42]
- When used according to label directions, bifenthrin is considered non-toxic to plants.[43]

Indoor
- No data were found on the indoor fate of bifenthrin.

Food Residue
- In 2007, the United States Department of Agriculture (USDA) Pesticide Data Program (PDP) analyzed 9207 food commodity samples. Bifenthrin residues were found in 303 samples (0.3% of the samples tested). No residue exceeded EPA's tolerance level.[44]
- In the same study, 253 finished water samples and 250 untreated water samples were analyzed for bifenthrin. Of these, only one sample of untreated water had a residue above the level of detection of 8.0 ppt.[44]

Ecotoxicity Studies:

Birds
- Bifenthrin is low in toxicity to birds with acute oral LD_{50} values of 1800 mg/kg and less than 2150 mg/kg for bobwhite quail (*Colinus virginianus*) and mallard ducks (*Anas platyrhynchos*), respectively.[1]
- Eight-day dietary LC_{50} values for bifenthrin were 1280 mg/kg and 4450 mg/kg for bobwhite quail and mallard ducks, respectively.[3]
- Bobwhite quail and Mallard ducks were fed bifenthrin at doses of 25, 50, and 75 ppm starting 12 weeks before the start of egg production and continuing over a 24-week period. Eggs were collected during weeks 13-24. No evidence of adverse effects on reproduction was observed.[12]
- There are potential exposure risks for birds and mammals that feed on aquatic organisms based on the environmental persistence and the high bioconcentration factor of bifenthrin in fish.[5]

Fish and Aquatic Life
- Bifenthrin is very highly toxic to fish with 96-hour LD_{50} values of 0.10 and 0.18 ppb for rainbow trout (*Onchorynchus mykiss*) and bluegill sunfish (*Lepomis macrochirus*), respectively.[1]
- Bifenthrin can concentrate in fish tissues. Fathead minnows (*Pimephales promelas*) exposed to 0.0037 µg/L bifenthrin had bioconcentration factors of 21,000 after 127 days and 28,000 after 254 days of exposure..[45]
- In one study, detritus feeders known as gizzard shad (*Dorosoma cepedianum*) were dosed with sediment-bound bifenthrin for eight days starting at concentrations of 0, 90, 185, 250, 1550, and 7750 ng/L. The eight-day LC_{50} values were 521 and 207 ng/L, respectively, when fish were exposed to one-hour and average bifenthrin concentrations. Behavioral responses from concentrations greater than 185 ng/L presented as slow swimming, head-shaking, opercle flaring, and gulping for air near the water's surface.[46]
- The strong adsorption of bifenthrin to soil can limit its availability to certain aquatic organisms, mitigating toxicity. However, cladocerans and other detritus-feeding species can be affected by soil-bound bifenthrin.[5]

- Third-generation pyrethroids, including bifenthrin, were more toxic to *Ceriodaphnia dubia* and *Daphnia magna* compared with first-generation pyrethroids, with reported LC_{50} values of 0.07 ppb and 0.32 ppb, respectively.[5]
- Bifenthrin is highly toxic to aquatic invertebrates. The 48-hour EC_{50} for *Daphnia magna* was 1.6 ppb and the 96-hour LC_{50} for *Mysidopsis bahia* was 3.97 ppt.[1] See the text box on **EC_{50}**.
- Researchers spiked sediment with bifenthrin and reported the mean 10-day LC_{50} for the amphipods *Eohaustorius estuaries* and *Ampelisca abdita* to be 0.008 and 0.948 mg/kg, respectively.[47]

EC_{50}: The median effective concentration (EC_{50}) may be reported for sublethal or ambiguously lethal effects. This measure is used in tests involving species such as aquatic invertebrates where death may be difficult to determine. This term is also used if sublethal events are being monitored.

Newman, M.C.; Unger, M.A. *Fundamentals of Ecotoxicology*; CRC Press, LLC.: Boca Raton, FL, 2003; p 178.

- In a sediment toxicity study, researchers found detectable levels ranging from 2.19 to 219 ng/g dry weight of bifenthrin in all 30 samples tested. All sediment samples were toxic to the amphipod *Hyalella azteca*, at 15° C. Several sediment samples included various combinations of other pyrethroids, piperonyl butoxide, organophosphates, and/or organochlorines. Researchers concluded that bifenthrin was one of the main contributors to sediment toxicity in this study.[40]
- Researchers collected sediment from three locations in California's Central Valley and spiked it with bifenthrin. The average 10-day LC_{50} reported for *Hyalella azteca* was 4.5 ng/g, with a range from 2.7 to 9.8 ng/g.[48]
- Copepods, who depend on suspended organic matter, had mortality at a concentration of 0.90 ppb of bifenthrin.[5]
- Researchers found a poor correlation between freely dissolved water concentrations and OC-based sediment concentrations of bifenthrin using solid-phase microextraction (SPME) method. They concluded that factors such as the characteristics of sediment organic matter and aging may significantly influence the bioavailability and toxicity of sediment-bound pyrethroids.[39]

Terrestrial Invertebrates

- Bifenthrin is very highly toxic to bees with a reported oral LD_{50} of 0.1µg/bee and contact LD_{50} of 0.01462 µg/bee.[3]

Regulatory Guidelines:

- The acute reference dose (RfD) for bifenthrin is 0.328 mg/kg/day.[49] See the text box on **Reference Dose**.

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

- The chronic reference dose (RfD) for bifenthrin is 0.013 mg/kg/day.[49]
- The U.S. EPA classified bifenthrin as a Group C, possible human carcinogen, based on an increased rate of urinary bladder tumors in mice, adenoma and adenocarcinoma of the liver in male mice, and bronchioalveolar adenomas and adenocarcinomas of the lung in some female mice.[24] See the text box on **Cancer** (page 5).
- The acute Population Adjusted Dose (aPAD) is 0.328 mg/kg/day based on a LOAEL of 70.3 mg/kg/day due to clinical observations and effects, differences in motor activity and mortality in rats.[49]
- The chronic Population Adjusted Dose (cPAD) is 0.013 mg/kg/day based on a LOAEL of 2.7 mg/kg/day due to an increased incidence of tremors in a one-year oral toxicity study in dogs.[49] See the text box on **Exposure** (page 10).
- The aPAD and cPAD are equal to the acute and chronic RfD, which indicates no difference in toxicity between adults and children.
- The Acceptable Daily Intake (ADI) of bifenthrin for humans is 0.02 mg/kg.[18]

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

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