

DICAMBA

TECHNICAL FACT SHEET

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:

- Dicamba is a selective pre- and post-emergent herbicide.¹ It is classified as either a benzoic acid or chlorophenoxy herbicide.^{2,3} The International Union of Pure and Applied Chemistry (IUPAC) name for the acid form is 3,6-dichloro-2-methoxybenzoic acid and the Chemical Abstracts Service (CAS) registry number is 1918-00-9.⁴
- Dicamba was first registered for use in the United States in 1967.⁵ See the text box on **Laboratory Testing**.
- Formulations include dicamba acid, dimethylamine salt (DMA), sodium salt, diglycoamine salt (DGA), isopropylamine salts (IPA), and potassium salt.³ Products containing dicamba frequently contain other herbicides as well.³

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.

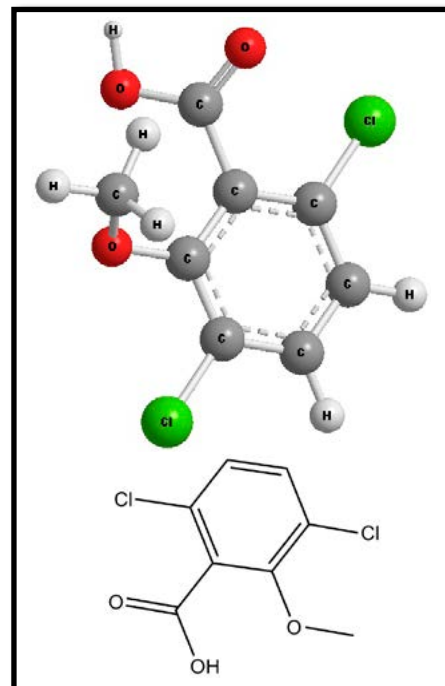
Uses:

- Dicamba is a selective herbicide used to control a wide spectrum of broadleaf weeds and woody plants. It is registered for use in agriculture and other applications.³
- In agricultural applications, dicamba is registered for use on rye, asparagus, barley, corn, oats, soybeans, sugarcane and wheat. Dicamba is also registered for use on golf courses, residential lawns, and rights-of-way along utility lines, roadsides and railways.³
- Signal words for products containing dicamba may range from Caution to Danger.¹⁰ 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 dicamba which are registered in your state, visit the website http://npic.orst.edu/reg/state_agencies.html select your state then click on the link for "State Products."

Physical / Chemical Properties:

- See table below for the physical/chemical properties of the two forms that are most widely used in herbicides. Unless otherwise stated, this fact sheet refers to the acid form.

Molecular Structure - Dicamba



Active Ingredient	CASRN ⁵	Form ^{5,6}	Vapor pressure ⁵	Henry's constant ⁴	Molecular Weight ⁵	Solubility In water (mg/L) ⁵	Log K _{ow} ⁴	K _{oc} ⁵
Dicamba acid	1918-00-9	White or brown crystalline solid	4.5 x 10 ⁻³ Pa @ 25 °C	1.0 x 10 ⁻⁴ Pa m ³ mol ⁻¹	221.04 g/ mole	4,500 mg/L @ 25 °C	pH 5.0: -0.55 pH 6.8: -1.88 pH 8.9: -1.9	2
Dimethylamine salt	2300-66-5	Colorless to white crystalline powder			266.12 g/ mole	720,000 mg/L		

Mode of Action:

Target Organisms

- At low doses, dicamba has similar hormonal properties to natural auxins.⁷ High concentrations of dicamba in plant tissues induces abnormal and uncontrollable growth, disrupting normal plant functions, resulting in death.⁸
- Auxins are a class of phytohormones that are involved in plant developmental processes that occur at the cellular level, affecting cellular elongation and turgor, as well as cellular differentiation and division.⁷

Non-target Organisms

- Chlorophenoxy herbicides display a wide variety of mechanisms of toxicity to non-target organisms, including disruption of acetylcoenzyme A metabolism, uncoupling of oxidative phosphorylation and dose-dependent cell damage.⁹
- Dicamba induced a significant increase in the frequency of sister chromatid exchanges (SCEs) in human lymphocytes at 200 ug/ml. At 500 ug/ml, dicamba was cytotoxic.¹⁰
- In isolated Wistar rat liver mitochondria, dicamba was shown to reduce the energy production efficiency of the cells, which may account for some toxic effects observed.¹¹

Acute Toxicity:

Oral

- The acute oral LD₅₀ in rats varies by strains and gender. The acute oral LD₅₀ of technical grade dicamba in male semi-adult Wistar rats was 757 mg/kg. Pure dicamba has an acute oral LD₅₀ of 2560 mg/kg in semi-adult Wistar females.¹² See the text boxes on **Toxicity Classification** (page 4) and **LD₅₀/LC₅₀**.
- In male adult Sherman rats, the acute oral LD₅₀ for dicamba was 1401 mg/kg and 1039 mg/kg for females. In weanling male Sherman rats 4-6 weeks of age, the acute oral LD₅₀ for dicamba was 3294 mg/kg.¹³
- In female Tuck mice, the acute oral LD₅₀ of technical grade dicamba was reported to be 1189 mg/kg. The LD₅₀ of formulated dicamba in male and female rabbits and in male albino guinea pigs was 566 mg/kg.¹²

LD₅₀/LC₅₀: A common measure of acute toxicity is the lethal dose (LD₅₀) or lethal concentration (LC₅₀) that causes death (resulting from a single or limited exposure) in 50 percent of the treated animals. LD₅₀ is generally expressed as the dose in milligrams (mg) of chemical per kilogram (kg) of body weight. LC₅₀ 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 LD₅₀/LC₅₀ is small and practically non-toxic when the value is large. However, the LD₅₀/LC₅₀ 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.

TOXICITY CLASSIFICATION - DICAMBA

	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)	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) (Ester, Salt)

The highlighted boxes reflect the values in the “Acute Toxicity” section of this fact sheet. Modeled after the U.S. Environmental Protection Agency, Office of Pesticide Programs, Label Review Manual, Chapter 7: Precautionary Labeling. <http://www.epa.gov/oppfeed1/labeling/lrm/chap-07.pdf>

- In male albino rats, the reported LD₅₀ for dicamba was 2740 mg/kg.³

Dermal

- The acute dermal LD₅₀ in rats was greater than 2000 mg/kg. The United States Environmental Protection Agency (U.S. EPA) considers dicamba to be low in dermal toxicity.³
- Dicamba caused moderate skin and eye irritation in rabbits. The U.S. EPA considers dicamba to be moderately toxic to the skin and eyes.³
- In studies with guinea pigs, dicamba did not cause skin sensitization and the U.S. EPA has classified dicamba as a non-sensitizer.³

Inhalation

- The acute inhalation LC₅₀ in rats was determined to be equal to or greater than 5.3 mg/L. The U.S. EPA determined that dicamba was very low in toxicity when inhaled.³

Signs of Toxicity - Animals

- Signs of dicamba-induced toxicosis in animals include shortness of breath, muscle spasms, cyanosis, urinary incontinence and collapse.¹⁴ Additionally, salivation with tympanism (excessive gas in the gastrointestinal tract) along with possible depression and convulsions may occur.¹⁵
- English Pointer dogs exhibited abnormal muscular activity in the biceps brachii, cranial tibial and quadriceps muscles following oral exposure to dicamba. Myotonia (persistent contraction of muscles after electrical stimulation has ceased) was also observed.¹⁶
- As a result of a single oral dose of DMA dicamba, bobwhite quail exhibited symptoms such as wing droop, loss of coordination, weakness, abnormal gait, rigidity of the legs and lethargy.¹⁷

Signs of Toxicity – Humans

- Following ingestion of dicamba, symptoms of poisoning may include vomiting, shortness of breath, slowed heart rate, loss of appetite, cyanosis and muscle spasms.¹ Gastrointestinal bleeding may occur occasionally.⁹ In very severe poisoning cases, vomiting, diarrhea and abdominal pain may be followed by coma.⁹
- Other reported health effects following dicamba ingestion include hyperthermia, metabolic acidosis, renal failure and increases in certain liver enzymes.⁹
- Extended inhalation exposures may cause dizziness, irritation of the nose, pharynx and chest, resulting in coughing.² Additionally, peripheral neuromuscular and gastrointestinal symptoms have been reported following inhalation exposures.⁹
- Always follow label instructions and take steps to minimize exposure. If any exposure occurs, 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 discuss an incident with the National Pesticide Information Center, please call 1-800-858-7378.

Chronic Toxicity:

Animals

- When researchers fed dicamba to rats for 90 days, no effects were observed at doses up to approximately 500 mg/kg/day. At doses near 1000 mg/kg/day, lower body weight gains, and changes in the liver's weight, color and size were noted.¹⁸
- A commercial product containing dicamba was fed to rats at concentrations up to 1% of the diet for three weeks. Dicamba was shown to be a peroxisome proliferator, which may increase the risk of hepatic tumors.¹⁹
- When researchers applied dicamba to the skin of rabbits at levels of 0, 40, 200 or 1000 mg/kg/day for 21 days, dose-dependent dermal irritation was observed at the site of application. No systemic toxicity was observed.²⁰

Humans

- No information was found concerning the chronic toxicity of dicamba in humans.

Endocrine Disruption:

- The U.S. EPA found no evidence of dicamba having endocrine disrupting effects.³
- No additional literature was found evaluating dicamba's potential activity as an endocrine disruptor.

Carcinogenicity:

Animals

- Male and female rats were fed dicamba for over two years at doses of 0, 50, 250 or 2500 ppm. There were no treatment-related effects observed on survival, body weight gain or food consumption. There was a slight increase in malignant lymphomas and thyroid parafollicular cell carcinomas in males. However, this was not significantly different from controls.¹⁸

Humans

- The U.S. EPA has determined that dicamba is not likely to be a human carcinogen.³
- In an epidemiological study examining the cancer rate among pesticide applicators reporting the use of dicamba, exposure was not associated with any significant increase in cancer incidence. Weak associations were observed for lung and colon cancer.²¹ 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.

Reproductive or Teratogenic Effects:

Animals

- Male and female rats were fed dicamba at 0, 500, 1500 and 5000 ppm in the diet in a two-generation reproduction study. At 5000 ppm, systemic toxicity was observed in both sexes. Decreased pup growth and delayed sexual maturity in males were observed at the two highest concentrations. Additionally, delayed sexual maturity was observed in male offspring. As a result, the reproductive toxicity NOEL was 500 ppm and the LOEL was 1500 ppm.²⁰ See the text box on **NOEL**, **NOEL**, **LOEL**, and **LOEL**.
- In a developmental toxicity study, pregnant female rats received oral daily doses of technical grade dicamba on day 6 through day 19 of gestation. Doses were 0, 64, 160 or 400 mg/kg. Maternal toxicity was observed only at the highest dose. Signs of neurotoxicity in survivors included ataxia, decreased motor activity, salivation and death. Examination of developing fetuses revealed no gross malformations; the developmental NOEL is greater than 400 mg/kg/day.²⁰
- Dicamba induced maternal toxicity in rats. Signs of toxicity included decreased weight gain and decreased food consumption. No treatment-related effects were observed in the fetuses. The maternal NOEL was 160 mg/kg/day and the fetal NOEL was established at greater than 400 mg/kg/day.²²
- When mouse embryos were exposed to dicamba at 0.030 µg/ml, dicamba significantly lowered the number and size of surviving embryos.²³
- Pregnant rabbits were exposed to dicamba in a two-generation teratology study and treatment-related effects include abortions, decreased food consumption and decreased weight gain. Developmental effects included irregular

NOEL: No Observable Adverse Effect Level

NOEL: No Observed Effect Level

LOEL: Lowest Observable Adverse Effect Level

LOEL: Lowest Observed Effect Level

ossification of nasal bones. The maternal NOAEL was 30 mg/kg/day and the maternal LOAEL was 150 mg/kg/day. The fetal developmental NOAEL was 150 mg/kg/day, with a LOAEL of 300 mg/kg/day.²²

Humans

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

Fate in the Body:

Absorption

- Skin absorption of dicamba is low.²⁴ When ingested, dicamba is absorbed and rapidly excreted in the urine.²⁵
- Dicamba and its 3,5-dichloro isomer were applied separately to shaved rats. Results indicated that 0.72 µg/ml dicamba was detected in blood one hour after administration and subsequently, levels rapidly declined. Results for dicamba's 3,5-dichloro isomer indicate the concentrations in blood increased for nine hours, then decreased slowly.²⁶
- Researchers fed adult Bengal goats a single dose of 1400 mg/kg DMA dicamba. Hematological results indicated that DMA dicamba reached maximum levels in the blood 15 minutes post administration with a concentration of 102.3 µg/mL. Two days after administration, DMA dicamba was not detected in the blood.²⁷

Distribution

- Rats were fed diets with radioactively labeled dicamba at concentrations ranging from 10 to 10,000 ppm. Dicamba was distributed in all tissues examined, including the liver, kidney, blood, muscle and fat. In general, aqueous tissues had higher residue than fatty tissues.²⁵
- A lactating cow was fed 60 ppm dicamba for five days (2.2 mg/kg/day). Results of tissue analysis indicated that the kidney is the major site of deposition for dicamba, followed by blood, then the liver. Among liver residues, 51% was unchanged dicamba.²⁴
- The distribution of DMA dicamba was examined in Bengal goats by examining the concentrations in various tissues following an oral dose of 1400 mg/kg. On day four following administration, 4-12 µg/g were recovered from skin, reticulum, muscle, heart, adrenal gland and spleen. By day seven, DMA dicamba was cleared from most tissues, leaving only trace amounts.²⁷

Metabolism

- Dicamba's metabolism in animals is limited. In mammals, o-demethylation and decarboxylation have been observed.²⁸ When dicamba was injected or fed to rats, over 90% of the dose was recovered in the urine unchanged. About 20% of recovered dicamba was conjugated with glucuronic acid.²⁵
- A lactating cow was fed 60 ppm dicamba for five days (2.2 mg/kg/day). Among liver residues, 51% was dicamba, and 21% was comprised of 3,6-dichloro-2-hydroxybenzoic acid (DCHBA) and two unidentified metabolites. In the kidney, 70% of the total deposited was dicamba, with 11% DCHBA. Most of the excreted product was unchanged dicamba. However, the major metabolite detected in the urine and feces was 3,6-dichloro-2-hydroxybenzoic acid (DCHBA), produced by the aryl-O-demethylation of the parent compound. The minor metabolites, 2,5-dichlorophenol and a glucuronide conjugate of DCHBA, were found in urine. DCHBA was the only metabolite detected in milk.²⁴

Excretion

- When dicamba was administered by either intubation or injection to Charles River rats, over 90% of the administered dose was excreted in the urine within 24 hours. When fed in the diet, the urinary excretion rate reached 96% in about 48 hours.²⁵
- Researchers dosed a lactating cow with 60 ppm dicamba (2.2 mg/kg/day) for five days and analyzed urine, feces and milk. Approximately 89% of the administered amount was excreted in the urine, less than 2% in the feces and approximately 0.02% in the milk.²⁴

- Dicamba and its 3,5-dichloro isomer were applied separately to shaved areas on the backs of male rats. The highest concentration of dicamba detected in urine occurred 12-24 hours following application and the highest concentration of the isomer was detected in urine 24-48 hours following application.²⁶
- Urinary analyses were conducted following the administration of a single, oral dose of 1400 mg/kg DMA dicamba to Bengal goats. Results indicated that at least five times the amount of DMA dicamba was excreted in the urine in the first 24 hours than during the second 24 hour period. Fecal excretion reached maximum levels in the 12-24 hour time period compared to any other time period and quickly declined.²⁷

Medical Tests and Monitoring:

- Researchers analyzed over 400 urine samples from the general population in the National Health and Nutritional Examination Survey II (NHANESII) for the presence of dicamba and it was not detected in any sample.²⁹
- In a national study of professional pesticide applicators following a pesticide application, 12- and 24 hour urine samples were analyzed by High Performance Liquid Chromatography/ Mass Spectrometry/Mass Spectrometry (HPLC/MS/MS). In approximately 50% of all samples, dicamba residues were below the limit of detection (1 ppb) and the maximum concentration detected in all samples was 4.8 ppb.³⁰

Environmental Fate:

Soil

- Microbial action promotes the degradation of dicamba in soil by a variety of processes, including O-demethylation, hydroxylation, and dechlorination.²⁸ The half-life of in soil ranges from 30-60 days in soil. See the text box on **Half-life**.
- The major decomposition product of dicamba in aerobic soil is 3,6-dichlorosalicylic acid (3,6-DCSA) and a minor decomposition product is 2,5-dihydroxy-3,6-dichlorosalicylic acid. The production of CO₂ is also associated with the degradation of dicamba.⁵
- The degradation of dicamba was examined in two forest-type soils and a grassland-type from Oklahoma. The half-life for dicamba in the two forest-types soils was 32 and 26 days, respectively, while the half-life in grassland soil was 17 days.³¹
- When tested on agricultural soil from the Midwest, the half-life of dicamba under aerobic conditions was 31 days and under anaerobic conditions, the half-life was 58 days. The major metabolite produced under both conditions was 3,6-dichlorosalicylic acid.³² In another study, almost no breakdown of ¹⁴C dicamba occurred in sterile soils after 9 weeks, suggesting the need for a microbial population capable of metabolizing dicamba.³³
- The effect of water content on the soil sorption characteristics of dicamba was examined. Generally, dicamba's soil sorption coefficient increased substantially with an increase in initial water content. Soil sorption coefficients ranges from 0.0 to 0.8. Thus, dicamba is expected to be highly mobile in soils.³⁴

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.

Water

- Dicamba is not significantly broken down by water or light.²⁸
- After 133 days in nonsterile water, 41% of dicamba dissipated when exposed to ultraviolet light.³⁰ In darkness for the same time period, 16% and 5% of dicamba dissipated in nonsterile and sterile water, respectively. These results suggest that microbial metabolism significantly affects the dissipation of dicamba in water and UV light may increase dissipation.³⁵

- The U.S. EPA monitored samples from 68,824 wells in 45 states from 1971 to 1991. Dicamba was detected in 3,172 wells in 24 states.³⁶ The U.S. Geological Survey (USGS) also monitored ground water at 2,305 sites in the U.S. from 1992-1996; dicamba was detected in 0.13% of sites and the highest concentration detected was 0.21 µg/L.³⁷
- The dissipation of DMA dicamba from water was examined from two ponds in Texas following the application of 4.3-4.5 kg/ha of pond surface area. One pond had many plants and the second had none. Dissipation was complete after about 40 days. Loss of dicamba was the most rapid in the first week following treatment and vegetation had no effect on the rate of dissipation.³⁵

Air

- Dicamba has volatilized under field conditions and injured non-target crops. In growth chamber experiments, the acid form was most volatile, and the inorganic salts were least volatile. In field experiments with the less volatile forms of dicamba, potted soybeans showed symptoms of injury when exposed to the vapors of treated corn up to 60 meters away.³⁸
- Weekly air samples were taken from an agricultural region of Quebec, Canada from May to June, 2004. The majority of samples (88%) contained dicamba with an average concentration of 171 pg/m³. From July to September, one third of samples contained dicamba at an average concentration of 9 pg/m³.³⁹

Plants

- Dicamba is readily taken up by the roots and foliage of plants and translocated throughout all plant tissues. The rate of absorption and distribution within the plant depends upon the plant species.⁴⁰
- Dicamba may be absorbed by foliage or roots in aqueous form, as a vapor or from treated soil. Foliar uptake of dicamba from treated soil appears to be limited.^{38,41,42}
- After dicamba is absorbed by roots or leaves, metabolism is negligible.²⁸
- Dicamba tended to accumulate in the young, actively growing leaves in Tartary buckwheat and wild mustard. In barley and wheat, dicamba was more evenly distributed throughout the plant. Tartary buckwheat and wild mustard absorbed dicamba through leaves much faster than barley and wheat.⁴¹

Indoor

- Dicamba has been found in the dust of New York farmer's homes in the range from 0 to 2.7 µg/m².⁴³ Dicamba has also been detected in almost 29% of house dust samples taken from homes near crop fields in Iowa. The average concentration of dicamba in those dust samples was 30.1 ng/g.⁴⁴
- No information was found about the breakdown or metabolism of dicamba indoors.

Food Residue

- In 2008, the United States Department of Agriculture's (USDA) Pesticide Data Program examined 744 samples of potatoes, 744 samples of spinach and 439 samples of strawberries for the presence of dicamba. Residues were not detected in any sample. Dicamba was detected at 94 ppt in one of 189 treated water samples. In two of 189 untreated water samples, dicamba was detected at concentrations of 50 and 91 ppt.⁴⁵
- In 2009, the USDA's Pesticide Data Program examined 534 samples of grapes and 534 samples of strawberries for the presence of dicamba. Residues were not detected in any sample. Additionally, dicamba was not detected in 238 drinking water samples, half of which were untreated.⁴⁶
- The United States Food and Drug Administration (FDA) market basket study examined over 400 foods for pesticide residues including dicamba. Dicamba was found in 23 of 44 oat ring breakfast cereal samples with an average concentration of 0.004 ppm.⁴⁷

Ecotoxicity Studies:

Birds

- Dicamba is slightly to moderately toxic to birds in the acid form. Based on feeding studies dicamba salts are practically non-toxic to birds.
- The acute oral LD₅₀ of technical grade dicamba with 87% active ingredient to the northern bobwhite (*Colinus virginianus*) is 216 mg/kg.¹⁷
- In an 8-day dietary study involving 14-day old mallard ducks (*Anas platyrhynchos*), researchers determined that dicamba's 8-day LC₅₀ was greater than 10,000 mg/kg and no effects were observed at concentrations below 4640 mg/kg.⁴⁸
- In a 14-day oral gavage experiment with mallard ducks, dicamba was slightly toxic, with an LD₅₀ of 1373 mg ae/kg (acid equivalent).⁴⁹ Another researcher conducted the same study with DMA dicamba. It was practically non-toxic to mallard ducks; the oral LD₅₀ was greater than 2452 ppm.⁵⁰
- In a 14-day oral gavage study with northern bobwhite quail, dicamba's LD₅₀ was 188 mg/kg. In similar studies with bobwhite quail using the potassium and diglycoamine salts of dicamba, the LD₅₀ values were 618 mg/kg⁵¹ and 262 mg/kg, respectively.⁵²

Fish and Aquatic Life

- Dicamba is slightly toxic to fish and aquatic invertebrates, based on the following acute toxicity studies using various forms of dicamba.³
- Dicamba's 96-hr LC₅₀ for cutthroat trout (*Oncorhynchus clarkii*) was greater than 50 mg/L.^{53,54,55} Using the sodium salt of dicamba with the rainbow trout (*Oncorhynchus mykiss*) and bluegill sunfish, the 96-hour acute LC₅₀s were 507 mg ae/L and 642 mg ae/L, respectively.^{56,57} When the potassium salt of dicamba was tested on bluegill sunfish, the 96-hour LC₅₀ was 196 mg ae/L.⁵⁸
- Immature coho salmon (*Oncorhynchus kisutch*) were more sensitive to dicamba, with reported 24- and 48-hour LC₅₀ values of 151 and 120 ppm, respectively.⁵⁹
- Forty-eight hour LC₅₀s have been established for daphnia using DMA dicamba, the sodium salt of dicamba, the potassium salt of dicamba and the diglycoamine (DGA) salt of dicamba. They were 1563 mg ae/L, 34.6 mg ae/L, 639.8 mg ae/L and greater than 270.8 mg ae/L, respectively.^{60,61,62,63}
- Calculated 48-hours TL₅₀s (median tolerance limit to 50% of the population) for dicamba were greater than 100 mg/L for waterfleas (*Daphnia magna*), seed shrimp (*Cypridopsis vidua*), scud (*Gammarus fasciatus*), sowbug (*Asellus brevicaudus*), glass shrimp (*Palaemonetes kadiakensis*) and crayfish (*Orconectes nais*).⁶⁴
- Researchers established TL₅₀s for dicamba to two species of 1-week old tadpoles. For *Adelotus brevis*, the 24-, 48- and 96-hour TL₅₀s were 220, 202, and 185 ppm, respectively. For *Limnodynasters peroni*, the 24-, 48- and 96-hour TL₅₀s were 205, 166 and 106 ppm, respectively.⁶⁵
- Dicamba's ability to affect the growth of 17 strains of algae (*Chlorophyceae*) was examined *in vitro*. Only one strain displayed a response to dicamba. When exposed to dicamba at a concentration of 0.1 to 0.5 ppm, the growth of *Hormidium barlowi* was inhibited by 12 percent.⁶⁶

Terrestrial Invertebrates

- Dicamba's toxicity to honey bees ranges from moderately toxic to practically non-toxic, based on U.S. EPA values.⁶⁷
- When researchers fed dicamba to newly emerged honey bees (*Apis mellifera*) at concentrations up to 1000 ppm, no significant difference in survival was observed.⁶⁸ The acute contact 48-hour LD₅₀ for dicamba to honey bees was greater than 90.65 µg/bee and the acute oral LD₅₀ was 3.6 µg/bee.⁶⁹

- Researchers evaluated the toxicity of dicamba to worker honey bees when exposed to dicamba on contact or by ingestion. Less than half of the bees died at all doses tested. The contact LD₅₀ was greater than 100 µg/bee and the oral LD₅₀ was greater than 10 µg/bee.⁷⁰

Regulatory Guidelines:

- Dicamba is classified by the U.S. EPA as not likely to be carcinogenic to humans.³ See the text box on **Cancer** (page 4).
- The U.S. EPA has set the oral reference dose (RfD) for dicamba at 0.5 mg/kg/day.⁷¹ See the text box on **Reference Dose (RfD)**.
- The drinking water equivalent level (DWEL) is a lifetime exposure concentration that is expected to be protective of adverse, non-cancer health effects, that assumes all of the exposure to a contaminant is from drinking water. For dicamba, the DWEL is 18 mg/L. The lifetime health advisory is defined similarly to the DWEL, except it does not assume a single source of lifetime exposure. The lifetime health advisory level for dicamba in drinking water is 4 mg/L.⁷¹
- The World Health Organization has set an acceptable daily intake and an acute RfD for dicamba and they are 0.3 mg/kg and 0.5 mg/kg, respectively.⁷²

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, Technology Transfer Network, Air Toxics Health Effects Glossary, 2009. <http://www.epa.gov/ttnatw01/hlthef/hapgglossaryrev.html#RfD>

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