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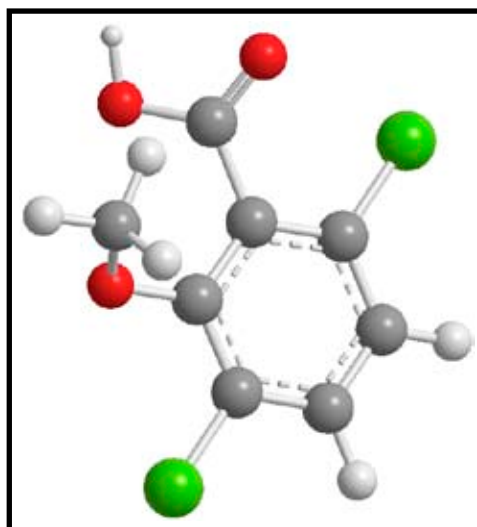
Some of the information in the following fact sheet (scroll down) is out-of-date. NPIC is planning to update this fact sheet in the future. In the meantime, updated information is available on the [US EPA's website](#).

Some of the information in the following fact sheet (scroll down) is out-of-date. NPIC has started a *NEW* set of fact sheets. If you would like to be notified when NPIC releases new publications, send an email to npicupdates@ace.orst.edu with "subscribe" in the subject line.

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Please call NPIC with any questions you have about pesticides at **1-800-858-PEST (7378)**.

Molecular Structure - Dicamba



NPIC Technical Fact Sheets are designed to provide information that is technical in nature for individuals with a scientific background or familiarity with the regulation of pesticides by the U.S. Environmental Protection Agency (U.S. EPA). This document is intended to be helpful to professionals and to the general public for making decisions about pesticide use.

National
Pesticide
Information
Center

Dicamba

(Technical Fact Sheet)

For less technical information, please refer to the General Fact Sheet.

The Pesticide Label: Labels provide directions for the proper use of a pesticide product. *Be sure to read the entire label before using any product.* A signal word on each product label indicates the product's potential hazard.

CAUTION - low toxicity

WARNING - moderate toxicity

DANGER - high toxicity

What is dicamba?

- Dicamba is an herbicide first registered in the United States in 1967 (1).
- Dicamba is selective. Users apply it pre- or post-emergence to control broadleaf weeds (1, 2). See the **Herbicide Selectivity** box.
- Manufacturers use different formulations of dicamba (acid and salt) in their products. Its salts include isopropylamine, diglycoamine, dimethylamine, potassium, and sodium (3). Use of the term “dicamba” in this fact sheet refers to the acid and/or salts.
- Dicamba belongs to the benzoic chemical family and is a crystalline solid that ranges in color from white to brown (2). It is water soluble (6.5 g/L @ 25 °C) and stable to oxidation and hydrolysis under ambient conditions (4). Dicamba has a low volatility (9.24 x 10⁻⁶ mm Hg @ 25 °C) (2).
- Signal words for products containing dicamba range from Caution to Danger (3). The signal word reflects the combined toxicity of dicamba and other ingredients in each product. See the **Pesticide Label** box above.
- Dicamba products are used on a variety of sites including food and non-food crops, pastures, rangeland, forests, right of ways, and lawns (1). Commercial formulations of the herbicide include granules, wettable powders, pressurized liquids, emulsions, solutions, and dusts (3).
- Herbicide products containing dicamba frequently contain other active ingredients such as 2,4-D, mecoprop (MCP), and/or MCPA (3). Dicamba affects plants in a manner similar to these active ingredients.

Herbicide Selectivity: Selective herbicides kill some plant species and not others. Resistant plants can survive by detoxifying the herbicide or not absorbing it. Often, a crop plant will be more tolerant of an herbicide than the weeds around it. This is the case for dicamba where the grass crop (bermudagrass, wheat, etc.) survives and broadleaf plants (dandelion, thistles, etc.) die.

What is the mode of action of dicamba?

- Dicamba mimics naturally-occurring plant growth hormones called auxins. It kills plants by destroying tissue through uncontrolled cell division and growth (2).
- Dicamba affects cell wall integrity and nucleic acid metabolism. It increases cell wall permeability, leading to cell enlargement. At low concentrations, dicamba increases synthesis of DNA, RNA, and proteins, resulting in altered cell division and growth. At high concentrations, inhibition of cell division and growth occur (2).
- Plant symptoms from dicamba exposure include leaf cupping and stem curling, swelling, and lengthening. These symptoms are followed by yellowing or bleaching of plant tissues, wilting, inhibited growth, and death (2).
- Dicamba uptake occurs by both the roots, stems, and foliage (2, 5). The chemical translocates to all plants tissues but accumulates in growing tissues (2, 5). Plants tolerant to dicamba typically translocate the chemical slowly relative to susceptible plants (2).

What are some products that contain dicamba?

- BANVEL®
- COOL POWER®
- HORSEPOWER™
- MILLENNIUM ULTRA™
- TRIMEC®
- TRIPLET®
- TRI-POWER®
- WEED AWAY®

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

How toxic is dicamba?

Animals

- Dicamba is low in toxicity when ingested. The acute oral LD50 in rats is >2740 mg/kg (6). See boxes on **Laboratory Testing**, **LD50/LC50**, and **Toxicity Category**.
- In a 13-week oral study, investigators exposed male and female mice to dicamba at approximate doses of 0, 500, 1000, 1250, or 1500 mg/kg/day. At doses of 1000 mg/kg/day and higher, they noted altered liver cells and lower body weights and reduced food consumption. The NOAEL was 500 mg/kg/day (6).
- Researchers fed dogs dicamba for 1 year at doses of 0, 2, 11, or 52 mg/kg/day. The dogs exhibited no adverse effects, and the NOAEL was 52 mg/kg/day (6).
- When applied to the skin, dicamba is low in toxicity. The acute dermal LD50 in rabbits is >2000 mg/kg. The U.S. EPA categorizes dicamba as moderately toxic for skin irritation (6). In studies with guinea pigs, dicamba did not cause skin sensitization (6).
- In a 21-day dermal study, laboratory workers exposed the skin of rabbits to dicamba. Workers applied dicamba at doses of 0, 40, 200, or 1000 mg/kg/day for 6 hours/day for 3 weeks. They noted no systemic toxicity. Workers observed dose-related skin irritation. The no observable adverse effect level (NOAEL) for dermal irritation was 40 mg/kg/day (6).

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 fed 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. When pesticide products are used according to the label directions, toxic effects are not likely to occur because the amount of pesticide that people and pets may be exposed to is low compared to the doses fed to laboratory animals.

- Dicamba caused low to moderate eye irritation in rabbits. The U.S. EPA categorizes dicamba as moderately toxic for eye irritation (6).
- Dicamba is very low in toxicity when inhaled. The acute inhalation LC50 in rats is >5.3 mg/L (6).
- Researchers performed an acute neurotoxicity study in rats by administering dicamba by gavage (stomach tube) at doses of 0, 300, 600, or 1200 mg/kg. At all doses, they detected neurological effects such as decreased locomotor activity and impaired gait, righting reflex, and startle response. The majority of neurological effects at the two lowest doses (300 and 600 mg/kg) occurred on the day of dosing and then reversed (6).
- Scientists conducted a subchronic neurotoxicity study by feeding rats dicamba for 13 weeks (males: 0, 197, 401, or 768 mg/kg/day; females: 0, 253, 472, or 1029 mg/kg/day). The NOAEL was 401 mg/kg/day for males and 472 mg/kg/day for females. At the highest doses, they noted rigid body tone and impaired walking and balance (6).

Humans

- Signs and symptoms reported from dicamba exposure include appetite loss, weight loss, vomiting, depression, and weakness (8).
- Dicamba can cause irritation to the skin and respiratory tract and may cause burns to the skin and eyes (8, 9).

Toxicity Category (Signal Word) (7)

	High Toxicity (Danger)	Moderate Toxicity (Warning)	Low Toxicity (Caution)	Very Low Toxicity (Caution)
Oral LD50	Less than 50 mg/kg	50 - 500 mg/kg	500 - 5000 mg/kg	Greater than 5000 mg/kg
Dermal LD50	Less than 200 mg/kg	200 - 2000 mg/kg	2000 - 5000 mg/kg	Greater than 5000 mg/kg
Inhalation LC50	Less than 0.05 mg/l	0.05 - 0.5 mg/l	0.5 - 2 mg/l	Greater than 2 mg/l
Eye Effects	Corrosive	Irritation persisting for 7 days	Irritation reversible within 7 days	Minimal effects, gone within 24 hrs
Skin Effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation

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.

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amba metabolized and eliminated from the body?

Animals

- Researchers injected rats with dicamba at a dose of 100 mg/kg and noted a biological half-life of 0.64 hours (8). See box on **Half-life**.
- Investigators concluded that rats orally exposed to dicamba excreted over 95% of the chemical in urine and did not

appreciably metabolize or accumulate dicamba (6).

- Scientists orally treated a lactating cow with dicamba for 5 days at a dose of 2.2 mg/kg/day. The cow eliminated in the urine approximately 89% of the administered chemical within 6 hours after the final dose. The animal excreted only minor amounts in the feces (<2%) and milk (0.02%). Scientists detected unchanged dicamba as the major (80%) elimination product (10).

Humans

- Investigators evaluated a woman who intentionally ingested a mixture of dicamba and 2,4-D. Investigators determined a biological half-life of approximately 15 hours for dicamba (11).

Half-life is the time required for half of the compound to degrade.

1 half-life	= 50% degraded
2 half-lives	= 75% degraded
3 half-lives	= 88% degraded
4 half-lives	= 94% degraded
5 half-lives	= 97% degraded

Remember that the amount of chemical remaining after a half-life will always depend on the amount of the chemical originally applied.

Does dicamba cause reproductive or teratogenic effects?

Animals

- In a two-generation study, laboratory workers fed rats dicamba in the diet (males (M): 0, 40, 122, or 419 mg/kg/day; females (F): 0, 45, 136, or 450 mg/kg/day). They noted systemic toxicity at the highest dose (males: 419/females: 450 mg/kg/day) manifested as liver effects and clinical signs of rigid body tone and impaired balance. Workers observed reproductive effects at the two highest doses. These effects included decreased progeny growth and delayed sexual maturation in male offspring (high dose only). The systemic NOAEL was the intermediate dose (males: 122/females: 136 mg/kg/day) and the reproductive NOAEL was the lowest dose (6).
- Researchers orally exposed pregnant rats to dicamba on gestation days 6-19 at doses of 0, 64, 160, or 400 mg/kg/day. No developmental effects occurred at the doses tested. At the highest dose (400 mg/kg/day), they detected effects to the mothers that included increased mortality, signs of neurotoxicity, lower body weight gains, and decreased food consumption. The NOAELs for maternal and developmental toxicity are 160 and 400 mg/kg/day, respectively (6).
- In a developmental study, scientists orally exposed pregnant rabbits to dicamba on gestation days 6-18 at doses of 0, 30, 150, or 300 mg/kg/day. At the two highest doses (150 and 300 mg/kg/day), mother rabbits had abortions and clinical signs of muscle incoordination, decreased activity, and abnormal respiratory sounds. No maternal effects occurred at 30 mg/kg/day (6).

Humans

- Data are not available from occupational exposures, accidental poisonings, or epidemiological studies regarding the reproductive and developmental toxicity of dicamba.

Is dicamba a carcinogen?

Animals

- Laboratory workers fed rats diets containing dicamba for 2 years (approximately 0, 2.5, 12.5, or 125 mg/kg/day). Workers noted no clinical signs of toxicity or carcinogenicity (6).
- In a carcinogenicity study, researchers fed male and female mice dicamba at doses of 0, 6, 18, 115, or 361 mg/kg/day for 2 years. They noted no evidence of carcinogenicity. Researchers did detect increased mortalities in males and decreased weight gain in females at the highest dose (361 mg/kg/day). The NOAEL is 115 mg/kg/day (6).
- Researchers often use studies designed to test for mutagenicity to screen chemicals for carcinogenicity. Scientists report

Cancer: The U.S. EPA has strict guidelines that require testing of pesticides for their potential to cause cancer. These studies involve feeding laboratory animals large *daily* doses of the pesticide over most of the lifetime of the animal. Based on these tests, and any other available information, EPA gives the pesticide a rating for its potential to cause cancer in humans. For example, if a pesticide does not cause cancer in animal tests at large doses, then the EPA considers it unlikely the pesticide will cause cancer in humans. Cancer tests are not conducted on human subjects.

positive and negative mutagenicity results for dicamba, depending on the assay utilized (6, 12-14).

Humans

- The U.S. EPA currently classifies dicamba as a group D carcinogen (15). This classification denotes that dicamba is not classifiable as to human carcinogenicity (15). See box on **Cancer**.

What is the environmental fate and behavior of dicamba?

- Dicamba is stable to oxidation and hydrolysis under ambient conditions (4). It is somewhat susceptible to photolysis in aqueous systems but not on the surface of or in soil (2, 8).
- The half-life of dicamba in soils ranges from 4-555 days with a typical half-life of 14-28 days (5, 16). Microbial degradation is the most probable route of degradation (16).
- Dicamba poorly adsorbs to soil, and its high soil mobility contributes to a significant leaching potential (5, 16). Researchers have detected dicamba in ground water (5).
- Microbial degradation appears to be the major degradation route for dicamba in water (16). Dicamba is not likely to volatilize significantly from aquatic systems (5). In a field study, dicamba had a half-life of <7 days in surface water (5).
- Dicamba may adversely affect nontarget plants (5). In soil, it may remain active for 3 to 12 weeks (2). Dicamba has an average foliar half-life of 9 days (17).

What effects does dicamba have on wildlife?

- Dicamba is slightly to practically nontoxic to fish (LC50 = 135 to >1000 mg/L) and practically non-toxic to aquatic invertebrates (LC50 >100 mg/L) (1). Dicamba is unlikely to bioaccumulate (5, 16).
- Dicamba is practically nontoxic to birds (LD50 >2510 mg/kg) (1, 18).
- Dicamba is low in toxicity to bees both orally (LD50 = 3.6 to >10 µg/bee) and by contact (LD50 >100 µg/bee) (19).

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