



Bromoxynil

Roadside Vegetation Management Herbicide Fact Sheet



This fact sheet was developed by Oregon State University and Intertox, Inc. to assist interested parties in understanding the risks associated with pesticide use in Washington State Department of Transportation's (WSDOT) Integrated Vegetation Management program. WSDOT updated in 2017 to reflect current products and usage.

Introduction

Bromoxynil is a nitrile herbicide used for post-emergent control of annual broadleaf weeds. Bromoxynil is toxic to plants by inhibiting photosynthesis. Bromoxynil octanoate ester is the only active ingredient (33.4%) in the herbicides **Brox 2EC** and **Maestro 2EC**. According to the product labels, they also contain 66.6% other ingredients, which include xylene/range petroleum distillates. The Washington State Department of Transportation (WSDOT) uses this product for selective nuisance and noxious annual broadleaf weed control. Bromoxynil also has agricultural and urban uses.

WSDOT assessed the potential risks to human, wildlife, and aquatic animals exposed to bromoxynil in their Integrated Vegetation Management (IVM) program. Evaluating potential risks takes into account both the toxicity of a pesticide and the characteristics of possible exposure.

WSDOT Application Rates and Use Patterns on Highway Rights-of-Way

A typical rights-of-way application rate for **Brox 2EC** and **Maestro 2EC** is 16 – 32 ounces—or a maximum of about 0.5 pounds of the active ingredient bromoxynil—per acre. Applicators use truck-mounted hand-guns, hose reels, or backpack sprayers to make single applications from May to June. Most applications are directed onto individual target plants. In some cases, when applied over wide-spread infestations, applications may be made through truck- or tractor-mounted booms. WSDOT workers applied about 78 ounces of bromoxynil statewide during 2016.

Laboratory Testing: Before pesticides are registered by the U.S. Environmental Protection Agency (EPA), they must undergo laboratory testing for short-term (acute) and long-term (chronic) health effects. Laboratory animals are purposely fed doses high enough to cause toxic effects. These tests help scientists determine how chemicals might affect humans, domestic animals, or wildlife in cases of overexposure. Pesticide products used according to label directions are unlikely to cause toxic effects. The amount of pesticide that people and pets may be exposed to is low compared to the doses fed to laboratory animals.

Human Health Effects

The U.S. Environmental Protection Agency (EPA) classifies **bromoxynil** as category II (Moderate Toxicity) with a signal word of WARNING (see "Toxicity Category and Signal Word" table).

Reproductive effects: Studies have shown that bromoxynil and the product Buctril fed to rats or applied to their skin during pregnancy can lead to developmental effects in offspring at the higher doses tested. When bromoxynil was applied to the skin of male rats at high doses, there was no effect on fertility or mating.

Carcinogenic effects: In cancer studies with rats, increases in the number of tumors have been observed, especially in males. Studies have shown that bromoxynil is not a mutagen. U.S. EPA considers bromoxynil to be a possible human carcinogen.

Toxicity Category and Signal Word

	High Toxicity (<i>Danger</i>)	Moderate Toxicity (<i>Warning</i>)	Low Toxicity (<i>Caution</i>)	Very Low Toxicity (<i>Caution</i>)
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	0.5-2.0 mg/l	Greater than 2.0 mg/l
Eye Effects	Corrosive	Irritation persisting for 7 days	Irritation reversible in 7 days	Minimal effects, gone in 24 hrs
Skin Effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation

Note: Highlighted categories specify the range for bromoxynil cited in this fact sheet.

Fate in humans and animals: Rats excrete bromoxynil octanoate in urine and feces as the phenol metabolite, with 75-90% cleared in 7 days. Bromoxynil octanoate does not bioaccumulate (build up) in mammals.

Wildlife and Aquatic Effects

Effects on mammals: Bromoxynil is classified by U.S. EPA as moderately toxic to small mammals based on results from acute oral studies with rats. Bromoxynil octanoate exposure resulted in an acute oral LD50 of 238 mg/kg for female rats and 400 mg/kg for male rats (see “LD50/LC50” text box and “Wildlife Toxicity Category” table).

Effects on birds: Bromoxynil is considered slightly to moderately toxic to birds based on acute toxicity studies. Acute oral LD50 values of 148 mg/kg and 193 mg/kg were reported for bobwhite quails exposed to bromoxynil octanoate and bromoxynil phenol, respectively. An LD50 of 359 mg/kg was reported for bobwhite quails exposed to bromoxynil heptanoate. The LD50 for mallard ducks exposed to bromoxynil octanoate was 2050 mg/kg.

Effects on fish: Acute toxicity studies indicate that bromoxynil octanoate is highly toxic to very highly toxic to freshwater fish species tested. In rainbow trout, an LC50 of 0.05 mg/L was reported following exposure to 36.6% bromoxynil octanoate. Exposure to 87.3% Bromoxynil octanoate produced an LC50 of 0.1 mg/L in rainbow trout. An LC50 of 0.053 mg/L was reported for bluegill sunfish exposed to 87.3% bromoxynil octanoate.

Wildlife Toxicity Category			
Risk Category	Mammals	Birds	Fish or Aquatic Insects
	Acute Oral or Dermal LD ₅₀ (mg/kg)	Acute Oral LD ₅₀ (mg/kg)	Acute LC ₅₀ (mg/L)
Practically nontoxic	>2,000	>2,000	>100
Slightly toxic	501-2,000	501-2,000	>10-100
Moderately toxic	51-500	51-500	>1-10
Highly toxic	10-50	10-50	0.1-1
Very highly toxic	<10	<10	<0.1

Highlighted categories specify the range for bromoxynil cited in this fact sheet. The toxicity of bromoxynil to wildlife receptors is species dependent.

Effects on aquatic insects: Bromoxynil octanoate was very highly toxic to freshwater invertebrates based on acute toxicity tests. Exposure of the “water flea” *Daphnia magna* to 87.3% bromoxynil octanoate resulted in an EC50 value of 0.096 mg/L. In *Daphnia pulex* exposed to 36.6% bromoxynil octanoate, an EC50 value of 0.011 mg/L was reported.

Environmental Fate

A typical half-life for bromoxynil in soils is 7 days (see “Half-life” text box). Microbes and sunlight break down bromoxynil in the environment. Bromoxynil’s potential to leach to groundwater is low; surface runoff potential is

low, and potential for loss on eroded soil is intermediate. Bromoxynil has moderate volatility and the potential for loss to the atmosphere is moderate. Bromoxynil is adsorbed through the leaves with limited translocation (moved throughout) to other plant parts.

Human Health Risk Assessment

WSDOT evaluated several human exposure scenarios, including workers applying herbicides and the public (adults and children) picking and eating drift-contaminated berries, eating drift-contaminated garden vegetables, and walking through sprayed vegetation. For each exposure scenario, WSDOT evaluated conditions of average exposure and extremely conservative conditions of maximum exposure (see “Human Cancer/Non-cancer Risk Classification” text box and “Human Risk Classification for Average Exposure Scenarios” table).

Bromoxynil is expected to pose negligible potential risks of adverse non-cancer effects to WSDOT workers and the public under conditions of average exposure. All hazard quotients are below 1. Under conditions of maximum exposure, Bromoxynil poses a low potential risk of adverse non-cancer effects to workers engaged in broadcast hydraulic spray operations and children eating drift-contaminated garden vegetables; the HQs are 1.1 and 1.2, respectively. The estimated potential risk to workers engaged in directed foliar applications and the public in all other exposure scenarios is negligible.

Bromoxynil is expected to pose negligible potential risks of cancer effects to WSDOT workers and the public under conditions of average exposure based on a cancer risk level of concern of 1×10^{-5} (1 in 100,000). Under conditions of maximum exposure, Bromoxynil poses a low potential risk of cancer to workers engaged in broadcast hydraulic spray operations and children eating drift-contaminated garden vegetables; the estimated upper bound risks are 2.9×10^{-5} and 6.2×10^{-5} , respectively. The estimated potential cancer risk to workers engaged in directed foliar applications and the public in all other exposure scenarios is negligible.

Wildlife Risk Assessment

Wildlife risk assessment considers herbicide behavior in the environment and routes of exposure. Indirect exposure to mammals and birds can occur when they eat contaminated prey or vegetation. Direct exposure can occur when mammals and birds contact herbicide residues with their skin or eyes or when they inhale

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

Human Cancer/Non-cancer Risk Classification: Scientists estimate non-cancer health risks by generating a hazard quotient (HQ). This number is the exposure divided by the toxicity. When the HQ is less than 1, exposures are unlikely to cause any adverse health effects. When the HQ is greater than 1, the potential for non-cancer health effects should be considered. Risk assessments for chemicals that cause cancer (carcinogens) estimate the probability of an individual developing cancer over a lifetime. Cancer risks estimated in this way are very conservative, and actual cancer risks are likely to be much lower. Cancer risk estimates of less than 1 in 100,000 are within the range considered negligible by most regulatory

Hazard Quotient (Non-cancer Risk)	Cancer Risk	Potential Risks and Management Priority
Less than 1	Less than 1 in 100,000	Negligible
Between 1 and 10	Between 1 in 10,000 and 1 in 100,000	Low
Between 10 and 100	Between 4 in 1,000 and 1 in 10,000	Moderate
Greater than 100	Greater than 4 in 1,000	High

Note: Highlighted categories specify the range of potential risk for specific exposure scenarios involving bromoxynil.

vapors or particulates. WSDOT's current application rates and use patterns for bromoxynil are expected to pose an insignificant risk to mammals. Estimated dietary doses for rats, mice, and meadow voles are approximately 340, 40, and 52-fold lower, respectively, than the acute dietary LD50 for bromoxynil. The estimated, acute dietary exposures of bromoxynil to quail, marsh wren, and American robin based on maximum label application rates would be 134, 15, and 12-fold lower, respectively, than the acute dietary LD50 for bobwhite quail. These estimated dietary exposures are considered a low risk to quail and a moderate risk to wren and robin.

Aquatic Risk Assessment

WSDOT takes extra precautions applying herbicides near open water, wetlands, and wellhead protection zones. However, contamination may result from application drift, rainfall runoff, or residue leaching through the soil into groundwater. Fish and aquatic insect exposure to bromoxynil occurs primarily through direct contact with contaminated surface waters or sediment. Bromoxynil is not expected to persist in surface waters or to bioaccumulate (build up) in fish. The relative risks to fish due to WSDOT's current application rates and use patterns for bromoxynil are expected to be slight in the Columbia Plateau and Blue Mountain provinces and moderate in all other physiographic provinces of the state. The relative risks to aquatic invertebrates from application of Bromoxynil are expected to be slight in all physiographic provinces of the state.

Additional Resources

- National Pesticide Information Center 1-800-858-PEST (7378) and <http://npic.orst.edu>
- Washington State Department of Transportation, Roadside Maintenance Branch 1-360-705-7865
- Washington Department of Agriculture, Pesticide Management Division 1-877-301-4555 (toll free)