Washington State Department of Transportation

Flumioxazin

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

Flumioxazin is an N-phenylphthalimide herbicide used to control selected grass and broadleaf weeds. Flumioxazin is a light-dependent peroxidizing herbicide (LDPH), which acts by blocking heme and chlorophyll biosynthesis resulting in the accumulation of photo-toxic porphyrins. Flumioxazin is the only active ingredient (51%) in the herbicide **Payload**. According to the product label, **Payload** also contains 49% other ingredients (unspecified). The Washington State Department of Transportation (WSDOT) has tested this product in some areas for grass and broadleaf weed control. WSDOT is considering its future use for total vegetation control.

WSDOT assessed the potential risks to human, wildlife, and aquatic animals exposed to flumioxazin 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.

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.

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

A typical rights-of-way application rate for **Payload** is 0.5 pounds of product—or 0.25 pounds of the active ingredient flumioxazin—per acre, with a maximum application rate of 0.38 pounds flumioxazin per acre. This product is used in maintenance of a bare ground strip at the edge of pavement. **Payload** is applied through truck-mounted booms placed 18" above the ground to make one application in the spring. WSDOT began using this product on a trial basis in 2004. In testing this product, WSDOT workers applied about 245 pounds of flumioxazin statewide during 2016.

Human Health Effects

The U.S. Environmental Protection Agency (EPA) classifies **Payload** as category III (Low Toxicity) with a signal word of CAUTION because it causes moderate eye irritation and is harmful if inhaled or absorbed through the skin (see "Toxicity Category and Signal Word" table).

Acute toxicity: Flumioxazin has low toxicity if residues get on the skin of individuals, and very low toxicity if eaten or inhaled. Flumioxazin was mildly irritating to the eyes of rabbits and neither irritating to rabbits nor sensitizing to guinea pigs when applied to skin.

Chronic toxicity: Mice fed flumioxazin for 18 months showed no evidence of toxicity at high doses. A 2-year study in rats fed flumioxazin in moderate doses resulted in kidney and blood abnormalities. Beagle dogs in a one year feeding study had changes in blood chemistry and increased liver weights at high doses of flumioxazin.

Toxicity Category and Signal Word

	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	0.5-2.0 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 flumioxazin cited in this fact sheet.

Reproductive effects: Developmental toxicity was seen in rat pups in a reproduction study at doses that were not toxic to the parents. No developmental toxicity was observed in rabbits. U.S. EPA considers the rat to be a conservative surrogate species for the potential for developmental toxicity in man.

Carcinogenic effects: Mice fed flumioxazin for 18 months showed no evidence of carcinogencity. U.S. EPA considers flumioxazin as not likely to be a carcinogen.

Fate in humans and animals: Rats excrete flumioxazin in urine and feces, with 97% cleared in 7 days. Flumioxazin does not bioaccumulate (build up) in mammals.

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

Wildlife and Aquatic Effects

Effects on mammals: Acute toxicity studies conducted with flumioxazin have found the product to be practically non-toxic to rats both by the oral and dermal routes. An LD50 of >5,000 mg/kg was reported for rats exposed to technical grade Flumioxazin in an acute oral exposure study. Via the dermal route, an LD50 of >2,000 mg/kg was reported for rats. An LD50 of 3,930 mg/m^3 (377 ppm) was reported for rats exposed to flumioxazin via inhalation.

Effects on birds: Flumioxazan is practically non-toxic to avian species according to studies conducted by the manufacturer. Acute oral LD50 values for bobwhite quail were >2,250 mg/kg. A dietary LD50 of >5,620 ppm was reported for the mallard duck.

Effects on fish: Flumioxazin is considered slightly to moderately toxic to fish based on 96-hour acute toxicity studies. In rainbow trout, an LC50 of 2.3 mg/L was reported; the LD50 for bluegill sunfish was >21 mg/L.

Effects on aquatic insects: Flumioxazin is considered moderately toxic to freshwater invertebrates and moderately to highly toxic to estuarine

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 flumioxazin cited in this fact sheet. The toxicity of flumioxazin to wildlife receptors varies by species.

invertebrates. Acute toxicity studies in *Daphnia pulex* resulted in a 48-hour EC50 of 5.5 mg/L. Exposure of *Daphnia magna* under the same conditions also resulted in an EC50 of 5.5 mg/L. Mysid shrimp exposed in a 96-hour toxicity test resulted in an EC50 of 0.23 mg/L; eastern oyster also exposed in a 96-hour test had an EC50 value of 2.8 mg/L based on shell deposition

Environmental Fate

A typical half-life for flumioxazin in soils is15 days (see "Half-life" text box). Microbes and sunlight break down flumioxazin in the environment. Flumioxazin's potential to leach to groundwater is low; surface runoff potential is intermediate, and potential for loss on eroded soil is intermediate. Flumioxazin has moderate volatility and the potential for loss to the atmosphere is moderate. Flumioxazin does not bioconcentrate (build up) through the food chain. Plants readily take up flumioxazin through the leaves and roots. Flumioxazin is translocated (moved throughout) to other plant parts.

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 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).

Flumioxazin is expected to pose negligible potential risks of adverse non-cancer effects to WSDOT workers and the public under conditions of average and maximum exposure. All hazard quotients are below 1. Flumioxazin is not regulated as a carcinogen.

LD50/LC50: Acute toxicity is commonly measured by the lethal dose (LD) or lethal concentration (LC) that causes death in 50 percent of treated laboratory animals. LD50 indicates the dose of a chemical per unit body weight of an animal and is expressed as milligrams per kilogram (mg/kg). LC50 is the concentration of a chemical per volume of air or water and is expressed as milligrams per liter (mg/L). Chemicals are highly toxic when the LD50 or LC50 value is small and practically nontoxic when the value is large. However, the LD50 and LC50 do not reflect potential health effects such as cancer, birth defects, or reproductive toxicity that may occur at levels of exposure below those that cause death.

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 vapors or particulates. WSDOT's anticipated application rates and use patterns for flumioxazin are expected to pose an insignificant risk to mammals. The

Human Risk Classifications for Average Exposure Scenarios

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 flumioxazin.

estimated dietary exposures to rats, mice and meadow vole from WSDOT's current application practices would be 14,000, 1,700 and 2,200-fold lower, respectively, than the acute oral LD50 for rats. The estimated dietary exposures of flumioxazin to quail, marsh wren and American robin from WSDOT's anticipated application practices would be 4,100, 450 and 350-fold lower, respectively, than the acute dietary LD50 for bobwhite quail. These estimated dietary exposures are considered insignificant for each of these species.

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 flumioxazin occurs primarily through direct contact with contaminated surface waters and sediment. Due primarily to its low persistence and relatively low application rate, the estimated risks to fish from flumioxazin applied at levels established by WSDOT are slight in all physiographic provinces of the state examined, except in the Columbia Plateau and Blue Mountain regions, where the risks would be characterized as low. The estimated risks to aquatic organisms from flumioxazin are slight in all physiographic provinces of the state examined.

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)