



Pendimethalin

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

Pendimethalin is a dinitroaniline herbicide used for pre-emergent control of annual grasses and broadleaf weeds. Pendimethalin inhibits cell division and cell elongation in plants. Pendimethalin is the only active ingredient in the **Pendulum 2G** (2%) and **Pendulum AquaCap** (38.7%). The Washington State Department of Transportation (WSDOT) has typically used **Pendulum** for annual grasses and broadleaf weed control on the east side of the Cascades. **Pendulum** products also have agricultural and urban uses.

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

Pendulum 2G is applied at 100-200 pounds of product per acre and **Pendulum AquaCaps** is applied at 64-128 ounces of product per acre. These products are used in maintenance of a bare ground strip at the edge of pavement. Applicators use truck-mounted booms placed 18" above the ground to make a single application of pendimethalin in the spring. WSDOT workers applied about 123 pounds of pendimethalin 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 **Pendulum 3.3 EC** and **Pendulum WDG** as category III (Low Toxicity) with a signal word of CAUTION because of moderate eye irritation and harm if swallowed or absorbed through skin (see "Toxicity Category and Signal Word" table).

Acute toxicity: A review of 71 pendimethalin poisoning cases reported in Taiwan identified 2 incidences resulting from skin and eye contact and the rest from swallowing intentionally or accidentally. Among them, 20 cases had no symptoms or signs, 38 had mild effects such as nausea, vomiting and sore throat, and 7 had effects such as severe retching, vomiting of blood, and seizures.

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 pendimethalin cited in this fact sheet.

In animal studies, pendimethalin has been found to have low toxicity if swallowed, and very low toxicity if it is inhaled or gets on the skin. In rabbits, pendimethalin caused slight eye irritation and no skin irritation. Pendimethalin did not cause skin sensitization in guinea pigs.

Chronic toxicity: In studies where rats were fed pendimethalin for 2 years, a variety of effects were observed at moderate to high doses. Increased mortality was noted at high doses of pendimethalin in an 18-month feeding study in mice.

Reproductive effects: No maternal or developmental toxicity was seen in rats exposed to high doses of pendimethalin during pregnancy. In rabbits, maternal mortality was noted at high doses, but no developmental effects were seen. In a study of reproduction in rats, decreased pup weight was observed at high doses.

Carcinogenic effects: Pendimethalin is classified as a “possible human carcinogen” by U.S. EPA based on benign thyroid tumors.

Fate in humans and animals: Rats rapidly excrete pendimethalin unchanged primarily in the feces. Pendimethalin does not bioaccumulate (build up) in mammals.

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 and Aquatic Effects

Effects on mammals:

Pendimethalin is considered to be slightly toxic to small mammals by the oral route based on an acute oral rat study in which LD50 values were reported as 1,050 mg/kg for females and 1,250 mg/kg for males.

Effects on birds: Pendimethalin was found to be slightly toxic to the mallard duck following an acute oral LD50 of 1,421

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

mg/kg. In a subacute dietary study, LC50 values of 4,187 ppm and 4,640 ppm were reported for bobwhite quail and mallard duck, respectively.

Effects on fish: Pendimethalin is considered highly toxic to fish based on acute toxicity studies evaluated by U.S. EPA using 93.2% (technical grade) active ingredient. The LC50 values for rainbow trout, bluegill sunfish and channel catfish were 0.138, 0.199, and 0.418, respectively. In studies using typical formulated product with 45% active ingredient, LC50 values were 0.52, 0.92, and 1.9 mg/L for rainbow trout, bluegill sunfish, and catfish, respectively.

Effects on aquatic insects: Technical grade pendimethalin was found to be highly toxic to freshwater invertebrates based on acute toxicity LC50/EC50 values of 0.28 and 1.0 mg/L for *Daphnia magna* and crayfish, respectively. A study that exposed *Daphnia magna* to formulated pendimethalin (45.6%) resulted in a LC50/EC50 value of 5.1 mg/L.

Environmental Fate

A typical half-life for pendimethalin in soils is 90 days (see “Half-life” text box). Microbes and sunlight break down pendimethalin in the environment. Pendimethalin’s potential to leach to groundwater is low; surface runoff potential is intermediate, and potential for loss on eroded soil is high. Pendimethalin has moderate volatility and the potential for loss to the atmosphere is moderate. Pendimethalin does not bioconcentrate (build up) through the food chain. Pendimethalin is adsorbed through the root and shoots and has limited ability to translocate (move 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).

Pendimethalin 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, Pendimethalin is estimated to pose a low potential risk of adverse non-cancer effects to WSDOT workers, adults and children ingesting drift-contaminated garden vegetables, and children coming into

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

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 pendimethalin.

dermal contact with drift-contaminated berries. The estimated potential risks are negligible in all other exposure scenarios. Pendimethalin is not regulated as a carcinogen.

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 current application rates and use patterns for pendimethalin are expected to pose a low risk to mammals. The estimated dietary exposures to rats, mice, and meadow vole from the maximum label application rate would be 250, 29, and 38-fold lower, respectively, than the acute dietary LD50 for pendimethalin. The estimated dietary exposures of pendimethalin to quail, marsh wren, and American robin from the maximum label application rate would be 210, 24, and 19-fold lower, respectively, than the acute dietary LD50 for bobwhite quail. These exposures results in estimated risks that are low for quail and moderate for 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 pendimethalin occurs primarily through direct contact with contaminated surface waters and sediment. Pendimethalin has a high potential to bioaccumulate in fish tissues and aquatic invertebrates. The estimated relative risks to fish and aquatic invertebrates from application of pendimethalin at levels established by WSDOT were moderate in all physiographic provinces 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)