Washington State
Department of Transportation

# 2,4-D

## 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.

### Introduction

2,4-Dichlorophenoxyacetic acid (2,4-D) is a selective herbicide used to control broadleaf weeds. 2,4-D is the first successful selective herbicide developed (1942, marketed by 1944). It is the third most widely used herbicide in the United States and Canada and the most widely used herbicide worldwide. 2,4-D controls plant growth by triggering reactions in plant cells that affect critical cell functions and cell growth, leading to plant death. 2,4-D is the only active ingredient in the herbicide products **Weedar 64** and **Amine 4**. It is combined with the active ingredient clopyralid in the product **Curtail** and with the active ingredient dicamba in **Veteran 720** and **Weedmaster**. The Washington State Department of Transportation (WSDOT) uses these products for selective control of broadleaf noxious and nuisance weeds. 2,4-D also has agricultural, urban, lawn and garden, and forestry uses.

WSDOT assessed the potential risks to humans, wildlife, and aquatic animals exposed to 2,4-D 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.

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

Typical rights-of-way application rates for Weedar 64 and Amine 4 range from 64 to 128 ounces of product -- or a maximum of about 3.8 pounds of 2,4-D -- per acre. Curtail is applied at 48 to 64 ounces of product -- or a maximum of about 1 pound of 2,4-D -- per acre. Veteran 720 and Weedmaster are applied at 48 to 96 ounces of product -- or a maximum of about 1.6 pounds of 2,4-D -- per acre. Because applications are directed only onto target vegetation, the total amounts applied in any given acre are far less than these maximums. All of the 2,4-D-containing products are applied by truck-mounted hand gun, hose reel, or side boom. Weedar 64, Amine 4, Veteran 720, and Weedmaster are applied throughout the year, while Curtail is applied from April to September. About 20,000 pounds of 2,4-D were applied statewide by WSDOT in 2002.

**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 herbicides containing 2,4-D as follows:

| Product | Category | Toxicity | Signal Word |
|---|---|---|---|
| Weedar 64 | toxicity class I | High toxicity | DANGER |
| Weedone | toxicity class III | Low toxicity | CAUTION |
| Curtail | toxicity class I | High toxicity | DANGER |
| Veteran 720 | toxicity class III | Low toxicity | CAUTION |
| Weedmaster | toxicity class III | Low toxicity | CAUTION |

*Acute toxicity*: 2,4-D has low toxicity if individuals accidentally eat, touch, or inhale residues. 2,4 causes severe eye irritation, moderate skin irritation, and no skin sensitization. (See Toxicity Category and Signal Word table).

**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 [1] | 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 [2] | 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 |

[1]Highlighted categories specify the range for 2,4-D use cited in this fact sheet.
[2]The High Toxicity classification is specific to the 2,4-D formulations for Weedar 64 and Curtail; they are severely corrosive to the eyes.

*Chronic toxicity*: Rats, mice, and dogs fed moderate to high doses of 2,4-D for 1 to 2 years showed cellular changes in the kidney and liver, blood chemistry changes, and kidney weight changes. At high doses, rats showed an increased incidence of cataracts and retinal degeneration.

*Reproductive effects*: 2,4-D caused some decreases in growth and survival of the offspring, but no birth defects, when fed to rats in moderate to high doses over two generations. Rats fed moderate to high doses of 2,4-D for two generations showed some decreases in growth and survival of offspring, but no birth defects. The offspring of rats and rabbits fed high doses of 2,4-D during pregnancy showed skeletal changes and some delays in bone formation. Male rats exposed to high doses of Tordon 75D (containing picloram and 2,4-D) for 9 weeks showed severe testicular weight loss and shrunken tubules with germ cell loss in the testes.

*Carcinogenic effects*: Rats, mice, fed moderate to high doses of 2,4-D for 1 ½ to 2 years showed no increase in tumors. Some studies of 2,4-D show no evidence that it causes mutations, while other studies show it does cause mutations. Some studies of pesticide workers have suggested that exposure to 2,4-D may increase the risk of soft-tissue sarcomas, Hodgkin's disease, and non-Hodgkin's lymphoma. However, there is controversy about these studies, and a U.S. EPA Science Advisory Board concluded these studies do not support a link between 2,4-D exposure and increased cancers. The EPA currently lists 2,4-D as a Group D human carcinogen (not classifiable as to human carcinogenicity).

*Fate in humans and animals*: 2,4-D is rapidly absorbed through the gut, skin, and lungs depending on how an individual is exposed. Animals excrete 2,4-D almost entirely in the urine. The half-life of 2,4-D in humans is between 10 and 20 hours. 2,4-D does not bioaccumulate (build up) in animals. Lactating animals pass only traces amounts in their milk for 6 days following exposure. 2,4-D passes through the placenta in pigs and rats. In rats, about 20% of the given dose is found in the uterus, placenta, fetus, and amniotic. Chickens given moderate amounts of 2,4-D in drinking water from birth to maturity had very low levels of the compound in their eggs.

**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*: 2,4-D is moderately toxic to mammals. (See LD50/LC50 text box and Wildlife Toxicity Category table). The LD50s for 2,4-D range from 375 to 666 milligrams per kilogram (mg/kg) in rats, 370 mg/kg in mice, and 320 to 1,000 mg/kg in guinea pigs.

**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 [2] | >100 [2] |
| Slightly toxic | 501-2,000 | 501-2,000 | >10-100 |
| Moderately toxic | 51-500 [1] | 51-500 | >1-10 |
| Highly toxic | 10-50 | 10-50 | 0.1-1 |
| Very highly toxic | <10 | <10 | <0.1 |

[1]Highlighted categories specify the range for 2,4-D use cited in this fact sheet.
[2]The toxicity of 2,4-D to fish and aquatic insects is highly dependent on the specific form of the chemical and the species that is exposed.

*Effects on birds*: 2,4-D ranges from practically non-toxic to moderately toxic in birds. 2,4-D is slightly toxic to wildfowl (mallards, pheasants, quail, and pigeons) with an LD50 of 272 mg/kg in pheasants to 1,000 mg/kg in mallards.

*Effects on fish*: 2,4-D ranges from practically non-toxic to highly toxic in aquatic (water) animals. The 2,4-D amine form is highly toxic to rainbow trout but practically non-toxic to bluegill. 2,4-D amine forms are generally non-toxic to fish. The 2,4-D ester form is moderately toxic to both rainbow trout and bluegill.

*Effects on aquatic insects*: 2,4-D compounds most toxic to aquatic insects are the ester and amine forms. Both 2,4-D amine and 2,4-D ester are moderately toxic to aquatic insects. 2,4-D is slightly toxic to Dungeness crab.

## Environmental Fate

The half-life of 2,4-D in soils is less than 7 days. Microbes break it down. 2,4-D is moderately mobile in the environment. Despite its low persistence in soils and its short half-life in waters, researchers have found 2,4-D in groundwater supplies in 5 states and Canada. They have also detected 2,4-D in very low levels in surfaces waters throughout the United States. 2,4-D is absorbed through the leaves, stems, and roots of plants. It is toxic to most broad leaf crops, especially cotton, tomatoes, beets, and fruit trees.

**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 adults and children eating drift-contaminated garden vegetables or children directly touching drift-contaminated berries or sprayed vegetation. For each exposure scenario, WSDOT evaluated conditions of average exposure and extremely conservative conditions of maximum exposure. (See Human Cancer/Non-cancer text box and Human Risk Classifications under Conditions of Average Exposure). 2,4-D poses a potential low adverse non-cancer risk to broadcast hydraulic spray applicators, but is not expected to cause adverse non-cancer health effects in any of the average public exposure pathways evaluated. The hazard quotient for broadcast spray applicators is 1.9, while all other hazard quotient values are less than 1. Under maximum exposure scenarios, 2,4-D poses a potential low to moderate adverse non-cancer risk to the public, except for adults who may eat contaminated berries. The highest potential public non-cancer risk is for children eating drift-contaminated garden vegetables, with a hazard quotient of 18. The conditions specified for the maximum exposure conditions are worst-case scenarios and are unlikely to occur. Workers engaged in broadcast spray applications of 2,4-D are at moderate risk under maximum exposure scenarios, with a hazard quotient of 17.

2,4-D poses a negligible risk of cancer for WSDOT workers and the public under all average case scenarios. Under maximum exposure conditions, 2,4-D poses a potential moderate risk ($1.6 \times 10^{-4}$) to WSDOT workers engaged in broadcast hydraulic spray applications. Under maximum exposure conditions, 2,4-D poses a

potential low cancer risk to individuals who eat contaminated vegetables ($8.7 \times 10^{-5}$) and individuals who directly touch sprayed vegetation ($8 \times 10^{-5}$). Cancer risks for the other two public exposure scenarios are negligible (less than $1 \times 10^{-5}$). Note that the EPA currently lists 2,4-D as a Group D human carcinogen (not classifiable as to human carcinogenicity).

**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, potential non-cancer health effects may be possible. 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 agencies.

**Human Risk Classifications under Conditions of Average Exposure**

| 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**[1] |
| 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 2,4-D.
[1]Low risks involving 2,4-D are specific to WSDOT workers making broadcast spray applications.

## Wildlife Risk Assessment

Wildlife risk assessment considers pesticide 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 pesticide residues with their skin or eyes or when they inhale vapors or particulates. Estimated dietary doses for rats, mice, and meadow voles are 13 to 113 times lower than toxic levels for various wildlife species. Using conservative assumptions (such as assuming that animals will only eat foods sprayed by 2,4-D rights-of-way applications), WSDOT's current application rates and use patterns for 2,4-D pose a low risk to rats and a moderate risk to mice and meadow voles.

Estimated dietary doses for bobwhite quail, marsh wrens, and American robins are approximately 5 to 56 times lower than the pheasant LD50 of 472 mg/kg and approximately 20 to 240 times lower than the mallard LD50 of 2,000 mg/kg. Based on the more toxic pheasant LD50, 2,4-D poses a low risk to quail and a high risk to marsh wrens and American robins. Based on the less toxic mallard LD50, 2,4-D poses a low risk to quail and marsh wrens and a moderate risk to American robins.

## 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 2,4-D occurs primarily through direct contact with contaminated surface waters. WSDOT's current application rates and use patterns for 2,4-D poses a low risk to fish and aquatic insects in all areas of the state.

## Additional Resources

- National Pesticide Information Center 1-800-858-PEST (7378) and http://npic.orst.edu
- Extension Toxicology Network (EXTOXNET) http://extoxnet.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)