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| PESTICIDE TYPE | Herbicide |
| CHEMICAL CLASS | Phenoxyacetic acid |
| COMMON TRADE NAMES | Enlist Duo™ |
| APPLICATION RATE (lbs a.i./A) | Single: 0.141-0.275 Max Annual: 0.550 |
| REGISTRATION STATUS | EPA: Registered December 2014 Minnesota: May 2015 |
| TOXICITY PROFILE FOR APPLICATORS | Signal word- Warning Toxicity III (inhalation), IV (dermal irritation), I (eye irritation) |
| BASIC MANUFACTURER | Dow AgroSciences |
| MDA LABORATORY CAPABILITIES | Methods developed for parent chemical |

HUMAN HEALTH

NON-CANCER Acute PAD = 0.67 mg/kg/day
Chronic PAD = 0.21 mg/kg/day

CANCER Not likely to be carcinogenic to humans

Acute and chronic PADs are doses that include all relevant uncertainty and safety factors

ENVIRONMENTAL AQUATIC TOXICITY

FISH Acute: >130 ppb
Chronic: 79.2 ppb

INVERTEBRATE Acute: 1,100 ppb
Chronic: 200 ppb

AQUATIC PLANTS Vascular: 66 ppb
Non-vascular: 330 ppb

POLLINATOR TOXICITY

HONEY BEE Acute Contact: 26.4 µg a.i./bee
Acute Oral: 26.4 µg a.i./bee

Level of Concern (LOC) has been applied to all values

Introduction

2,4-dichlorophenoxyacetic acid (2,4-D) is a phenoxyacetic acid herbicide that is used post-emergence for selective control of broadleaf weeds. The herbicide kills weeds by disrupting plant hormone responses. 2,4-D is currently registered in a variety of salt, amine and ester formulations for use on corn, soybeans and a variety of other food and feed crops. 2,4-D was previously registered for over-the-top applications to corn up to 8 inches tall and only pre-plant applications to soybeans. The new use is for a 2,4-D choline salt, which allows over-the-top applications to genetically engineered (GE) corn and GE soybeans up to 48 inches in height. 2,4-D choline is less prone to drift and volatilization than its other forms. Minnesota Department of Agriculture (MDA) review of 2,4-D choline and risk assessments for issues relevant to Minnesota are summarized below.

Projected New Use in Minnesota

The EPA approved a new use of this herbicide for controlling pre-plant or pre-emergence or post-emergence weeds on GE corn and soybean. The new formulated herbicide product "Enlist Duo™" combines 2,4-D choline and glyphosate (the active ingredient in Roundup). All uses of glyphosate are already registered on GE corn and soybean, so Enlist Duo does not represent a new use for glyphosate. The new use of 2,4-D in choline form is expected to augment the current use of glyphosate on weeds that have become resistant to glyphosate. The new product is available as:

- **Enlist Duo™** (EPA Reg. No. 62719-649)– a slow release product comprising 24.4% 2,4-D choline salt and 22.1% glyphosate for use on Enlist™ AAD-1 Corn and Enlist™ AAD-12 Soybean.

Label Environmental Hazards

Labels for outdoor crop applications carry the following restrictions or advisories, mostly associated with the 2,4-D component of the Enlist Duo mixture:

Water Quality:

- This chemical has properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination. Application around a cistern or well may result in contamination of drinking water or groundwater.
- This pesticide is toxic to fish and aquatic invertebrates. Do not apply directly to water, to areas where surface water is present. Drift or runoff may adversely affect aquatic invertebrates and non-target plants.

Other:

- Causes substantial but temporary eye injury, prolonged or frequently repeated skin contact may cause allergic reactions in some individuals. Do not get in eyes or on clothing. Chemical resistant gloves and protective eyewear are recommended.



Toxicology and Exposure

EPA's screening models generate high-end, conservative exposure estimates for active ingredients and toxicologically significant degradates. Model inputs include annual usage at maximum use rates, maximum treated acres, maximum food residues, peak runoff and drift scenarios, etc. Some proposed products, application rates and use scenarios are not relevant to Minnesota. EPA's estimates, therefore, may not reflect future use and impacts in Minnesota.

Human Health

- **Carcinogenic Effects**- Classified as "Not classifiable as to human carcinogenicity"
- **Drinking Water Guidance**- High-end, exposure model estimates by the EPA for drinking water and a Minnesota-specific drinking water rapid assessment by the Minnesota Department of Health suggest that drinking water exposure estimates are below levels of concern. Applications of 2,4-D may result in groundwater detections where soils are permeable, particularly where the water table is shallow or when applications are made around a cistern or well. Residues in groundwater may be made up of 2,4-D and/or the degradate 2,4-DCP; however, EPA determined that 2,4-D degradates are not of risk concern for drinking water due to low occurrence, comparatively low toxicity for humans, or a combination thereof. *For more information on degradate toxicity see "Degradates" section.*
- **Occupational Exposure**- Prolonged or frequently repeated skin contact with 2,4-D may cause allergic reactions in some individuals. However, the proposed uses of 2,4-D do not pose any dermal or inhalation toxicity concern for handlers when used in accordance with label.
- **Endocrine Disruption**- 2,4-D is currently undergoing a Tier I Endocrine Disruptor Screening. The results of the screening analysis are not yet available.

Environment- Non-target Species

- **Aquatic Life Exposure** – High-end, screening exposure estimates for risks to fish and invertebrates generated some concern for 2,4-D. The compound is classified as toxic to fish and invertebrates, moderately toxic to birds and mammals, and practically non-toxic to honey bees on acute basis. The EPA concludes that risks are mitigated by labeling requirements. Estimates suggest that estimated surface water concentrations will not exceed available aquatic life toxicity benchmarks.
- **New Use Exposure** - The proposed new uses of 2,4-D choline salt do not generate unacceptable risks to organisms of concern when used in accordance with label.

Environmental Fate

Soil

- **Half-life**- Aerobic = 1.4 - 12.4 days
Anaerobic = 28.5 - 333 days
- **Adsorption**- K_{d-ads} : 0.17 – 1.27 mL/g
- **Persistence**- 2,4-D is not expected to be persistent in soils.

Water

- **Half-life via hydrolysis** = Stable.
- **Surface water**- 2,4-D is expected to reach surface water and/or adjacent terrestrial environments through spray drift, and runoff of sediment bound residues.
- **Groundwater**- 2,4-D may reach groundwater in areas where soils are permeable with shallow water table. Application around a cistern or well may result in contamination of groundwater.

Air

- **Volatilization**- 2,4-D is not expected to be significantly volatile. Vapor pressure (1.4×10^{-7} mm Hg); Henry's Law constant = 8.56×10^{-6} atm m³ mole⁻¹.

Degradates

2,4-D degrades into 3 major degradates 1,2,4-benzenetriol, 2,4-dichlorophenol (2,4-DCP), and chlorohydroquinone (CHQ). Minor degradates include 4-chlorophenol, 4-CPA and 2,4-DCA. EPA determined that 2,4-D degradates are not of risk concern for drinking water due to low occurrence, comparatively low toxicity for humans, or a combination thereof. The degradation of 2,4-D is considered to be dependent on oxidative microbially-mediated mineralization in the terrestrial environment and photodegradation in water. There is some evidence that 2,4-DCP, which is degradate of concern under anaerobic aquatic conditions, is more toxic to fish and invertebrates than its parent compound 2,4-D; however, 2,4-DCP's higher toxicity was considered in EPA risk assessments, and the estimated environmental concentrations of 2,4-DCP due to the Enlist Duo use pattern are much lower than reported toxicity values. 2,4-DCP is a minor degradate in terrestrial environments.