

PESTICIDE TYPE	FUNGICIDE
Chemical Class	Pyrazole carboxamide
Common Trade Names	Kalida
Major Degradate	3-Hydroxy-IR9792, cis-1-Carboxy-IR9792/F9990, and trans-1-Carboxy-IR9792/F9990
Application Rate (lbs a.i./acre/year)	Max Single: 0.27 (foliar) Max Annual: 1.1 (soil/foliar)
Registration Status	EPA: Registered unconditionally in May 2021 Minnesota: 2022
Toxicity Profile for Applicators	Signal word: CAUTION Category III: Oral and dermal Category IV: Inhalation exposure
Basic Manufacturer	FMC Corporation
MDA Laboratory Capabilities	In discussion
HUMAN HEALTH	
Non-Cancer	Acute PAD: 0.6 mg/kg/day Chronic PAD: 0.04 mg/kg/day
Cancer	Not likely to be carcinogenic to humans
<i>Acute and chronic population adjusted doses (PAD) are doses that include all relevant uncertainty and safety factors</i>	
ENVIRONMENTAL AQUATIC TOXICITY	
Fish	Acute: 55 µg a.i./L Chronic: 31 µg a.i./L
Invertebrate	Acute: 207 µg a.i./L Chronic: 120 µg a.i./L
Aquatic Plants (IC ₅₀)	Vascular: >2,000 µg a.i./L Non-vascular: 1,500 µg a.i./L
POLLINATOR TOXICITY	
Honeybee (adult LD ₅₀)	Acute Contact: >120 µg ai/bee Acute Oral: >13 µg ai/bee
<i>Level of Concern (LOC) has been applied to all values.</i>	

INTRODUCTION

Fluindapyr is a new fungicide active ingredient recently registered by the U.S. Environmental Protection Agency (EPA) for use on cereal grains, tree nuts, and corn. Fluindapyr is also registered for use on turf and ornamentals with use sites including golf courses, greenhouses, rights-of-way, and public, institutional, and commercial lawns and landscapes. It is a pyrazole carboxamide fungicide and belongs to the Fungicide Resistance Action Committee Group 7. Fluindapyr is a succinate dehydrogenase (SDH) inhibitor that functions by binding to the ubiquinone binding site of the SDH enzyme which then blocks the tricarboxylic acid cycle at the level of succinate and fumarate oxidation. It provides protection against a range of pathogenic fungi including anthracnose, alternaria leaf spot, bermudagrass decline, leaf rust, pink snow mold, powdery mildew, and rot eastern filbert blight.

The Minnesota Department of Agriculture’s (MDA) extensive review of the EPA fluindapyr labels and risk assessments for issues relevant to Minnesota is summarized below.

PROJECTED USE IN MINNESOTA

Fluindapyr is expected to be a valuable preventive and curative tool for managing certain fungal diseases in cereal grains, corn, and turf and ornamentals (e.g., brown patch on turfgrass). Fluindapyr also has potential to be a beneficial tool in IPM and fungicide resistance management programs (e.g., mode of action rotation plan). Its performance against some major diseases is expected to be comparable with other currently registered fungicides, but it has a much lower maximum single application rate. Fluindapyr can be applied by aerial, ground boom, air blast, and handheld equipment as well as by chemigation. Single foliar application rates range from 0.18 to 0.27 lbs a.i. per acre and annual foliar application rates range from 0.23 to 1.1 lbs a.i. per acre, depending on the crop/use sites.

Six end-use products are currently registered by the EPA (see examples below). At the time of this review, only Kalida Fungicide has been registered in Minnesota.

- Kalida Fungicide** (EPA Reg. No. 279-3641) – This product contains 20.9% fluindapyr + 20.9% flutriafol for use on turf and ornamentals in lawns and landscape areas around public, institutional, and commercial properties (including golf courses) and use on container, enclosed, and field-grown ornamentals.
- F9944-74** (EPA Reg. No. 279-3637) – This product contains 42.4% fluindapyr for use on tree nuts, corn, grain sorghum, wheat, triticale, and barley.
- F4412-1** (EPA Reg. No. 279-3642) – This product contains 15.7% azoxystrobin + 10.5% fluindapyr + 15.7% flutriafol for use on corn, grain sorghum, wheat, triticale, and barley.

LABEL ENVIRONMENTAL HAZARDS

Water Quality

- Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high-water mark. Do not contaminate water when disposing of equipment wash water or rinsate.
- Products co-formulated with flutriafol and/or azoxystrobin include groundwater and surface water advisory statements and note that the formulated product is toxic to fish and aquatic invertebrates.

Pollinators

- This product is not acutely toxic to pollinators; however, chronic exposure to the product through pollen and nectar may cause risk to pollinators. Protect pollinators by following label directions intended to limit exposure.

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** – EPA classified fluindapyr as “not likely to be carcinogenic to humans.”
- **Drinking Water Guidance** – Fluindapyr and its major degradates have potential to reach surface and ground sources of drinking water. The estimated drinking water concentrations (EDWCs) for fluindapyr residue of concerns in groundwater were 254 µg/L and 218 µg/L for the acute and chronic exposure, respectively. Based on these EDWCs, both acute and chronic dietary (food and drinking water) exposures and risk estimates are below the EPA level of concern.
- **Occupational Exposure** – Occupational handling and post-application exposures and residential post-application exposures are possible; however, EPA found that risk estimates were not of concern with baseline attire, appropriate PPE, and following label restricted-entry intervals. A restricted-entry interval (REI) of 12 hours is required except for detasselling field corn and popcorn grown for seed and for hand-detasselling and hand-harvesting sweet corn (REI = 14 days).

Non-target Species

- **Aquatic Life Exposure** – Fluindapyr is highly toxic to fish and aquatic invertebrates on an acute exposure basis and has the potential to bioaccumulate in these species. It has minimal toxic effects on vascular and non-vascular aquatic plants.

- **Terrestrial Life Exposure** – Fluindapyr is practically non-toxic to mammals and birds on an acute oral/dietary basis. Risk from chronic exposure is expected to be low for both birds and mammals. Bioaccumulation risks are also expected to be low. Fluindapyr is practically non-toxic to plants and the risk to terrestrial plants is not a concern.
- **Pollinators** – Fluindapyr is practically non-toxic to adult honeybees and honeybee larvae on an acute oral and contact basis; however, it had some lethal and reproductive sublethal effects in adult honeybees in the chronic studies. It is therefore advised not to apply select fluindapyr products to select plants until after petal fall to mitigate risks concerns to honeybees.

ENVIRONMENTAL FATE

Fluindapyr is slightly mobile, stable to hydrolysis, and degrades slowly in both soil and aquatic environments. It has limited potential to leach through the soil but may slowly reach shallow groundwater due to its persistence. It may be transported to surface water via spray drift, runoff, and erosion.

Soil

- **Half-life (20°C)** – Aerobic: 144 to 437 days
Anaerobic: 938 to 1841 days
- **Mobility** – K_{oc} values range from 1288 to 3302 L/kg_{oc}
Solubility in water (20°C, pH 7) is 1.63 mg/L
- **Photolysis Half-life** – 170 days (25°C)
- **Persistence** – DT₅₀ values range from 7 to 275 days

Aquatic

- **Half-Life** – Aerobic: 258 to 272 days
Anaerobic: 420 to 643 days
- **Photolysis Half-life** – 158 days (at 25°C)
- **Hydrolysis Half-life** – Stable

Air

- **Volatilization** – Nonvolatile; Vapor pressure (20°C) = 2.14×10^{-10} torr; Henry's law constant (20°C) = 6.05×10^{-11} atm·m³ mol⁻¹

Degradates

Fluindapyr has three major (3-hydroxy-IR9792, cis-1-carboxy-IR9792/F9990, and trans-1-carboxy-IR9792/F9990) and two minor (pyrazole-carboxamide and pyrazole-carboxylic acid) environmental degradates. While toxicity data is not available for the three major degradates, they are estimated to be 1 to 3 orders of magnitude less toxic than fluindapyr and are not considered residues of concern in the EPA's ecological risk assessment. The three major degradates have the potential to leach to groundwater in some environments and are categorized as residues of concern in drinking water.