

PESTICIDE TYPE	Insecticide
CHEMICAL CLASS IRAC Code	Sulfoximines 4C
COMMON TRADE NAMES	Closer, Transform
MAJOR DEGRADATE	X-11719474 (X-474)
APPLICATION RATE (lbs a.i./A)	Single: 0.043-0.086 Max Annual: 0.266
REGISTRATION STATUS	EPA: 2013 Minnesota: June 2013
TOXICITY PROFILE FOR APPLICATORS	Signal word: Caution (Closer) or Danger (Transform) Toxicity III or IV
BASIC MANUFACTURER	Dow AgroSciences
MDA LABORATORY CAPABILITIES	In discussion

HUMAN HEALTH

NON-CANCER	Acute PAD = 0.06 mg/kg/day Chronic PAD = 0.05 mg/kg/day
CANCER	Suggestive evidence of carcinogenic potential

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

ENVIRONMENTAL AQUATIC TOXICITY

FISH	Acute: >181,500 ppb Chronic: 660 ppb
INVERTEBRATE	Acute: >200,000 ppb Chronic: 50,500 ppb
AQUATIC PLANTS	Vascular: >99,000 ppb Non-vascular: 81,200 ppb

POLLINATOR TOXICITY

HONEY BEE	Acute Contact: 0.052 µg ai/bee Acute Oral: 0.0208 µg ai/bee
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Level of Concern (LOC) has been applied to all values

Introduction

Sulfoxaflor is the first member of sulfoximines class of insecticides. It is considered an agonist of nicotinic acetylcholine receptor (nAChR). In laboratory experiments, sulfoxaflor was found to be highly efficacious against target insects those displayed resistant to neonicotinoids such as imidacloprid. Sulfoxaflor is a systemic insecticide registered by EPA to control piercing/sucking insects such as aphids, stink bugs, plant bugs, and thrips on a variety of row crops. Sulfoxaflor is formulated as a suspension-concentrate (SC) and as water dispersible granules (WDG) containing. Applications can be made with either ground or aerial equipment. Sulfoxaflor can also be applied through chemigation system.

It was first registered by EPA for emergency use on cotton to control tarnished plant bug, *Lygus lineolaris* in the state of Mississippi, Arkansas, Louisiana, and Tennessee in June 2012. Its use was extended to other crops in 2013. Sulfoxaflor is registered for use in Minnesota in June 2013. Minnesota Department of Agriculture (MDA) extensive review of the U.S. Environmental Protection Agency (EPA) sulfoxaflor labels and risk assessments for issues relevant to Minnesota is summarized below.

Projected Use in Minnesota

Sulfoxaflor may be registered for use on the following major crops in Minnesota: soybeans, potatoes, wheat. According to UMN extension, sulfoxaflor worked well against aphids in soybean and potatoes. It will be of use against piercing/sucking insects such as aphids, leafhoppers, plant bugs, etc. It is not labeled for residential uses.

This insecticide is found in 2 end-use unconditionally registered products:

- **Closer™ SC (EPA Reg. No. 62719-625)** – a suspension concentrate (SC) for foliar application to all approved crops. Closer is not labeled for use on soybean, potato and wheat crops.
- **Transform™ WG (EPA Reg. No. 62719-623)** – a water dispersible granular (WDG) product for foliar application to all approved crops.

Label Environmental Hazards

Water Quality:

- Label for applications carry advisories for surface water impacts.

Other:

- This product is highly toxic to bees exposed through contact during spraying and while spray droplets are still wet. This product may be toxic to bees exposed to treated foliage for up to 3 hours following application. Toxicity is reduced when spray droplets are dry.
- Risk to managed bees and native pollinators from contact with pesticide spray or residues can be minimized when applications are made before 7:00 am or after 7:00 pm local time or when temperature is below 55 F at the site application.
- There are additional restrictions and/or advisories to protect pollinators on wheat, canola and fruit and vegetable crops.



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 "Suggestive Evidence of Carcinogenic Potential." EPA has determined the chronic population adjusted dose (PAD) is protective of all long-term effects, including potential carcinogenicity. As a result, a separate dietary exposure assessment for the purpose of assessing cancer risk was not necessary.
- **Drinking Water Guidance**- Model estimates suggest that degradates will be found in groundwater to a greater degree than the parent sulfoxaflor. This is due to sulfoxaflor rapidly degrading in soil. Residues in groundwater will primarily be made up of the degradate X11719474 (X-474) and to a lesser extent X11519540 (X-540). *For more information on degradate toxicity see "Degradates" section.* High-end, screening exposure estimates for drinking water suggest that applications of sulfoxaflor degradates may result in surface water and groundwater detections; however, EPA concludes that conservative exposure estimates are below levels of concern for the general population and all population subgroups.
- **Occupational Exposure**- Protective eyewear was added for use of Transform due to Category II acute ocular toxicity.

Environment- Non-target Species

- **Stressor of concern** – For aquatic organisms parent sulfoxaflor plus its degradate X11519540; for terrestrial organisms sulfoxaflor only.
- **Aquatic Life Exposure** – High end screening exposure estimates for risks to fish and invertebrates did not generate concern for aquatic life. Estimates suggest that surface water concentrations will not exceed 10% of the available aquatic life toxicity benchmark. Bioaccumulation is not expected in aquatic life.
- **Pollinators** -Sulfoxaflor is highly toxic to honeybees on acute exposure basis. Label statements are designed to mitigate these effects.

Environmental Fate

The fate of sulfoxaflor in the environment is highly dependent on whether it is in a soil system, groundwater system, or surface water system. Environmental fate characteristics are listed for parent and all relevant degradates where appropriate.

Soil

- **Half-life**- Aerobic: Sulfoxaflor = < 1 day; X-474 = > 1,000 days; X-540 = 2,808 days
Anaerobic: Sulfoxaflor = 113-120 days; X-474 = 1,090-5,270; X-540 = Not available
- **Adsorption** (mL/g) - Parent/degradates are very high to highly mobile. Sulfoxaflor = K_{foc} 11-72; X-474 = K_{foc} 7-68; X-540= K_{foc} 1-25
- **Persistence**- Sulfoxaflor is expected to be non-persistent in soils and exhibits low affinity to soil or sediment particles. In the aerobic soil system, sulfoxaflor degrades into metabolites. Degradates are considered to be highly persistent in soil.

Aquatic

- In both aerobic and anaerobic aquatic conditions sulfoxaflor degrades slowly to X-474 (Half-life- Aerobic - 37-88 days, Anaerobic- 103-382 days). Degradate X-474 is expected to be more persistent than its parent in both aerobic and anaerobic aquatic systems.
- Sulfoxaflor is not expected to partition into the sediment.
- **Surface water**- Sulfoxaflor is expected to be the principle residue in surface water. Contamination of surface water is expected to be mainly related to drift and very little due to run-off. This is because sulfoxaflor drift that reaches aquatic systems is expected to persist while that reaching soil will degrade. Surface water is also expected to be contaminated by X-474 and X-540.
- **Groundwater**- Sulfoxaflor is expected to be absent from groundwater. Degradates X-474 and, to a lesser extent, X540 are expected to be found in groundwater.
- **Hydrolysis in water**: Parent and degradates characterized as stable.

Air

- **Volatilization**- Not a major route of dissipation. Vapor pressure = < 2.5×10^{-6} pa; Henry's Law = 1.2×10^{-11} atm m³ mole⁻¹.

Degradates

Sulfoxaflor has three important degradates; one major degradate, X-474, and two minor degradates, X-540 and X11579457 (X-457). Available evidence indicates that X-474 and X-457 is much less toxic to humans and the environment than the parent. X-540 appears to be more toxic than sulfoxaflor, but is not expected to be found at high concentrations.