Flupyradifurone

CAS 951659-40-8; EPA PC CODE 122304

New Active Ingredient Review
Updated July 2017

PESTICIDE TYPE	**Insecticide**
CHEMICAL CLASS IRAC Code	Butenolide 4D
COMMON TRADE NAMES	Sivanto, BYI 02960 480 FS
MAJOR DEGRADATE	6-chlornicotinic acid (6CNA) and difluoroacetic acid (DFA)
APPLICATION RATE (lbs a.i./A)	Single: 0.365 Max Annual: 0.365 -1.107 depending upon the crop
REGISTRATION STATUS	EPA: January 2015 Minnesota: November 2015
TOXICITY PROFILE FOR APPLICATORS	Signal word: Caution III (oral and dermal), IV (inhalation)
BASIC MANUFACTURER	Bayer CropScience
MDA LABORATORY CAPABILITIES	In discussion

HUMAN HEALTH	
NON-CANCER	Acute PAD = 0.35 mg/kg/day Chronic PAD = 0.078 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: >35,250 ppb Chronic: >4410 ppb
INVERTEBRATE	Acute: 31.95 ppb Chronic: 3.3 ppb
AQUATIC PLANTS	Vascular: 67,700 ppb Non-vascular: >80,000 ppb

POLLINATOR TOXICITY	
HONEY BEE	Acute Contact: 49.12 µg a.i./bee* Acute Oral: 0.48 µg a.i./bee

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

Values above indicate toxicity from the technical grade active ingredient (TGAI).

*End use products resulted in higher acute contact toxicity (15 µg a.i./bee) than technical grade active ingredient to honey bees. However, the end use product remains practically nontoxic to adult honey bees at this value.

Introduction

Flupyradifurone is the first member of butenolide class of insecticides. Its mode of action is similar to neonicotinoid insecticides that act on the central nervous system of target insect pests as an agonist of the nicotinic acetylcholine receptor (nAChR). However, its chemical structure differs from the nitroguanidine neonicotinoids and thus it is a separate sub-class of IRAC Group 4. Flupyradifurone is a systemic insecticide and targets piercing, sucking insects such as aphids and whiteflies. The EPA has registered flupyradifurone on berries (except cranberry), cereal grains (except rice), alfalfa, clover, and vegetables (except sugar beet), fruits, and ornamental plants. On soybean flupyradifuron is registered for foliar and seed treatment use only. Flupyradifurone is formulated as soluble liquid (SL) and flowable concentrate (FS). Application to soybean seeds is approved via commercial seed treatment application only.

Projected Use in Minnesota

Flupyradifurone is registered for use on the following major crops in Minnesota: soybeans, vegetables, fruits, alfalfa, clover, cereal grains, and ornamental plants. According to UMN extension, flupyradifurone works well against aphids. With soybean aphids showing resistance to synthetic pyrethroids in MN, flupyradifurone can be a potential tool for managing insecticide resistance to soybean aphids.

This insecticide is found in multiple end-use unconditionally registered products such as Aeron, Altus, FDF 50SL concentrate, Sivanto 200 SL, Sivanto Prime, Sivanto Prime 200 SL etc.

- **Sivanto 200 SL™** *(EPA Reg. No. 264-1141)* – a soluble liquid (SL) for foliar and soil drench application to all approved crops. Sivanto carries 1.67 pounds a.i. per gallon and can be applied foliarly on soybeans.

Label Environmental Hazards

Water Quality:

- Label carries an advisory that flupyradifurone may leach into ground water in permeable soils with shallow water table.
- Label also carries advisories for surface water impacts.

Other:

- The product is highly toxic to aquatic invertebrates.
- Flupyradifurone is practically non-toxic to adult bees on an acute contact exposure basis and it is practically non-toxic to larval bees on an acute contact/oral exposure basis. Flupyradifurone is classified as toxic to adult bees on an acute oral exposure basis in laboratory studies. Field studies with this product, Sivanto, when used at the maximum labeled rates, show no long-term impact to bee colonies.
- Flupyradifurone products must not be applied in a tank-mixture with azole fungicides (FRAC group 3) during bloom period.
- The product may have an effect on endangered species. The measures contained in the endangered species protection bulletin for the county where the product is intended for use must be followed to protect endangered species.

DEPARTMENT OF AGRICULTURE

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 likely to be carcinogenic to humans."
- Drinking Water Guidance- Model estimates suggest that flupyradifurone and its degradates have a potential to reach groundwater through leaching. Flupyradifurone may move from the treated field to the surface water through run-off, erosion, and spray drift. Persistence and mobility of flupyradifurone's degradates may be of concern for drinking water, however, EPA concludes that conservative exposure estimates are below levels of concern for the general population and all population subgroups.
- Occupational Exposure- Occupational risks do not exceed EPA's levels of concern.

Environment- Non-target Species

- Stressor of concern – Because of mobility and persistence, flupyradifurone may move from the treated field to surface water through run-off and erosion.
- Aquatic Life Exposure – Flupyradifurone is very highly toxic to aquatic and benthic invertebrates. Label statements are intended to mitigate anticipated risks. Nevertheless, estimates suggest that surface water concentrations could exceed 50% of the acute freshwater aquatic invertebrate toxicity benchmark.
- Pollinators – High-end, screening exposure estimates show flupyradifurone's risk to adult honey bees as practically nontoxic for acute contact exposure. Flupyradifurone is practically nontoxic to larval honey bees for acute oral exposures; however, it is considered highly toxic to adult honey bees for acute oral exposure. Field studies with Sivanto when used at the maximum labeled rates showed no long-term impact to bee colonies.

Environmental Fate

The fate of flupyradifurone 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: = 79-799 days depending upon the soil type.
  Anaerobic: >391 days or non-quantifiable
- Adsorption- Flupyradifurone is classified as mobile to moderately mobile. K_{oc}=80-283 (mL/g).
- Persistence- Flupyradifurone is persistent to very persistent in soil particles.

Water

- Surface water- Flupyradifurone is characterized as persistent to very persistent and is expected to be mobile; therefore, it can move to surface water through run-off, erosion, and spray drift where it may persist in the surface water and sediments for extended periods of time with a potential for both short-term and long-term exposure to aquatic organisms. However, dissipation in clear, shallow waters can be relatively rapid because of photolysis.
- Groundwater Flupyradifurone has the potential to reach and persist in groundwater for several months following application.
- Half-life via hydrolysis: Stable.
- Sediment: Persistent to very persistent in sediment particles.

Air

- Volatilization- Not a major route of dissipation. Vapor pressure = < 1.7×10^{-6} pa; Henry's Law = 8.1×10^{-13} atm m^3 $mole^{-1}$.

Degradates

Flupyradifurone (parent) has four important degradates; 6-chloronicotinic acid (6-CNA)10, difluoroacetic acid (DFA), BYI 02960-succinamide (M48), and BYI 02960-azabicyclosuccinamide (M47). Of these, only the parent is included in the risk assessment for drinking water from groundwater. Because M48 and M47 are formed by photolysis in shallow surface water, they, along with the parent, are included when drinking water is sourced from surface water. Degradates do not appear to be more toxic than parent to fish, aquatic invertebrates, plants, earthworms, or terrestrial invertebrates (based on the honey bee toxicity data). The degradate DFA, the only residue of concern for terrestrial vertebrates, is considered highly mobile (K_{OC}=17.2-134 mL/g) while the degradate 6-CNA is mobile (1.55-8.75 mL/g); thus they have the potential to runoff or leach to groundwater and persist for extended periods. Model estimates suggest that both M47 and M48 have the potential to be persistent in surface waters. The structures of M47 and M48 are similar to that of the parent compound and are likely to possess a similar mode of action.