



**U. S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460**

**OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION**

PC Code: 122304

DP Barcode: 430349, 430366, 430367

MEMORANDUM

July 18, 2016

SUBJECT: Flupyradifurone: Environmental Fate and Ecological Risk Assessment in support of the Proposed Uses of Flupyradifurone on Ornamentals, Residential, Greenhouse, Nursery, Stone fruit C12-12, Caneberry 13-07A, Taro leaves, Turnip greens, Abiu, Akee Apple, Avocado, Bacury, Banana, Canistel, Cupuacu, Etambe, Jatoba, Kei apple, Langstat, Lanjut, Lucuma, Mabolo Mango, Mangosteen, Paho, Papaya, Pawpaw, Pelipisan, Pequi, Persimmon, Plantain, Pomegranate, Poshte, Quandong, Sapote, Sataw, Screw-pine, Star apple, Tamarind of the indies and Wild loquat.

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Flupyradifurone (PC Code 122304, 2(5H-(furanone), 4-{{(6-chloro-3-pyridinyl)methyl}(2,2-difluoroethyl)amino]-, also known as BYI 02960) is a butenolide insecticide that is persistent, at least moderately mobile, and can be systemically distributed in plants. The Environmental Fate and Effects Division (EFED) first assessed flupyradifurone as a new pesticide active ingredient in 2014 (DP 415164). In 2015, the technical registrant, Bayer CropScience, requested new uses of flupyradifurone for a variety of greenhouse and outdoor ornamental and agricultural crop species. The complete list of proposed new uses can be found in **Appendix A**. EFED has reviewed the proposed new uses of flupyradifurone and degrade residues of concern for their potential effects in the environment, and the exposure and risk conclusions for non-target organisms resulting from

the proposed new uses do not substantially differ from those described in EFED's 2014 risk assessment.

Most proposed uses have a single maximum application rate of 0.18 lbs active ingredient per acre (lbs a.i./A) and a maximum annual application rate of 0.365 lbs a.i./A. This is the same maximum application rate as previously assessed for uses on: crop group 15 cereal grains (except rice), cotton, non-grass animal feeds (forage, fodder, straw, hay), peanut, root vegetables (except sugarbeet), tuberous and corm vegetables, leafy vegetables (except *Brassica* sp.), *Brassica* sp. (cole leafy vegetables), legume vegetables (succulent or dried), fruiting vegetables, cucurbit vegetables, citrus fruit, pome fruit, bushberry (except cranberry), low growing berry (except cranberry), small fruit vine climbing group (except fuzzy kiwifruit), tree nuts, prickly pear, and soybean seeds (ERA DP 415164; USEPA, 2014). The exceptions are the proposed new uses on turnip greens and taro leaves which have a lower yearly application rate of 0.044 lbs a.i./A and 0.007 lbs a.i./A, respectively. Some labels do not specify the maximum number of proposed annual crop cycles, maximum application rate, and minimum retreatment intervals range from "not specified" to 10 days (specifically for residential uses). This creates uncertainty as to the timing and magnitude of individual exposure events, but based on the maximum single and annual application rates which are specified in all cases, the risk conclusions for flupyradifurone are expected to be reasonably protective.

EFED previously concluded potential acute risks to federally listed threatened/endangered species (hereafter referred to as "listed") species of aquatic invertebrates, chronic risks to freshwater invertebrates (when used for multiple crop cycles), acute risks to birds (which also serve as surrogates for terrestrial-phase amphibians and reptiles exposed through the diet), and chronic risks to mammals. Subsequent to the ecological risk assessment for the Section 3 new chemical registration of flupyradifurone, new data have been submitted which are not expected to impact risk estimates but may further characterize risks to aquatic and terrestrial invertebrates; these studies are in review. Two studies have been submitted on acute toxicity to freshwater midge larvae (**MRID 49416617**¹ and **MRID 49416618**²). Regarding terrestrial invertebrates, for the initial Section 3 registration of flupyradifurone, there were 25 laboratory-based studies, 6 semi-field studies, a colony feeding study and 2 full-field studies with honey bees (*Apis mellifera*). Acute and chronic risk levels of concern (LOCs) were triggered for the honey bee based on laboratory toxicity studies, but semi-field and full-field studies indicated only transient effects with no apparent long-term adverse impact. An additional 12 studies involving both *Apis* and non-*Apis* bees have since been submitted to further characterize potential exposure and risks to honey bees and to bumblebees (*Bombus terrestris*). These studies include data on formulated products of flupyradifurone co-formulated with fungicides such as tebuconazole, fluopyram, trifloxystrobin and propineb. An acute oral toxicity test was reviewed and demonstrated that technical grade flupyradifurone is no more than moderately toxic to the bumblebee (**MRID 49846301, Supplemental**) with a 48-hr non-definitive median lethal dose for 50% of the bees tested (LD₅₀) of >8.52 µg a.i./bee. The other submissions are currently in review. These data are not expected to impact the Tier 1 risk estimates for flupyradifurone. However, they may be helpful in further

¹ **MRID 49416617**. Bruns, E. (2013) Acute Toxicity of Flupyradifurone SL50 to Larvae of *Chironomus riparius* in a 48 h Static Laboratory Test System.

² **MRID 49416618**. Silke, G. (2013) Acute Toxicity of Flupyradifurone SL 50A G to Larvae of *Chironomus riparius* in a 48 h Static Laboratory Test System.

refining the assessment. For example, residue data may be used as another line of evidence in the exposure characterization. The toxicity data may be useful for describing risks to different bee species and life stages, and risks from field-relevant mixtures of flupyradifurone and other pesticide active ingredients.

- **MRID 49619802.** Gladbach, D.; Theis, M.; Przyoda, D.; *et al.* (2013) Assessment of Chronic Effects of BYI 02960 Tech. to the Honey Bee, *Apis mellifera* L., in a 10 Days Continuous Laboratory Feeding Test.
- **MRID 49416619.** Schmitzer, S. (2013) Effects of Flupyradifurone SL 50A G (Acute Contact and Oral) on Honey bees (*Apis mellifera* L.) in the Laboratory.
- **MRID 49846301.** Pfeiffer, S. (2016) Flupyradifurone (BY 02960): Acute Oral Toxicity to the Bumble Bee, *Bombus terrestris* L., under Laboratory Conditions. **Supplemental.**
- **MRID 49619901.** Rexer, H. (2013) Determination of Residues of BYI 02960 after Application of BYI 02960 SL 200 G Once Before and Once During Flowering in a Semi-field Honeybee (*Apis mellifera* L.) Study in *Phacelia tanacetifolia* in 2012.
- **MRID 49619902.** Verge, E. (2012) Flupyradifurone SL 200 G: Acute Contact Toxicity to the Bumblebee *Bombus terrestris* L. (Hymenoptera, Apidae) Under Laboratory Conditions (Multi Doses Test).
- **MRID 49619903.** Schmitzer, S. (2012) Effects of a Test Item Mix of Flupyradifurone (BYI 02960) SL 200 G + Tebuconazole (HWG 1608) EW 250C G (Acute Contact) on Honey Bees (*Apis mellifera* L.) in the Laboratory.
- **MRID 49619904.** Schmitzer, S. (2012) Effects of a Test Item Mix of Flupyradifurone (BYI 02960) SL 200 G + Fluopyram SC 500B G (Acute Contact) on Honey Bees (*Apis mellifera* L.) in the Laboratory.
- **MRID 49619905.** Schmitzer, S. (2012) Effects of a Test Item Mix of Flupyradifurone (BYI 02960) SL 200 G + Trifloxystrobin WG 50 W (Acute Contact) on Honey Bees (*Apis mellifera* L.) in the Laboratory.
- **MRID 49619906.** Schmitzer, S. (2012) Effects of a Test Item Mix of Flupyradifurone (BYI 02960) SL 200 G + Propineb WG 70A W (Acute Contact) on Honey Bees (*Apis mellifera* L.) in the Laboratory.
- **MRID 49619906.** Schmitzer, S. (2012) Effects of a Test Item Mix of Flupyradifurone (BYI 02960) SL 200 G + Propineb WG 70A W (Acute Contact) on Honey Bees (*Apis mellifera* L.) in the Laboratory.
- **MRID 49619907.** Schmitzer, S. (2012) Effects of a Test Item Mix of Flupyradifurone (BYI 02960) SL 200 G + Pyrimethanil SC 300 G (Acute Contact) on Honey Bees (*Apis mellifera* L.) in the Laboratory.
- **MRID 49619908.** Schmitzer, S. (2014) Toxicity Testing of a Tank Mix of Flupyradifurone (BYI 02960) SL 200 G + Tebuconazole EW 250C G on Honey Bees (*Apis mellifera* L.) under Semi-Field conditions - Tunnel Test.

Risks of concern were not identified for most aquatic or terrestrial plant species. The likelihood of an adverse effect to listed species of dicotyledonous (dicot) plants could not be estimated because statistically significant ($p < 0.05$) effects were observed at all treatment rates in both vegetative vigor and seedling emergence studies; therefore, the no-observed adverse effect concentration (NOAEC) is non-definitive (*i.e.*, < the lowest application rate revaluated). However, the difference from untreated control plants was less than 25% in both the vegetative vigor and seedling emergence studies.

The maximum annual application rates for the new uses are equal to or lower than currently registered rates for existing uses of flupyradifurone (with the exception of residential use which the maximum application rate is not specified on the label). In addition, some of the previously modeled scenarios covered the proposed new uses such as California (CA) citrus, CA fruits, New Jersey (NJ) Melon, Mississippi (MI) melon, Florida (FL) citrus (just to mention a few). Therefore, exposure and risk conclusions for non-target organisms resulting from the proposed new uses of flupyradifurone do not differ substantially from those described in EFED's 2014 risk assessment (**Appendix B**). **Table 1** and **Table 2** are excerpted from the 2014 risk assessment and provide an overview of ecological risk conclusions for the assessed uses.

Table 1. Summary of risk conclusions for non-target animals for proposed uses of flupyradifurone.

Group	RQs		Risks of Concern			Refinements Used	Uncertainties
	Acute ^{1,2,3,4}	Chronic ⁵ (Effects)	Acute: Listed	Acute: Non-listed	Chronic		
Freshwater Vertebrates	NC ⁶	≤0.01 (fry survival)	None	None	None		--
Estuarine/Marine Vertebrates	NC ⁶	NC ⁷	None	None	Not expected ⁷		No chronic toxicity data available ⁷
Freshwater Invertebrates	0.05-1	0.87-18.8 (emergence/ development rates)	All uses	≥2 crop cycles per season	Most uses		
Estuarine/Marine Invertebrates	0.01-0.26	0.22-4.70 (young/female/day)	Most uses	None	Most uses		
Birds, Reptiles, and Terrestrial Phase Amphibians	<0.01-1.13	0.01-1.49 (parental survival & body weight; multiple reproductive endpoints)	All Uses	All Uses (except hops)	Seed treatment only		
Mammals	NC ⁶	0.01-5.6 (pup body weight and weight gain)	Not Expected	Not Expected	All uses	Days exceeding chronic LOC calculated (spray/drench applications); examined influence of foliar dissipation half-life on RQs	
Honeybees	<0.01-4.8	0.02-12.5 ⁸	NA	All foliar Uses ⁹	All foliar uses ⁹	RQs refined based on empirical residue data; higher-tiered studies available	No chronic oral effects near dose at which acute oral mortality observed

NC = Not calculated; NA = Not applicable

¹ Acute risk to listed species LOC = 0.05 for all animals.

² Acute risk to non-listed species LOC = 0.5 for aquatic animals.

³ Acute risk to non-listed species LOC = 0.1 for terrestrial vertebrates.

⁴ Acute risk to non-listed species LOC = 0.4 for terrestrial invertebrates.

⁵ Chronic risk LOC = 1 for all animals.

⁶ RQs could not be calculated because toxicity endpoints are non-definitive (*i.e.*, greater than the highest concentration tested)

⁷ Chronic toxicity data are not available for estuarine/marine fish; however, based on risk estimations for freshwater fish, chronic risks to this group of organisms are not expected.

⁸ No effects at highest concentration tested.

⁹ Although laboratory-based studies with individual adult bees indicate that 50% of bees will be subject to acute mortality following ingestion of residues at relatively low exposure levels, semi-field studies with whole colonies, in which applications were made while bees were actively foraging at full bloom using maximum proposed foliar application rates, only identified transient increases in adult bee mortality within hours to several days of treatment as compared to untreated control colonies. Colonies exposed to flupyradifurone did not exhibit any detectable long-term effects. Field studies examining colonies through overwintering did not demonstrate any adverse effects in the treated colonies.

Table 2. Summary of risk conclusions for non-target plants for proposed uses of flupyradifurone.

Group	RQs		Risks of Concern		Uncertainties
	Listed Spp. ¹	Non-Listed Spp. ¹	Listed Spp.	Non-Listed Spp.	
Aquatic Vascular Plants	<0.01	NC	None	Not expected	
Aquatic Non-Vascular Plants	<0.01	NC	None	Not expected	
Terrestrial Monocotyledonous Plants	<0.01-0.5	NC ²	None	Not expected	
Terrestrial Dicotyledonous Plants	NC ³	NC ²	Uncertain ³	Not expected	NOAEC not established in seedling emergence or vegetative vigor studies

NC = Not calculated

¹ Risk to aquatic and terrestrial plant listed and non-listed LOC is 1.

² RQs could not be calculated because toxicity endpoints are non-definitive (*i.e.*, greater than the highest concentration tested)

³ RQs could not be calculated because a NOAEC was not established in seedling emergence or vegetative vigor studies.

Appendix A-Proposed Uses of Flupyradifurone

Use Site	Max Single App. Rate in lbs. a.i./A (kg a.i./ha)	# of App Per*	Max App. Rate per year lbs. a.i./A (kg a.i./ha)	MRI (days)	Type of application, label
Ornamentals ¹	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	NS	Drench application and foliar, Altus
Residential ¹	NS (assumed 0.365)	NS (assumed 1)	NS (assumed 0.365)	NS	Drench application, Altus, FDF Ready to use
Nursery ¹	0.14 (0.16)	NS (assumed 2)	0.365 (0.409)	7	Foliar, Altus
Stone Fruits C12-12	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	10	Aerial, Altus
	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	7	Foliar, Sivanto
Caneberry 13-07 A	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	7	Foliar, Altus
	0.122 (0.137)	NS (assumed 3)	0.365 (0.409)	7	Aerial, Sivanto
Taro leaves ¹	0.0023 (0.0026)	NS (assumed 3)	NS assumed 0.007 (0.008)	NS	Foliar, Altus
	0.122 (0.137)	3	0.365 (0.409)	7	Foliar, Sivanto
Turnip greens	0.0044 (0.0049)	1	0.0044	NA	Foliar, Altus
	0.122 (0.137)	3 crops	0.365 (0.409)	7	Aerial, Sivanto
Avocado	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Sataw	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Pequi	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Tamarind of indies	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Abiu	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Pomegranate	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	7	Foliar, Sivanto
	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Altus
Persimmon	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	7	Foliar, Sivanto
	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Altus
Papaya	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	7	Foliar, Sivanto
Mabolo	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Mango	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto and Altus

Use Site	Max Single App. Rate in lbs. a.i./A (kg a.i./ha)	# of App Per*	Max App. Rate per year lbs. a.i./A (kg a.i./ha)	MRI (days)	Type of application, label
Canistel	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Etambe	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Kei apple	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Langstat	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Lucuma	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Pawpaw	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Mangosteen	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Paho	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Quandong	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Wild loquat	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Akee apple	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Pelipisan	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Poshte	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Plantain	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto and Altus
Banana	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto and Altus
Sapote	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Screw-pine	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Start apple	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Lanjut	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Jatoba	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Cupuacu	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto
Bacury	0.18 (0.20)	NS (assumed 2)	0.365 (0.409)	14	Foliar, Sivanto

App=application; MRI=minimum retreatment interval; PHI=preharvest interval; NA=not applicable; NS=not specified on the label; a.i.=active ingredient; A=acre

*Applications limitations were on a single and crop number application basis. It is possible that the chemical could be applied over multiple crops to one field.

¹ There are uncertainties regarding the application rate on these crops as the labels do not provide the information.

Appendix B
2014 Environmental Fate and Ecological Risk Assessment for Foliar, Soil Drench, and Seed Treatment Uses of the New Insecticide Flupyradifurone (BYI -2960)



ERA 2014