



The Chemical Company

Sultan™ Miticide

U.S. Technical Information Brochure

This brochure is for the education of university researchers, distributors, retailers and consultants only.

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Note: *This brochure is for the education of university researchers, distributors, retailers and consultants only. Sultan™ miticide is not currently registered and is not for sale. This educational material is provided for informational purposes and is not intended to promote the sale of the product.*

Any sale of this product after registration is obtained shall be solely on the basis of the EPA approved product label, and any claims regarding product safety and efficacy shall be addressed solely by the label.

Introduction

Cyflumetofen, the active ingredient in *Sultan*[™] miticide, belongs to the beta-ketonitrile class of chemistry, which has a novel mode of action. *Sultan* miticide will be the first Insecticide Resistance Action Committee (IRAC) Group 25 product in North America.

Sultan miticide controls all life stages of Tetranychid mites (spider mites) and *Brevipalpus* species (false spider mites) – eggs, nymphs and adults – in ornamentals grown in greenhouses, nurseries and landscapes. Tests have shown that *Sultan* miticide is also highly effective against mites that have developed resistance to other acaricides, showing no indication of cross-resistance problems.

On contact, *Sultan* miticide provides good knockdown and long residual activity while showing excellent plant safety. *Sultan* miticide also has a favorable toxicological profile with regard to non-target and beneficial organisms (see page 7).

Key Features and Benefits:

- High efficacy against all life stages of mites
- Unique, alternative mode of action for integrated pest management
- No cross-resistance to other commercial miticides
- Excellent safety to ornamentals
- Practically non-toxic to mammals, beneficial mites, predatory insects and pollinators
- Rapid knockdown of targeted mites



above:

Sultan miticide controls all life stages of spider mites in ornamentals grown in greenhouses, nurseries and landscapes.



Mites Controlled by *Sultan*™ Miticide

The following table provides an overview of key mites controlled by cyflumetofen, the active ingredient in *Sultan* miticide.



Scientific Name	Common Name
<i>Oligonychus ilicis</i>	Citrus red mite
<i>Oligonychus ununguis</i>	Spruce spider mite
<i>Tetranychus cinnabarinus</i>	Carmine mite
<i>Tetranychus gloveri</i>	Glover mite
<i>Tetranychus pacificus</i>	Pacific spider mite
<i>Tetranychus urticae</i>	Twospotted spider mite



Mode of Action

Cyflumetofen's novel mode of action involves inhibition of the mitochondrial electron transport complex II enzyme within mite cells. This inhibition halts the production of ATP, rapidly depleting the cell of energy, which leads to paralysis and death of the affected mites. Cyflumetofen's mode of action is unique compared to the other miticides shown below. This unique mode of action imparts cyflumetofen's mite selectivity, and provides another mite control option for resistance management and sound integrated pest management.

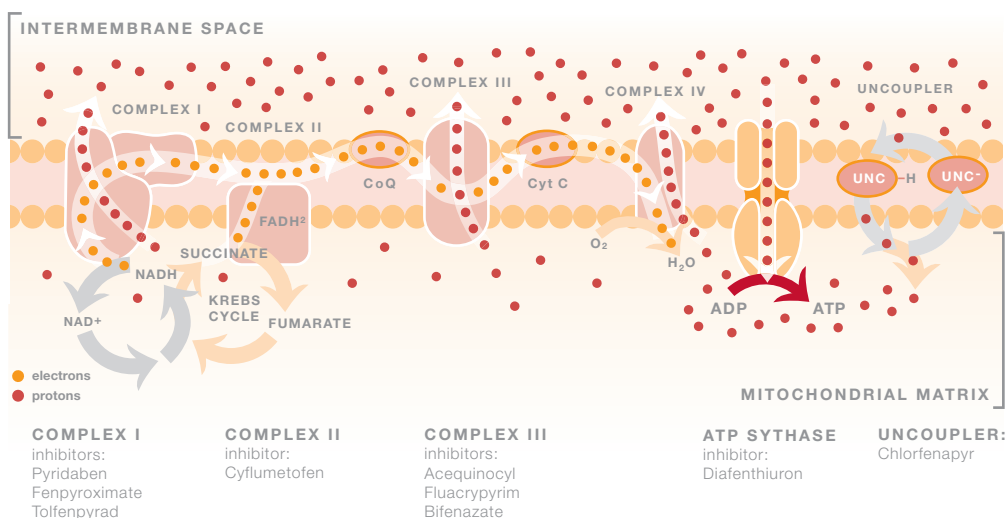
above:

Sultan miticide protects against the twospotted spider mite, the spruce spider mite, and the Pacific spider mite.

High energy electrons derived from nutrients travel through the four protein complexes of the mitochondrial electron transport chain, along the pathways shown in orange in the figure below, powering expulsion of protons from the mitochondrial matrix into an intermembrane space between the inner and outer membranes. Flow of these high energy protons back into the matrix through a fifth protein complex, ATP synthase, drives synthesis of ATP, the high energy molecule that supplies all energy needed within cells.

right:

The normal functioning of the electron transport chain, showing various action sites of electron transport chain inhibitor insecticides.



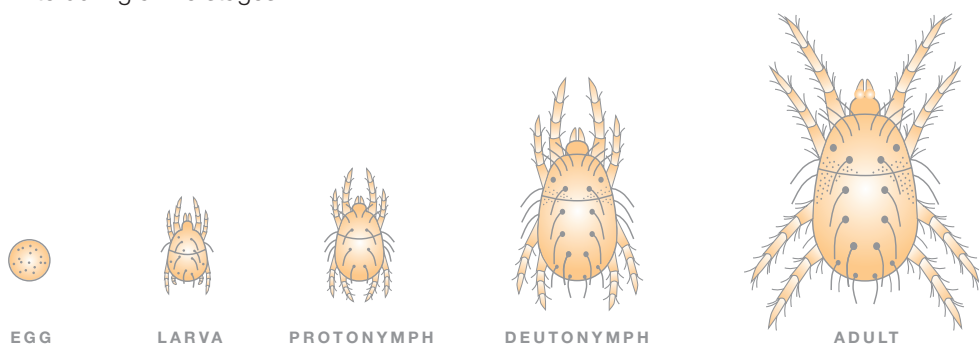
Four of these five mitochondrial protein complexes are important targets for the miticides shown. Chlorfenapyr disrupts mitochondria by yet a fifth mechanism: by ferrying the high energy protons back into the matrix so that they cannot drive ATP synthesis. Since complex II, the target of cyflumetofen is part of the Krebs cycle, where NADH is generated from NAD+ produced by complex I, blocking either complex inhibits most electron transport.

Efficacy and Plant Safety

Sultan™ miticide has been submitted for registration for foliar applications on many annual and perennial ornamental species. Research has shown that *Sultan* miticide, formulated as a suspension concentrate (1.6 lbs a.i./gallon), with use rates of 0.1 - 0.4 lbs a.i./100 gallons finished spray, will control all mite life stages when used in both greenhouses and on plants grown in the nursery or landscape. No phytotoxicity has been observed after two applications 14 days apart at use rates of 0.1 - 0.7 lb a.i./100 gallons finished spray.

Life Stages of a Mite

Shown below are the typical growth stages of a plant-feeding mite. Eggs are usually found attached to plant leaves or in silken webs, the first evidence of infestation. Left unchecked, the mites develop through two nymph stages before maturing into adults. *Sultan* miticide protects against the twospotted spider mite, the spruce spider mite and the carmine spider mite during all life stages.

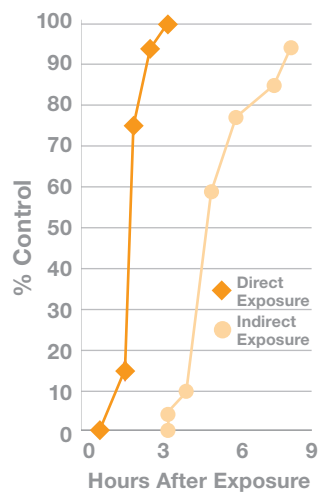


Knockdown and Residual Activity

Sultan miticide provides rapid knockdown of targeted mite pests through contact activity, typically observed within 3 hours of application. For optimal activity, *Sultan* miticide will be recommended for applications made at economic pest infestation thresholds.

When properly applied, *Sultan* miticide has been observed to control mite populations for up to 28 days after application. Once dried on the foliage, the product is rainfast, with no significant reduction in efficacy due to subsequent rainfall or dew. However, application of the product is not recommended when heavy rainfall is expected within one hour of application.

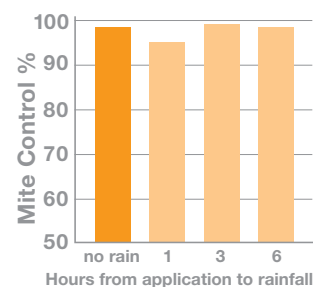
Sultan Miticide Speed of Control



above:

Sultan miticide provides rapid control of mites via direct spray contact, or indirect contact from a treated substrate as shown in a BASF study.

Rainfastness of Cyflumetofen



above:

Efficacy of cyflumetofen against twospotted spider mites without a simulated rainfall event, and 1, 3 and 6 hours after 0.5 inches of simulated rainfall, as shown in a BASF study.

Research Trial Results

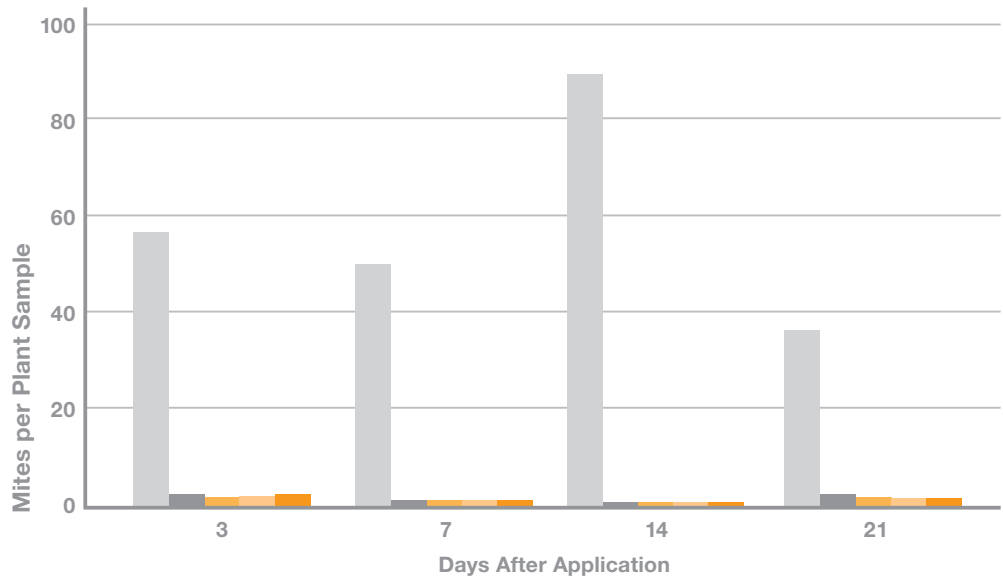
Trial results show that *Sultan*[™] miticide is a highly effective mite control solution, offering excellent efficacy and long residual activity against all mite life stages while being practically non-toxic to beneficial arthropods. These attributes combine to make *Sultan* miticide a valuable tool for integrated pest management.

Mite Control Under Greenhouse Conditions

The charts below show the efficacy of *Sultan* miticide against twospotted spider mite (*Tetranychus urticae*) motiles and eggs on marigold under greenhouse conditions.

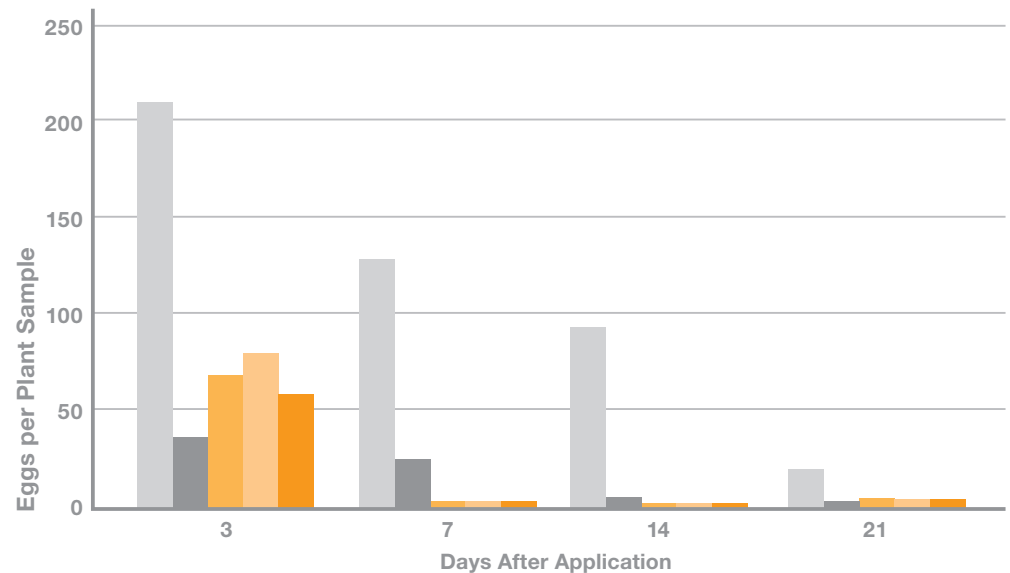
Products Researched

- Untreated
- Floramite® 4 fl. oz./100 gal.
- *Sultan* 9 fl. oz./100 gal.
- *Sultan* 7 fl. oz./100 gal.
- *Sultan* 13.7 fl. oz./100 gal.



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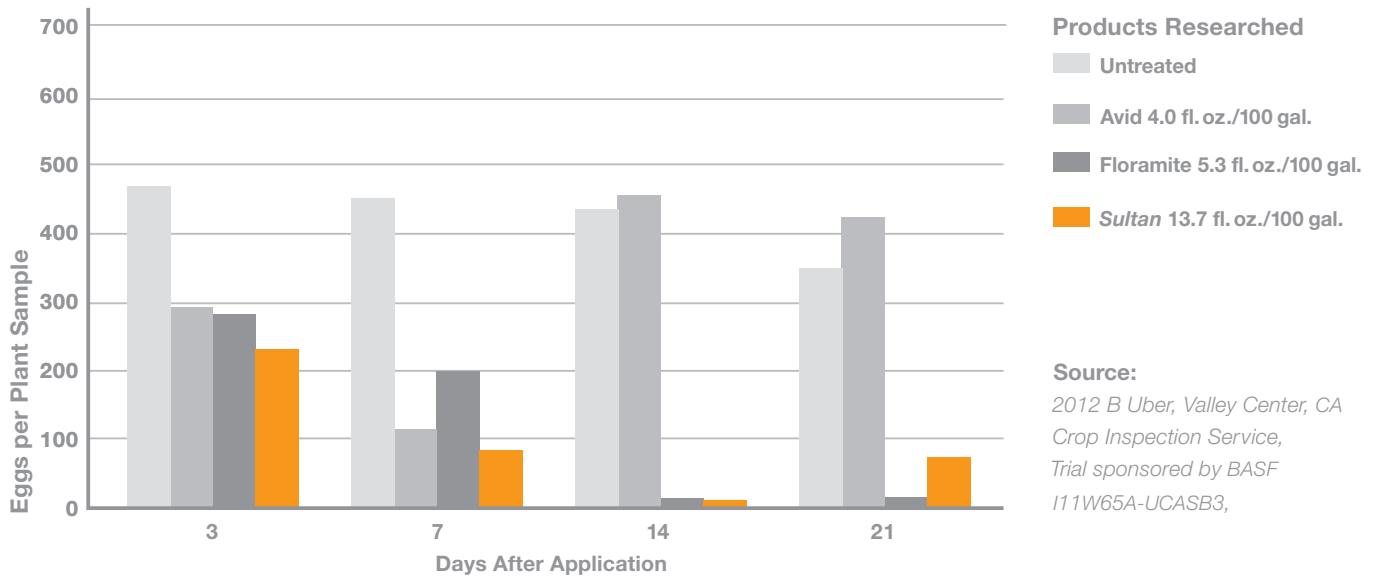
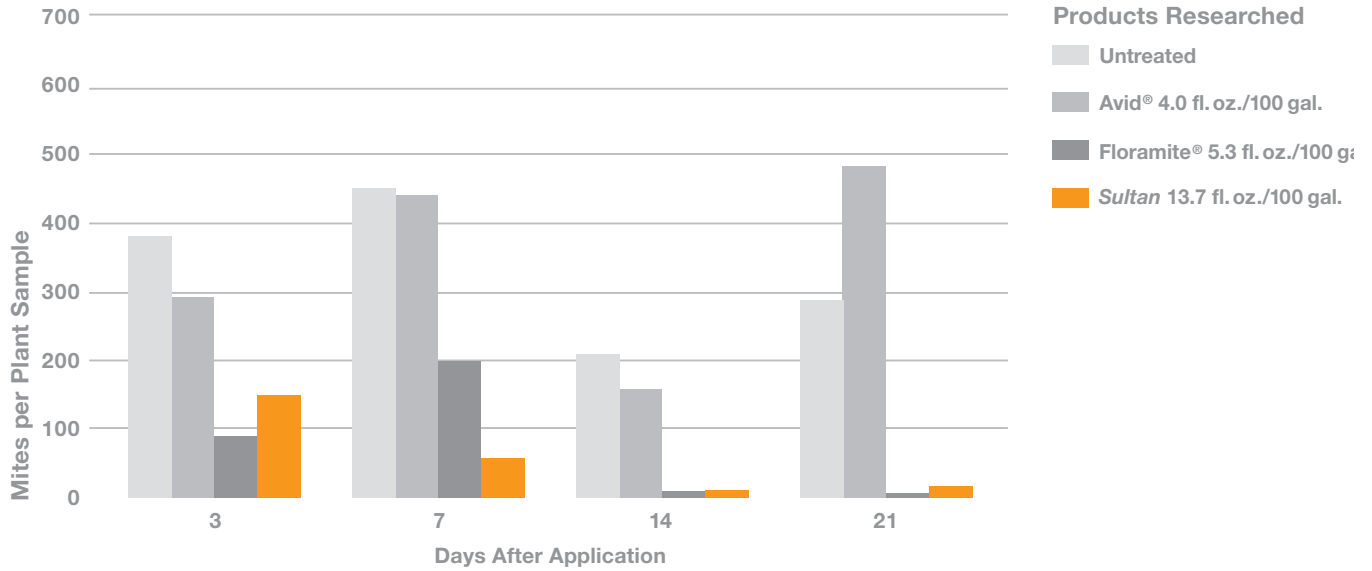


Source:

2012, Florence, SC
 Clemson Univ., JC Chong,
 Trial sponsored by BASF
 I12W62A-USCG01

Mite Control Under Nursery Conditions

The charts below show the efficacy of *Sultan*™ miticide against twospotted spider mite (*Tetranychus urticae*) motiles and eggs on marigold under nursery conditions.



Adjuvants

Under some conditions, the use of additives or adjuvants may improve the performance of cyflumetofen. The compatibility with a broad range of commercially available tank mix partners is currently under evaluation. Research with cyflumetofen includes a variety of site and use conditions such as methods of application, application equipment and growth stages of plants produced in ornamental operations.

Resistance Management

Sultan[™] miticide has demonstrated high efficacy against mites that have developed resistance to other acaricides. No instances of target site cross-resistance have been observed. Because of its unique mode of action, cyflumetofen is an important insecticide resistance management tool when used according to good agricultural practices and when local resistance management recommendations are followed. BASF recommends the following integrated pest management (IPM) techniques:

- Rotate miticides with different modes of action; ensure that each generation is treated just one time with the same miticide mode of action
- Always follow local IPM recommendations and the recommended thresholds for each insect/mite pest
- Apply the recommended label dose rate during the proper timing to ensure complete control of the pest species
- Follow good application techniques in order to maximize the product activity; applications at less than the recommended label rate will allow the surviving mites to build up the population again, increasing the pest pressure and potentially triggering resistance problems in the future

Toxicological and Environmental Profile

Toxicity to Honeybees

Unlike many insecticides and miticides that have bee toxicity issues, cyflumetofen is practically non-toxic to bees.

Species	Study	Effect Level
Honeybee, <i>Apis mellifera</i>	Acute contact	LD ₅₀ > 102 µg a.i./bee

Toxicity to Beneficial Insects

Cyflumetofen has been tested against a wide range of beneficial arthropods, including predatory mites. The results from standard laboratory bioassays indicate that cyflumetofen does not impact a variety of non-target arthropod species, including parasitic wasps, predatory mites, predatory bugs, ladybird beetles, rove beetles and lacewings, when the organisms are exposed to fresh residues on inert substrates. Due to its highly selective nature, cyflumetofen will be a good fit in integrated pest management programs, or in programs that release beneficial mites, as it is likely to have little impact on the predatory mite populations.

Non-Target Arthropod Species

Species	Scientific Name
Acari	<i>Amblyseius californicus</i> , <i>Amblyseius cucumeris</i> , <i>Amblyseius womersleyi</i> , <i>Galendromus occidentalis</i> , <i>Neoseiulus fallacis</i> , <i>Phytoseiulus persimilis</i> , <i>Typhlodromus pyri</i>
Hymenoptera	<i>Aphidius colemani</i> , <i>Aphidius rhopalosiphi</i> , <i>Encarsia formosa</i> , <i>Neochrysocharis formosa</i> , <i>Trichogramma</i> spp.
Coleoptera	<i>Harmonia axyridis</i> , <i>Oligota kashmirica benefica</i> , <i>Stethorus japonicus</i>
Heteroptera	<i>Orius strigicollis</i> , <i>Macrolophus caliginosus</i>
Neuroptera	<i>Chrysoperla carnea</i>
Thysanoptera	<i>Scolothrips takahashii</i>



above:

Unlike many insecticides and miticides that have bee toxicity issues, cyflumetofen is practically non-toxic to bees.

below:

Beneficial parasitic wasps, like these, prey on destructive cutworms or hornworms.

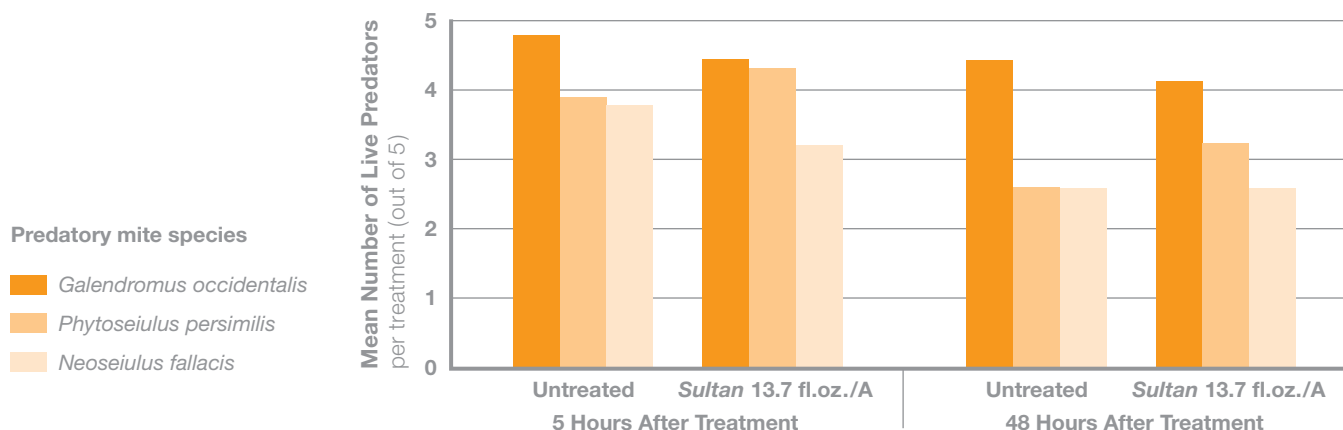


above:

Ladybird beetles are a good natural defense against aphids. Sultan™ miticide is highly effective on target pests while being practically non-toxic to beneficial insects.

Impact on Beneficial Mites

The graph below shows the impact of *Sultan*[™] miticide when applied directly to three species of predatory mites. Mite survival was determined 5 and 48 hours after direct spray.



Toxicity to Aquatic Species

Cyflumetofen is poorly soluble in water and will not dissolve to a significant extent. As required by regulatory agencies, the toxicity of cyflumetofen has been tested up to the limit of its solubility for a variety of aquatic organisms. These studies demonstrate that cyflumetofen has no effect on aquatic organisms at its maximum dissolved concentration. Furthermore, cyflumetofen rapidly hydrolyzes in water, especially at pH above 7.0. Degradates of cyflumetofen also exhibit low toxicity to aquatic organisms.



above:
Studies show that cyflumetofen has no effect on aquatic organisms like rainbow trout.

There is no bioaccumulation concern, because cyflumetofen and its metabolites do not accumulate in fish tissue (carp).

Species	Study	Effect Level*
Rainbow trout, <i>Oncorhynchus mykiss</i>	Fish, acute	96 h LC ₅₀ > 0.0175 mg a.s./L
Fathead minnow, <i>Pimephales promelas</i>	Fish, acute	96 h LC ₅₀ > 0.0292 mg a.s./L
Fathead minnow, <i>Pimephales promelas</i>	Fish, early life stage	34 d NOEC ≥ 0.0292 mg a.s./L
Water flea, <i>Daphnia magna</i>	Daphnia, acute	48 h LC ₅₀ > 0.0172 mg a.s./L
Water flea, <i>Daphnia magna</i>	Daphnia, reproduction	34 d NOEC ≥ 0.0162 mg a.s./L
Green algae, <i>Pseudokirchneriella subcapitata</i>	Algae growth	96 h EC ₅₀ > 0.0238 mg a.s./L

* Nominal concentrations of the test substance were maintained at the solubility threshold using a generator column. Therefore, effect levels are at or above the water solubility of the test substance.

Toxicity to Earthworms and Effects on Soil Microflora

Cyflumetofen is practically non-toxic to earthworms. At the maximum concentration typically tested in regulatory studies (1,000 mg a.i./kg) with the preferred species, *Eisenia fetida*, no mortality was caused by cyflumetofen (14 d acute LC₅₀ > 1,000 mg/kg soil). In a 56-day test, including reproduction, no adverse effect was caused to earthworms (56 d NOEC ≥ 1,000 mg/kg soil).

Experimental studies have shown that cyflumetofen applied at rates well above commercial rates did not affect nitrification and soil respiration processes, which show that cyflumetofen does not affect soil microbial activity.

Species	Study	Effect Level
Earthworm, <i>Eisenia fetida</i>	Earthworm, acute	14 d LC ₅₀ > 1,000 mg/kg soil
Earthworm, <i>Eisenia fetida</i>	Earthworm, reproduction	56 d NOEC ≥ 1,000 mg/kg soil

Mammalian Toxicology

Cyflumetofen has low oral, dermal, and inhalation acute toxicity. Cyflumetofen is not irritating to the skin, is slightly irritating to the eye, and is a dermal sensitizer. Cyflumetofen does not cause neurotoxic or immunotoxic effects, does not have teratogenic potential, does not impair reproduction, and is not genotoxic.

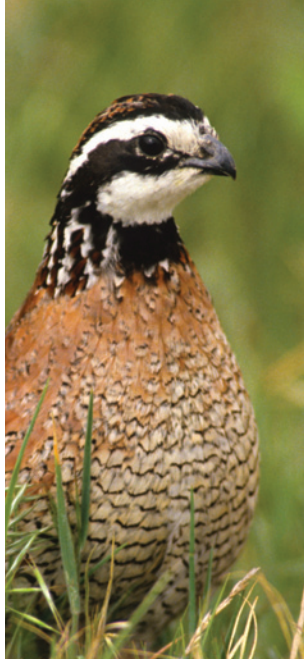
Species	Study	Effect Level
Rat	Acute oral	LD ₅₀ > 2,000 mg/kg bw
Rat	Acute dermal	LD ₅₀ > 5,000 mg/kg bw
Rat	Acute inhalation	LC ₅₀ = > 2.65 mg/l
Rabbit	Skin irritation	Non irritating
Rabbit	Eye irritation	Slightly irritating
Guinea pig	Skin sensitization (maximization)	Sensitizing



above:
Cyflumetofen is practically non-toxic to earthworms.



above:
Cyflumetofen has low oral, dermal and inhalation acute toxicity.



above:

Cyflumetofen has been shown to be practically non-toxic to birds such as the Bobwhite quail.

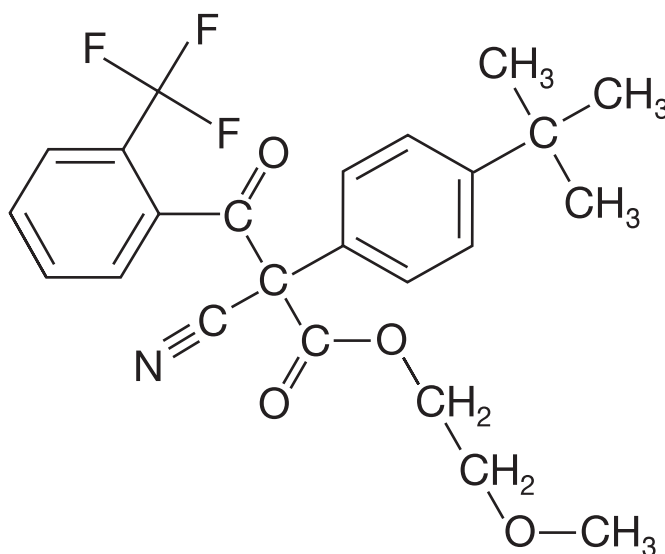
Toxicity to Avian Species

Cyflumetofen has been studied in a number of avian species. In each case, cyflumetofen has been shown to be practically non-toxic to birds.

Species	Study	Effect Level
Bobwhite quail, <i>Colinus virginianus</i>	Bird, acute oral	LD ₅₀ > 2,000 mg a.s./kg bw NOEL = 74 mg a.s./kg bw
Bobwhite quail, <i>Colinus virginianus</i>	Bird, acute dietary	LC ₅₀ > 5,000 mg a.s./kg feed NOEL = 1,250 mg a.s./kg feed
Bobwhite quail, <i>Colinus virginianus</i>	Bird, acute reproduction	NOEL ≥ 1,000 mg a.s./kg feed
Mallard duck, <i>Anas platyrhynchos</i>	Bird, acute oral	LD ₅₀ > 2,250 mg a.s./kg bw NOEL ≥ 2,250 mg a.s./kg bw
Mallard duck, <i>Anas platyrhynchos</i>	Bird, acute dietary	LC ₅₀ > 5,620 mg a.s./kg feed NOEL ≥ 5,620 mg a.s./kg feed
Mallard duck, <i>Anas platyrhynchos</i>	Bird, reproduction	NOEL ≥ 1,000 mg a.s./kg feed
Zebra finch, <i>Taeniopygia guttata</i>	Bird, acute oral	LD ₅₀ > 2,000 mg a.s./kg bw NOEL ≥ 2,000 mg a.s./kg bw

Physical and Chemical Properties

BSI common name	Cyflumetofen (ISO 1750 approved)
Chemical family	Beta-ketonitrile derivatives
CAS Number	400882-07-7
Chemical name (IUPAC)	2-methoxyethyl (<i>RS</i>)-2-(4- <i>tert</i> -butyl phenyl) -2-cyano-3-oxo-3-(<i>a, a</i> -trifluoro- <i>o</i> -tolyl)propanoate
Chemical name (CA)	2-methoxyethyl <i>a</i> -cyano- <i>a</i> -[4-1,1-dimethylethyl]phenyl]- <i>β</i> -oxo2-(trifluoromethyl)benzene propanoate
Molecular formula	C ₂₄ H ₂₄ F ₃ NO ₄
Molecular mass	447.45
Appearance	White to pale yellow solid powder
Odor	No characteristic odor
Melting point	77.9° - 81° C
Density	1.229 g/cm ³
Octanol/water partition coefficient (log)	at 25° C: 4.3
Vapor pressure	at 25° C: < 5.9 x 10 ⁻⁶ Pa
Solubility in water	at 20° C: 28µg/L
pH:	4.31 at 25° C





BASF Agricultural Products
26 Davis Drive
Research Triangle Park, NC 27709
USA
+1 919-547-2000
www.betterplants.basf.us

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