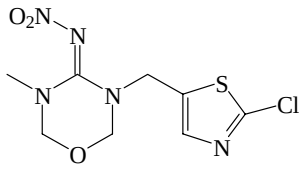
ENVIRO*facts* ***Syngenta Crop Protection***

Thiamethoxam

Used to formulate Platinum®, Actara®, Centric®, Cruiser®. Flagship®, and Helix®

Chemical Structure:



Chemical Nomenclature:

CAS Name: 4H-1,3,5-Oxadiazin-4-imine,3-[(2-chloro-5-thiazolyl)methyl)methyl]tetrahydro-5-methyl-N-nitro

CAS No.: 153719-23-4

Use: Broad spectrum neonicotinoid insecticide

Molecular Formula:	$C_8H_{10}ClN_5O_3S$	*Physical Properties:*	
Molecular Weight:	291.72	State:	Fine Crystalline powder
		Melting Point:	139.1°C
Physicochemical Properties:		*Chemical Stability:*	
Aqueous Solubility:	4100 mg/l @ 25°C	Aqueous Photolysis ($t_{1/2}$):	2-3 days @ pH 5 and 25°C
Log P:	-0.13 @ 25°C	Aqueous Hydrolysis ($t_{1/2}$ @ 25°C):	Stable at pH 5, 572-643 days at pH 7 and 4-8 days at pH 9
Vapor Pressure:	6.6×10^{-9} Pa @ 25°C	Volatility:	Nonvolatile
Henry's Law Constant:	4.7×10^{-10} Pa m^3 mol^{-1}		
Environmental Fate Profile:		*Ecotoxicological Profile:*	
Soil photolysis ($t_{1/2}$):	47-54 days	Wildlife:	
Lab aerobic soil metabolism ($t_{1/2}$, sandy loam):	25-32 days (dissolved phase)	Bobwhite Quail	LD50 = 1552 mg/kg
		Mallard	LD50 = 576 mg/kg
	69-132 days (desorption phase)	Rat	LD50 = 1563 mg/kg
		Bees:	
		Honeybee (contact)	LD50 = 0.024 ug/bee
		Honeybee (acute oral)	LD50 = 0.005 ug/bee
Field soil dissipation ($t_{1/2}$):	5-100 days (average 29)		
		Earthworm	EC50 = >1000 mg/kg soil
Koc:	Short-term batch-equilibrium: 33-177 (average 70)	Fish:	
		Rainbow Trout	LC50 = >100 ppm
	Aged: 163-638 (average 308)	Bluegill	LC50 = >114 ppm
		Sheepshead Minnow	LC50 = >111 ppm
Sediment/water ($t_{1/2}$, anaerobic aquatic):	24-44 days	Aquatic Invertebrates:	
		Daphnia magna	EC50 = >100 ppm
Sediment/water ($t_{1/2}$, aerobic aquatic):	8 - 16 days	Aquatic Plants/Algae:	
		Green algae	EC50 = >100 ppm
		Lemna	EC50 = > 90 ppm

Application Rates: For the control of many sucking and chewing insects, at rates of 88 to 140 g/ha (soil) and 26 to 96 g/ha (foliar). Actual rate range depends on crop. Maximum annual total is 140 g/ha. Crops registered for soil and/or foliar application include fruiting vegetables, cucurbits, potatoes, pome and stone fruit, tobacco, pecans, strawberries, and cotton. Cruiser® or Helix® products are used as seed treatments on a wide variety of crops including corn, cotton, sorghum, barley, wheat, potatoes, sunflowers, and legumes.

Environmental Risk Summary: The exposure of non-target species is limited by the rapid dissipation of thiamethoxam and its low use rates. Most aquatic species are at low risk. Terrestrial invertebrates such as bees and some beneficial species may be temporarily affected but, overall, risks to terrestrial invertebrates are low. The risks to birds and mammals from residues in food are low.

Environmental Overview

The safety of a chemical in the environment and potential risk to non-target plants and animals is determined not only by the inherent toxicity of a chemical to these species but also by the level of exposure that they experience. Exposure is determined by the application rate and the fate of the chemical in the environment. In the absence of chemical exposure, there is no opportunity for toxicological effects.

Terrestrial Environment

With foliar applications, the majority of thiamethoxam will contact target plant foliage, with a smaller amount falling onto the soil depending on extent of canopy cover. On plant surfaces and to a lesser extent on the very top layer of soil, the compound is degraded photolytically. Plants take up thiamethoxam rapidly through both the leaves and roots. In soil, the primary degradation pathway for thiamethoxam is microbial and the rate of dissipation relatively quick, increasing under warm, moist conditions and decreasing under dryer and cooler conditions. Thiamethoxam adsorbs to the soil over a period of days. Once thiamethoxam is adsorbed to the soil, it is less readily desorbed, and unlikely to leach. Thiamethoxam is not toxic to earthworms and studies have shown that, when used at the highest labeled rates, there are no effects of thiamethoxam or its metabolites on earthworms or on any of the nutrient cycling processes mediated by microorganisms. No adverse effects of the compound on the fertility of the soil are to be expected. Thiamethoxam is highly toxic to bees exposed to direct treatment or residue on blooming crops, but exposure is minimized by following label directions. Since thiamethoxam controls insects that are *feeding* on the plant and since thiamethoxam is rapidly dissipated from leaf surfaces, beneficial species *walking* on the leaf surface tend to avoid exposure. Field studies have shown transient decreases in the abundance of some predators and parasites after the application of thiamethoxam, but their populations recover to pre-application levels.

Thiamethoxam is moderately toxicity to birds and mammals when applied as a single dose; however, when there is chronic exposure to residues of the chemical in food, studies show that thiamethoxam is rapidly excreted and does not accumulate in animals. The risk to birds and mammals in the field is driven by their exposure to residues in foodstuffs, such as foliage, grain or invertebrates that have been sprayed. Because of the rapid dissipation of thiamethoxam on these foodstuffs, the risk to wildlife is low. Thiamethoxam will not accumulate in terrestrial ecosystems.

Aquatic Environment

If thiamethoxam enters a natural water body such as a pond or creek, it rapidly dissipates by a variety of routes. It is rapidly adsorbed to sediment. Degradation through sunlight in water is rapid. In the absence of sunlight, thiamethoxam degrades in the aquatic/sediment environment with a half-life of 24-44 days under anaerobic conditions and with a half-life of 8-16 days under aerobic conditions. With the combined degradation pathways, it is thus expected that thiamethoxam will dissipate quickly in natural water systems.

Thiamethoxam is not toxic to a wide range of fish and algae species and is not predicted to cause any risk to them. Though it is not toxic to many invertebrate species, it is toxic to some, particularly insect larvae. Because of the very rapid dissipation of thiamethoxam by microbial degradation, photolysis and adsorption in natural water, risks to these species are low and transient. Thiamethoxam will not accumulate in aquatic ecosystems.

Common Questions and Answers

Q. How does thiamethoxam work?

A. Thiamethoxam comes from a family of insecticides known as the second-generation neonicotinoids. The neonicotinoids disrupt the transmission of impulses between nerve cells in insects by blocking the reception of signals. Within 15-60 minutes after exposure, insects stop feeding, withdraw their sucking mouthparts and stretch their legs and antennae. Death follows between a few hours and two days later, depending on the species.

Q. Is thiamethoxam just like nicotine, only much more powerful and therefore very dangerous?

A. The neonicotinoid insecticides have been developed to have properties different from nicotine. Thiamethoxam is very active in insects, but has very low activity in higher animals such as mammals. Although thiamethoxam and nicotine both disrupt the transmission of impulses between insect nerve cells, it is believed that thiamethoxam does it in a slightly different way. Thiamethoxam and nicotine also have different properties in treated plants after application.

Q. What happens to thiamethoxam after it has been sprayed onto a plant?

A. When a foliar application is made in accordance with the instructions on the label, the majority of the thiamethoxam will come into contact with the target plant leaves and be quickly absorbed. Thiamethoxam is also taken up by the plant from the smaller amounts that land on the soil. At the leaf surface, thiamethoxam is quickly degraded, 30% within the first two days. Inside the plant, thiamethoxam that is absorbed from either leaves or soil moves in the xylem towards the leaf tips. Once inside the plant tissues, the chemical is rapidly metabolized.

Q. What happens to thiamethoxam when it is applied to the soil or reaches the soil after a foliar application?

A. The primary degradation pathway for thiamethoxam in soil is microbial. In addition, sunlight on the soil surface can significantly increase the rate of degradation. Hydrolysis in alkaline conditions is also important.

Q. How does thiamethoxam bind to the soil?

A. The process by which agrochemicals become immobilized in the soil is known as adsorption. Thiamethoxam binds to soil in a unique time-dependent nature. Upon application, the material dissolves in the soil pore water and begins the adsorption process to the soil matrix. This “uptake” of

thiamethoxam from the aqueous phase is initially quick, but slows down as more thiamethoxam leaves the dissolved phase. Once bound to the soil, thiamethoxam is less readily desorbed into the pore water, and thus less likely subject to potential leaching.

Q. Since this adsorption process is complex, how persistent are thiamethoxam and its degradates in the soil?

A. The rate of dissipation in soil is relatively quick, with plow layer dissipation half-lives in field experiments ranging from 5 to 100 days (29 days on average). The rate of dissipation is increased under warm, moist conditions and decreased under dryer and cooler conditions.

Q. Will thiamethoxam and its metabolites accumulate in the soil?

A. Based on its environmental profile, neither thiamethoxam nor any of its degradates are expected to accumulate in soil.

Q. Since thiamethoxam is soluble in water and can persist for several months in the soil, is it likely to leach into groundwater?

A. Some simple physical properties of thiamethoxam and its major metabolites, such as relatively high solubility and weak adsorption immediately after application, may indicate potential leaching in the soil profile. However, as adsorption increases over time, the leaching potential becomes limited because the desorption from the adsorbed phase is slow and degradation in the dissolved phase (i.e. soil pore water) is quick (half-life 25-32 days). The leaching potential of thiamethoxam has been evaluated in a range of laboratory and field studies and found to be decreased under field conditions. Field experiments have been conducted over a 2-yr period to assess the leaching potential under worst-case conditions of light soils, low organic matter, highest application rates and high levels of irrigation. These experiments showed minimal movement of thiamethoxam and its aerobic soil metabolites compared to predictions by its simple solubility and short-term adsorption parameters.

Q. Could residues of thiamethoxam and its metabolites in the soil have effects on soil organisms such as earthworms and microorganisms that maintain the fertility of the soil?

A. Laboratory studies have shown that there are no effects of thiamethoxam on earthworms at greater than 500 times the normal application rate. The aerobic metabolite was shown to have a low level of toxicity to earthworms in the laboratory, the LC_{50} being about 100 times less than the predicted concentration in the soil. In order to investigate this further, laboratory and field studies were conducted over the entire life cycle of the earthworm to detect any chronic effects. The laboratory study at 5 times the maximum use rate and the field study at the maximum rate showed no effects. It can be concluded that thiamethoxam does not pose a risk to earthworms.

Laboratory studies of the effects of thiamethoxam and its major aerobic metabolites have shown that there are no effects on microbial processes in the soil. Carbon and nitrogen cycles are unaffected. Since thiamethoxam and its major aerobic metabolites do not have any adverse effects on earthworms and soil microorganisms, they will not affect the fertility of the soil.

Q. Since thiamethoxam is a potent insecticide, will it affect beneficial insects such as predators and parasites of pests?

A. The effects of thiamethoxam have been extensively studied in the laboratory, under controlled field conditions and in the field. In general, thiamethoxam is of low to moderate risk to invertebrate predators and parasites. In the field, beneficial insect populations decrease after application but recover within 2 to 6 weeks. Predatory mites have been shown to have lower sensitivity to thiamethoxam, making it useful in crops where such predators can be important, e.g. cotton and tree fruits. Exposure of beneficial species walking on leaves is limited by the rapid photolysis of residues and absorption into the leaf.

Q. Since thiamethoxam is a potent insecticide, will it affect honeybees and other pollinators?

A. Thiamethoxam is highly toxic to bees exposed to direct treatment or residues on blooming crops. However, toxicity can be easily prevented by following all label directions. Do not apply thiamethoxam or allow it to drift to blooming crops or weeds if bees are visiting the treatment area. After an application, wait the required interval before placing beehives in the treated field. Care with application timing (relative to crop/weed bloom and beehive placement) avoids bee injury.

Q. Will thiamethoxam drift into water bodies?

A. Thiamethoxam is not volatile; this means that it will not form a *vapor* that could disperse widely from the application site. The use of appropriate, well maintained equipment and recommended spraying pressures and conditions will minimize *spray* drift.

Q. Can thiamethoxam move in runoff water from the field following rainfall and contaminate water bodies?

A. Thiamethoxam is adsorbed and extensively degraded in sediment and water; water residues are also rapidly degraded by a combination of phytolytic, aerobic and anaerobic routes. In addition, "aged" residues in soil appear to be more strongly bound than fresh ones and so the availability of thiamethoxam in run-off water appears to be very low.

Q. What happens to thiamethoxam if it does get into a water body such as a pond or creek?

A. If thiamethoxam enters a natural water body such as a pond or creek, it rapidly dissipates by a variety of routes. It is rapidly adsorbed to sediment. A combination of abiotic and biotic degradation processes, such as sunlight and microorganisms, degrades thiamethoxam. Degradation by sunlight in water is rapid, with a half-life of 2-3 days. Thiamethoxam is resistant to hydrolysis in acidic conditions; however, the hydrolysis half-life becomes only 4-8 days when pH increases to 9. In the absence of sunlight, thiamethoxam degrades in the aquatic/sediment environment with a half-life of 24-44 days under anaerobic conditions and with a half-life of 8-16 days under aerobic conditions. As a result of the combined adsorption, photolysis, microbial degradation, and hydrolysis, it is expected that thiamethoxam will dissipate quickly in natural water systems.

Q. Other nerve-poison insecticides are known to be toxic to fish. Is thiamethoxam toxic to fish?

A. Thiamethoxam and its main water metabolites are not toxic to freshwater and estuarine fish. There are substantial safety margins between the maximum levels predicted in the field and the highest concentrations having no effect in the laboratory.

Q. Since thiamethoxam is a potent insecticide, will it affect aquatic invertebrates?

A. In the laboratory thiamethoxam has been tested against at least 14 different species of freshwater and estuarine invertebrates. About half of these species (mostly insects) were found to be susceptible to thiamethoxam. However, due to the very rapid dissipation of the chemical in natural water, the predicted risk is low.

Q. Could thiamethoxam affect anything else that lives in water?

A. Thiamethoxam and its main water metabolite have been shown to be of low toxicity to green algae and bacteria and are not predicted to cause any effects in natural water.

Q. Will thiamethoxam and its water metabolites accumulate in sediment or the aquatic ecosystem?

A. The dissipation of thiamethoxam in sediment shows that it will not accumulate in aquatic sediments. The chemical is rapidly excreted from organisms and will not accumulate in aquatic ecosystems.

Q. Is thiamethoxam dangerous to birds?

A. In the laboratory, thiamethoxam is of moderate toxicity to birds when applied as a single dose. However, regarding chronic exposure of birds to residues of the chemical in food, radiolabeled metabolism studies in mammals have indicated that thiamethoxam is rapidly excreted and does not accumulate in animal tissues. The main aerobic metabolite of thiamethoxam is non-toxic to birds. The principal route of exposure of birds in the field is through eating insects, fruits, foliage or seeds that have been treated. The dissipation of thiamethoxam on these foodstuffs is rapid and, coupled with the expected ability of birds to excrete low residues of thiamethoxam from food, the predicted risk to birds is low.

Q. Is thiamethoxam dangerous to mammals?

A. As with birds, thiamethoxam is of moderate toxicity when applied as a single dose but is quickly excreted unchanged by mammals that are chronically exposed to residues in food. Because of the rapid dissipation of thiamethoxam on their foods, the risk to mammals is predicted to be low.

Q. What Best Management Practices (BMPs) should an applicator and/or grower adopt when using thiamethoxam?

A. Crops to be treated should be planted more than 25 feet from aquatic habitats. In areas where heavy rainfall can be expected and where fields are located near rivers or streams, growers should use

land management practices that limit water runoff and soil erosion from treated fields. This includes practices such as contour farming, terraces and buffer strips.

Do not spray flowering weeds that may be used as forage by bees. Avoid spray drift into off-target areas and water bodies. Use nozzles that are accurate and uniform. Applications should not be made when wind speed exceeds 10 mph or during a temperature inversion. When applying from the air, spray when wind speeds are from 3 to 10 mph, and away from water bodies, to avoid drift. Aerial spray booms should be shorter than the wing of the aircraft in order to avoid releasing the spray into the wing-tip vortices. The application should be made as close as is practical to the target crop and using the largest drop size suitable for the crop and target.

Q. How can a grower use thiamethoxam in a manner that is consistent with sustainable agriculture practices (IPM, ICM, resistance management, etc)?

A. Thiamethoxam has been extensively tested for cross-resistance to major families of insecticides and no cross-resistance has yet been determined. Though thiamethoxam may have a slightly different site of action in the insect than other neonicotinoids, it is still recommended to alternate its use with chemicals from other insecticide families, in order to decrease the resistance selection pressure. Only labeled rates should be applied, in a way that achieves uniform crop coverage. Some beneficial arthropods such as predatory mites show some tolerance to thiamethoxam and this can prolong the time over which control of pests is achieved. Since foliar-applied thiamethoxam is rapidly degraded on plant surfaces and then moves systemically within the plant, the exposure quickly becomes limited to insects feeding on the leaves rather than walking on them. The treatment of flowering crops or plants and direct overspray of water bodies should be avoided and the best management practices referred to above should be implemented to minimize run-off and spray drift into aquatic habitats.

Important: Always read and follow label instructions before buying or using this product.

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