ChemicalWatch Factsheet

A Beyond Pesticides/ NCAMP Factsheet

ENDOSULFAN

Endosulfan is a toxic broad-spectrum organochlorine insecticide and acaricide used on food and non-food crops. It is also used as a wood preservative. Endosulfan is formulated as a wettable powder and liquid emulsifiable concentrate,[1] and appears as cream to brown-colored crystals or flakes.[2] First registered in the U.S. in 1954, over 1 million lbs of endosulfan are used per year[1,3] on a wide variety of vegetables, fruits, cereals, and cotton, as well as ornamental shrubs, trees, vines, and ornamental herbaceous plants in commercial agricultural settings[1]. Aphids, Colorado potato beetles, leafhoppers and cabbageworms are some pests controlled with endosulfan. In certain regions of the world, it is used on tea and cotton, and to control the tsetse fly.[4]

Bayer CropScience is one of the largest manufacturers of endosulfan. Technical/commercial formulations contain 2 isomers of endosulfan: α-endosulfan and β-endosulfan, and are marketed under the trade names Drexel, Malix, Phaser, Thiodan and Thionex. In the U.S., endosulfan is classified as a restricted use pesticide (RUP) and is also listed in the acute toxicity I category, due to its high toxicity. As a result, product labels must bear the signal word 'Danger.'[5]

Mode of Action

Endosulfan is a central nervous system stimulant that produces convulsions. It antagonizes the action of the neurotransmitter gamma-aminobutyric acid (GABA), which leads to a state of uncontrolled neuronal excitation. Disturbances of calcium transport of Ca+2-ATPase activity may also be involved, as well as phosphokinase activities.[6]

Insects are exposed on contact or through stomach action, and hyper-excitation and paralysis lead to death.

Routes of Exposure

People may be exposed to endosulfan through various avenues, the most common being ingestion of contaminated food and water.[2] Endosulfan is one of the most commonly encountered pesticides on food, especially fruits and vegetables. The U.S. EPA found that acute risk estimates for food and drinking water exceeded levels of concern, which prompted mitigation measures to be put in place, as well as the cancellation of the use of endosulfan on vulnerable crops such as succulent beans, succulent peas, grapes, and spinach.[1] Residues on food have been detected wherever endosulfan is used. Cows milk from tobacco farming areas in the US have tested positive for endosulfan, along with tomatoes, peppers, fish, beef, vegetable oil and sunflower seeds from various parts of the world[7]. Even though the US EPA has established tolerance levels for endosulfan on food commodities, residue concentrations continue to be a concern. Despite this, the EPA in 2006, allowed a greater concentration of endosulfan on certain foods after increasing the tolerances for almonds, barley grain, wheat grain, blueberries, broccoli, cabbage, celery, lettuce and livestock products.[8]

Endosulfan exposure also occurs via inhalation and skin absorption, mainly from occupational use of the chemical. A report by the International Programme on Chemical Safety (IPCS) stated that endosulfan has been shown to persist on the hands of pest control operators for up to 31 days after exposure.[9] Excessive and improper application and handling of endosulfan have been linked to congenital physical disorders, mental retardations and deaths in farm workers and villag-

chemicalWATCH Stats:

CAS Number: 115-29-7
Chemical Name: 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide
Chemical Class: Organochlorine
Signal Word: Danger
Acute Toxicity: Very highly toxic: US EPA Category I – highly hazardous
Chronic Toxicity: Neurotoxic. Reproductive/develop mental effects, as well as endocrine disruption.
Environmental Fate: Very persistent. Toxic to birds and aquatic organisms.

ers in developing countries.[10] Endosulfan has also been found in the air in natural parks and industrial areas.[11] Residues of α- and β-endosulfan have been detected in ambient air samples in the U.S., with the α-isomer being more persistent, being measured with a maximum concentration of 2256 ng/m^3.[4] Absorption through the skin is considered a potentially hazardous route.[6] Skin rashes and irritation have been reported, along with dizziness, vomiting, diarrhea, agitation, muscular twitching, convulsions, and other neurological manifestations.[1,2,6] Loss of consciousness and death have also been reported.[1] Persons suffering from asthmatic and convulsive disorders are at high risk. Persons on protein deficient diets also possess high risk.[7]

Aerial drifting of the pesticide has been observed to leave residues up to three meters beyond the perimeter of sprayed agricultural fields.[9] Endosulfan not only travels great distances, but also accumulates in the food chain. It has been detected in the air and polar bears of the Arctic, as well as in indigenous Inuit populations.

Health Effects

Acute toxicity

Clinical signs of acute exposure to endosulfan include salivation, hyperactivity, respiratory distress, diarrhea, tremors, hunching and convulsions.[4] LC_{50} studies involving laboratory rabbits fed endosulfan resulted in liver, kidney, intestine, lung and adrenal toxicity, including irritation of the small and large intestine, salivation, excessive masticatory movements, decreased respiration, discharge from eyes and nasal cavity, sprawling of the limbs, tremors and convulsions and death.[4,12]

Blindness was also documented for cows that grazed in a field sprayed with the compound, but the animals recovered after a month following the exposure. In another accidental exposure, sheep and pigs grazing on a sprayed field suffered a lack of muscle coordination and blindness.[13]

Chronic Toxicity

There is limited data on chronic exposure to endosulfan in human subjects; however, the sub-acute and chronic toxicity studies of endosulfan in animals suggest that the liver, kidneys, immune system, and testes are the main target organs.[14] Studies have shown that rats fed 5 mg/kg/day endosulfan suffered liver enlargement, reduced growth and survival, changes in kidney structure, and changes in blood chemistry.[13] Female mice fed 0.1 mg/kg/day endosulfan had damage to their reproductive organs. Oral dosage at 10 mg/kg/day in male rats caused damage to the seminiferous tubules and lowered testes weights.[13] Birth defects have been seen in the offspring of rats ingesting endosulfan during pregnancy.[2,13] One study found endosulfan and its metabolites in the placentas of pregnant women, which increased congenital malformations in male offspring.[15] A 2000 Japanese study found that endosulfan was genotoxic and that the genotoxicity of β-endosulfan seemed stronger than that of α-endosulfan.[16] So far, studies regarding its carcinogenicity have been inconclusive,[2] but there is evidence that endosulfan can be mutagenic to humans.[13]

Endosulfan, like other organochlorine contaminants, bioacummulate and remain preferentially in fat, and concerns about its long-term effects have been raised.[17] Recent studies have associated endosulfan exposure to autism in children.[18]

Endocrine Disruption

The U.S. EPA considers endosulfan to be a potential endocrine disruptor.[1] It is also listed in the European Union as a potential endocrine disruptor and appears on Colborn's List. Endosulfan exhibits estrogenic properties, comparable to that of DDT. It competes with estradiol to bind to estrogen receptors, thereby inhibiting hormonal function.[7,11,15,19] Saiyed et al. (2003),[14] examined the relationship between environmental endosulfan exposure and reproductive development in male children and adolescents, and concluded that exposure in male children may delay sexual maturity and interfere with sex hormone synthesis. Endosulfan also decreases semen quality, sperm count, spermatogonial cells, and sperm morphology, and contributes to other defects in male sex hormones.[7,20] Other studies have found that endosulfan produced testicular atrophy in male rats fed a diet containing 10 ppm and it also lowered gonadotropin and testosterone plasma levels.[17]

Animal studies have suggested that the effects on the male reproductive system are likely to be

Endosulfan is a broad-spectrum pesticide. This means that many non-target organisms are affected by its use, including humans. As a result, endosulfan has caused severe poisonings and even death in many parts of the world. This dangerous chemical should be banned in the US.

Here are just 10 reasons endosulfan should be banned…

- ✓**High acute toxicity**
- ✓**Permanent neurological impairment**
- ✓**Endocrine disruption**
- ✓**Male reproductive disorders**
- ✓**Birth defects**
- ✓**Liver and kidney damage**
- ✓**Genotoxicity in human cells**
- ✓**Persistent global navigation**
- ✓**Bioaccumulation in food web**
- ✓**Air and water contamination**

greater if exposure occurs during the developmental phase.[14] Other evidence of endosulfan's disrupting effects include impaired development in amphibians, reduced cortisol secretion in fish, and impaired development of the genital tract in birds.[10]

Environmental Effects

Endosulfan is very toxic to nearly all types of organisms.[10] The EPA's environmental risk assessment suggests that exposure could result in both acute and chronic risks of concern for terrestrial and aquatic organisms.[1,6] Endosulfan is highly to moderately toxic to bird species and is very highly toxic to fish species and aquatic invertebrates. It is also moderately toxic to bees.[10,13] Some phytotoxic effects of endosulfan have been reported including, reduced germination and growth rate, inhibition of root growth and stunting of shoots.[6]

Endosulfan is resistant to biological degradation and has low water solubility which favors its binding to soil particles and persistence within surface waters.[21] The average half-life in soil is 50 days,[22] but the two isomers have different degradation times in soil, with the β-isomer being more persistent, with a half life of over 200 days.[23] The major breakdown product of endosulfan, endosulfan sulfate, is however much more persistent than its parent, with an average half life of 1336 days,[23] and is just as toxic. Contamination of groundwater is not likely, however, endosulfan has been detected in wells in California.[13]

Regulatory Status

Endosulfan has either been banned or restricted in several parts of the world due to its persistent and toxic nature. Hundreds of farmworker health damage and deaths, along with thousands of fish kills, have been attributed to endosulfan across the globe. In several villages in India, endosulfan has been linked to hundreds of deaths, disorders and deformities among cashew nut plantation workers and villagers.[9]

The EPA classifies endosulfan as Category I – highly hazardous. The European Union also rates it as highly hazardous. The World Health Organisation (WHO) classifies endosulfan in Category II - Moderately Hazardous. Endosulfan is under consideration to be listed as a Toxic Air Contaminant (TAC) in the state of California.[24]

It has been recently nominated to be included in the Stockholm Convention on Persistent Organic Pollutants, the international treaty that bans persistent chemicals from global use. Endosulfan is recognized as a Persistent Toxic Substance (PTS) by the United Nations Environment Programme, UNEP.[7]

In 2008, the United Kingdom recommended that endosulfan be included on the Prior Informed Consent (PIC) list of the Rotterdam Convention. Under this treaty, a chemical that has been banned in two or more countries in different regions of the world can be added to the PIC list in order to facilitate an exchange of information on hazardous chemicals.

In November 2007, the EPA opened for public comment the review of human health and ecological risk assessments as part of the 2002 Registration Eligibility Decision (RED) for endosulfan. Since then, thousands of concerned individuals and environmental and public health activists have petitioned the EPA to ban endosulfan.

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