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Pesticide Toxicity Profile: Copper-based Pesticides[1]

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This document provides a general overview of use patterns and human toxicity, a listing of laboratory animal and wildlife toxicities, and a cross reference of the specific uses and common names of copper-based pesticides registered for use in Florida.

General

Pesticides containing copper have a historical significance in that the fungicidal properties of "Bordeaux mixture", named after the Bordeaux region in France, were accidentally discovered. When Bordeaux mixture, a chemically undefined mixture of copper sulfate and hydrated lime, was applied to grapes to discourage local pilfering, it was observed that downy mildew disappeared from the treated plants. It was from this serendipitous event that commercialization of fungicides originated. Today, Bordeaux mixture is still sold commercially, and there are approximately 15 various active ingredients registered for use in Florida that contain some form of copper, depending on how their composition is defined. Because the inorganic forms of copper are relatively water insoluble, they do not wash easily from foliage, thus providing longer protection against disease than many other compounds. Copper is relatively safe from a handling perspective, but there is some concern regarding its buildup in agricultural soils. In Florida, certain citrus areas have experienced problems of copper toxicity on sites that had been treated with fixed copper for disease control for many years. With their wide range of uses, compounds of copper form one of the most useful groups of pesticides. They are used in home and industrial environments for control of algae in various water bodies including backyard swimming pools, are applied to boat hulls to resist marine and fresh water organisms, are used for control of aquatic weeds, for wood preservative treatments, and for control of many fungal and bacterial diseases in fruits, vegetables, ornamentals and field crops. Table 1 summarizes the uses of available copper-based pesticides registered in Florida. Because there are numerous trade names of products that contain some form of a copper compound as their active ingredient, the reader is referred to the Florida Department of Agriculture and Consumer Services' (FDACS) Pesticide Information Retrieval System at http://state.ceris.purdue.edu/doc/fl/statefl.html. FDACS keeps this system up-to-date; therefore it is an accurate reflection of products registered for use in

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Florida at any given time. Product formulations of copper-based pesticides include aqueous solutions, wettable powders, dry flowables, dusts, flowables, water dispersible granules, emulsifiable concentrates, and granules.

Toxicity

The dust and powder formulations of copper compounds are irritating to the skin, respiratory tract, and particularly the eyes. Limited solubility and absorption probably account for the generally low systemic toxicity of most compounds. Irritant effects from occupational exposures to copper-based pesticides have been fairly frequent, including allergic reactions, itching, and eczema. Most of what is known about mammalian toxicity of copper-based pesticides has come from veterinary toxicology. Livestock seem uniquely vulnerable to copper's effects. Deliberate ingestion of copper for suicidal purposes in humans has been reported; accidental ingestion has occurred through food or water that had been contained in copper vessels. Early signs and symptoms of copper poisoning include a metallic taste, nausea, vomiting, and abdominal pain. Chronic effects have been reported with vineyard workers who experienced liver disease after 3 to 15 years of exposure to Bordeaux mixture. The EPA does not require data on the teratogenic, mutagenic, carcinogenic, and reproductive effects on mammals for many of the copper-based pesticides. Mammalian toxicities for the copper-based pesticides are shown in Table 2, if available. Table 3 lists the toxicities to wildlife by the common name of the pesticide.

Additional Information

Crop Protection Handbook. 2005. vol. 91. Willoughby, Ohio: Meister Publishing Co. http://www.meisterpro.com/mpn.

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Table 1. Use patterns of copper-based pesticides registered in Florida.

Copper-based pesticide	Use pattern(s)
Copper (metallic)	Algaecide, antifouling paint
Copper (metallic in the form of chelates of copper citrate and copper gluconate)	Algaecide, bactericide, fungicide
Copper carbonate	Algaecide, herbicide, wood preservative
Copper ethanolamine complex	Algaecide, wood preservative
Copper ethylenediamine complex	Herbicide
Copper hydroxide	Antifouling paint, bactericide, fungicide, plant growth regulator, wood preservative
Copper naphthenate	Wood preservative
Copper oxychloride	Algaecide, bactericide, fungicide
Copper salts of fatty and rosin acids	Bactericide, fungicide
Copper sulfates	Algaecide, bactericide, desiccant,fungicide, herbicide
Copper triethanolamine complex	Algaecide
Copper oxides	Algaecide, antifouling paint, wood preservative

Table 2. Copper-based pesticide mammalian toxicities (mg/kg of body weight).

Common name	Rat oral LD_{50}	Rabbit dermal LD_{50}
Copper (metallic)	---	---
Copper (metallic in the form of chelates of copper citrate and copper gluconate)	---	---
Copper carbonate	---	---
Copper ethanolamine complex	0.5 – 2	---
Copper ethylenediamine complex	680	700
Copper hydroxide	1,000 – 2,000	---
Copper naphthenate	>5,000	2,000 – 20,000
Copper oxychloride	1,470	---
Copper salts of fatty and rosin acids	---	---
Copper sulfates	30	---
Copper triethanolamine complex	>1,300	---
Copper oxides	1,500	---

Table 3. Copper-based pesticide wildlife toxicity ranges.

Common name	Bird acute oral LD_{50} (mg/kg)*	Fish (ppm)**	Bee†
Copper (metallic)	---	MT	---
Copper (metallic in the form of chelates of copper citrate and copper gluconate)	---	---	---
Copper carbonate	---	MT - VHT	---
Copper ethanolamine complex	---	ST - HT	---
Copper ethylenediamine complex	---	---	---

Table 3. Copper-based pesticide wildlife toxicity ranges.

Common name	Bird acute oral LD_{50} (mg/kg)*	Fish (ppm)**	Bee†
Copper hydroxide	ST – PNT	---	---
Copper naphthenate	PNT	HT	---
Copper oxychloride	---	---	PNT
Copper salts of fatty and rosin acids	ST – PNT	MT – HT	---
Copper sulfates	MT – PNT	MT – VHT	---
Copper triethanolamine complex	PNT	MT – VHT	---
Copper oxides	PNT	ST	PNT

*Bird LD_{50}: Practically nontoxic (PNT) = >2,000; slightly toxic (ST) = 501 – 2,000; moderately toxic (MT) = 51 – 500; highly toxic (HT) = 10 – 50; very highly toxic (VHT) = <10.
**Fish LC_{50}: PNT = >100; ST = 10 – 100; MT = 1 – 10; HT = 0.1 – 1; VHT = <0.1.
†Bee: HT = highly toxic (kills upon contact as well as residues); MT = moderately toxic (kills if applied over bees); PNT = relatively nontoxic (relatively few precautions necessary).