



Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses

CAPTAN

Captan ($C_9H_8Cl_3NO_2S$) has a CAS name and registry number of 3a,4,7,7a-tetrahydro-2-[(trichloro-methyl)thio]-1*H*-isoindole-1,3(2*H*)-dione and 133-06-2, respectively (Tomlin 1994). The most common trade name for captan is Orthocide, but other trade names and formulations registered in Canada can be found in Agriculture and Agri-Food Canada (1997).

Captan is a broad-spectrum, nonsystemic fungicide that was first registered in Canada in 1953 and is used to control disease in vegetables, fruit, tobacco, turf, and ornamentals. It may be used as a seed treatment on corn, beans, peas, and other crops and also to control mildew in vinyl, lacquer, wallpaper flour paste, rubber, and polyethylene articles (Agriculture and Agri-Food Canada 1997).

The persistence of captan can range from a half-life of 1 d in a thoroughly mixed soil to little degradation in 21 d under localized application conditions (seed treatments) (Griffith and Matthews 1969). Hydrolysis and microbial degradation are both significant fate processes for captan in soil, while volatilization is not important (USEPA 1984). Captan stability increases with decreasing pH and soil moisture content (Goring 1972; Agriculture Canada 1982). A half-life of 3.5 d was observed in a moist (17.5% water) and slightly acidic (pH 6.4) soil (Burchfield 1959). The half-life increased to 50 d with a decrease in pH to 6.2 and reduction in soil moisture content to 1.6%. However, Kluge (1969) reported that captan degradation was not influenced by soil pH changes in the range pH 3.6–7.4. Captan is not very mobile in soil and should not leach in appreciable quantities to groundwater (Goring 1972; USEPA 1985).

For more information on the use, environmental concentrations, and chemical properties of captan, see the fact sheet on captan in Chapter 4 of *Canadian Environmental Quality Guidelines*.

Water Quality Guideline Derivation

The interim Canadian water quality guideline for captan for the protection of livestock water (CCME 1991) was developed prior to the implementation of the CCME

protocol (CCME 1993) and, therefore, does not follow the protocol.

Livestock Water

Captan typically exhibits low acute oral toxicity to mammals and birds. Reported acute oral LD_{50} values for mice and rats are $7000 \text{ mg}\cdot\text{kg}^{-1}$ and $>9000 \text{ mg}\cdot\text{kg}^{-1}$, respectively (USEPA 1984, 1986). The lowest LD_{50} for a bird species was $>2000 \text{ mg}\cdot\text{kg}^{-1}$ bw for 3- to 4-month-old male mallard ducks (Hudson et al. 1984).

Many studies have been conducted on the long-term effects of captan ingestion by mammals and birds. A LOEL of $100 \text{ mg}\cdot\text{kg}^{-1}$ per day and a NOEL of $25 \text{ mg}\cdot\text{kg}^{-1}$ per day based on hepatocellular hypertrophy, increased kidney weight, and decreased body weight were determined in rats (USEPA 1985). A total oral dose of $78 \text{ mg}\cdot\text{kg}^{-1}$ bw over a 2-month period was reported to affect blood hemoglobin concentration, leucocyte and erythrocyte counts, prothrombin levels, serum cholesterol, and sperm motility in treated rats. Intermittent dosing with captan produced a more pronounced toxic response than continuous dosing (Dekanozishvili 1975).

Martin and Lewis (1979) injected chicken embryos with captan at $12 \text{ mg}\cdot\text{kg}^{-1}$ egg weight. The biosynthesis of DNA, RNA, and various proteins in the developing limbs was inhibited or delayed, and total protein concentration was lower. However, chicks fed captan-treated seed corn in a mixed ration (producing a final level of $320 \text{ mg}\cdot\text{kg}^{-1}$) for 74 d suffered no harmful effects (Link et al. 1956).

Table 1. Water quality guidelines for captan for the protection of agricultural water uses (CCME 1991).

Use	Guideline value ($\mu\text{g}\cdot\text{L}^{-1}$)
Irrigation	NRG*
Livestock water	13 [†]

* No recommended guideline.

[†] Interim guideline.

The USEPA classified captan as a Group B₂ (probable human) carcinogen (USEPA 1989). Several studies have also reported positive mutagenic responses in a variety of in vitro test systems (Legator et al. 1969; USEPA 1985). Mutagenesis assays indicated that captan induces DNA repair mechanisms, produces chromosome aberrations in mammalian cell cultures (USEPA 1985), and increases the number of X-chromosome breaks in human embryo cell cultures (Legator et al. 1969). Xu and Schurr (1990) labelled captan a “strongly positive” genotoxic compound.

Captan may produce embryological and maternal toxic effects in mammals. Weight loss was observed in pregnant mice receiving oral doses of captan of 100 mg·kg⁻¹ per day (Bionetics Research Laboratories 1968). Oral administration of captan to golden Syrian hamsters on gestation days 6–10 (cumulative doses to 1500 mg·kg⁻¹ per day) or as a single dose of 300 mg·kg⁻¹ per day resulted in reduced fetal weight, increased maternal mortality, and teratogenic effects (i.e., fused ribs and exencephally) (Robens 1970). Doses of 200 mg·kg⁻¹ per day have also been reported to cause maternal and fetal weight loss and death, increased early and late resorptions, and post-implantation losses (Goldenthal 1978). Doses of 12 mg·kg⁻¹ per day administered to rabbits reduced maternal, mean litter, and fetal weights (Chevron Chemical Co. 1981). Daily doses of 30 mg·kg⁻¹ administered to beagle dogs throughout gestation increased the percentage of stillborn pups and produced a low incidence of terata (Earl et al. 1973). These teratogenic effects were not dose-dependent and did not show any consistent pattern.

Two reproduction studies with rats were submitted to the USEPA (1985). During a three-generation study, rats were fed dietary captan levels of 25, 100, 250, and 500 mg·kg⁻¹ per day. Treatment-related effects included reduced weight gain of the parents at the three highest doses, reduced pup litter weights at all dosage levels, and reduced food consumption at most treatment levels. During a one-generation rat study, captan in the diet at 5, 12.5, and 25 mg·kg⁻¹ per day caused no treatment-related effects. The USEPA (1985) combined these two studies and concluded that the NOAEL for toxic effects was 12.5 mg·kg⁻¹ per day.

In the absence of adequate information concerning the toxicity to livestock of compounds consumed in their drinking water, the Canadian drinking water quality guideline is usually used as a surrogate interim guideline for livestock watering. A Canadian drinking water quality

guideline for captan, however, has not been developed (Health Canada 1996). The NOAEL of 12.5 mg·kg⁻¹ per day for reproductive effects in rats (USEPA 1985), therefore, was used as the basis for guideline development. For a conservative estimate, an uncertainty factor of 0.001 (USEPA 1987) is applied to the NOAEL to produce an estimated NOAEL of 0.0125 mg·kg⁻¹ per day for livestock. Multiplying this value by the ratio of animal body weight to water intake for a lactating dairy cow yielded an RC of 64.1 µg·L⁻¹. To account for exposure to captan from sources other than water, the lowest RC is multiplied by an apportionment factor of 0.2 to give an interim water quality guideline of 13 µg·L⁻¹ for the protection of livestock (CCME 1991).

References

- Agriculture and Agri-Food Canada. 1997. Regulatory Information on Pesticide Products (RIPP) Database (CCINFODISK). Produced by Agriculture and Agri-Food Canada and distributed by the Canadian Centre for Occupational Health and Safety. CD-ROM.
- Agriculture Canada. 1982. Guide to the chemicals used in crop protection. 7th ed. Agriculture Canada, Research Branch Publication 1093.
- Bionetics Research Laboratories. 1968. Evaluation of the teratogenic activity of selected pesticides and industrial chemicals in mice and rats. National Cancer Institute Contracts PH-43-64-57 and PH-43-67-735. (Cited in USEPA 1985.)
- Burchfield, H.P. 1959. Comparative stabilities of styrene, 1-fluoro-2,4-dinitrobenzene, dichlone and captan in a silt loam soil. *Contrib. Boyce Thompson Inst.* 20:205–215.
- CCME (Canadian Council of Ministers of the Environment). 1991. Appendix VIII—Canadian water quality guidelines: Updates (April 1991), metolachlor, simazine, and captan. In: Canadian water quality guidelines, Canadian Council of Resource and Environment Ministers. 1987. Prepared by the Task Force on Water Quality Guidelines.
- . 1993. Appendix XV—Protocols for deriving water quality guidelines for the protection of agricultural water uses (October 1993). In: Canadian water quality guidelines, Canadian Council of Resource and Environment Ministers. 1987. Prepared by the Task Force on Water Quality Guidelines. [Updated and reprinted with minor revisions and editorial changes in Canadian environmental quality guidelines, Chapter 5, Canadian Council of Ministers of the Environment 1999, Winnipeg.]
- Chevron Chemical Co. 1981. Teratology study in rabbits. EPA accession No. 246624. (Cited in USEPA 1985.)
- Dekanozishvili, N.K. 1975. Comparative responses of the body following continuous and intermittent exposure to captan in a 78 mg/kg dose. *Sb. Tr. Nauchno-Issled. Inst. Gig. Tr. Profzabol. Tiflis.* 14:305-310. (CA 89:18063V). (Cited in USEPA 1984.)
- Earl, F.L., E. Miller, and E.J. van Loon. 1973. Reproductive, teratogenic and neonatal effects of some pesticides and related compounds in beagle dogs and miniature swine. Paper read at 8th Int-Am. Conf. Toxicol. Occup. Med. (Cited in USEPA 1985.)
- Goldenthal, E.I. 1978. Teratology study in hamsters. International Research and Development Corporation study performed for Chevron Chemical Co. EPA Accession No. 249681. (Cited in USEPA 1985.)

- Goring, C.A.I. 1972. Fumigants, fungicides and nematicides. In: Organic chemicals in the soil environment, Vol. 2. C.A.I. Goring and J.W. Hamaker, eds. Marcel Dekker, Inc., New York.
- Griffith, R.L., and S. Matthews. 1969. The persistence in soil of the fungicidal seed dressings captan and thiram. *Ann. Appl. Biol.* 64:113-118.
- Health Canada. 1996. Guidelines for Canadian drinking water quality. 6th ed. Prepared by the Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial Committee on Environmental and Occupational Health.
- Hudson, R.H., R.K. Tucker, and M.A. Haegle. 1984. Handbook of toxicity of pesticides to wildlife. U.S. Fish Wildl. Serv. Resour. Publ. 153. 2d ed. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.
- Kluge, E. 1969. Zur Wirkungsdauer von Thiuram, Ferbam und Captan in Waldböden (Duration of the effect of thiuram, ferbam, and captan in forest soils. *Arch. Pflanzensch.* 5:39-53. (In German with English summary.)
- Legator, M.S., F.J. Kelly, S. Green, and E.J. Oswald. 1969. Mutagenic effects of captan. *Ann. N.Y. Acad. Sci.* 106:344-351.
- Link, R.P., J.C. Smith, and C.C. Morrill. 1956. Toxicity studies on captan-treated corn in pigs and chickens. *J. Am. Vet. Med. Assoc.* 128(12):614-616.
- Martin, D.H., and R.A. Lewis. 1979. Alterations of nucleic acid and protein syntheses in vivo in the chick embryo mediated by captan. *Xenobiotica* 9(9):523-532.
- Robens, J.F. 1970. Teratogenic activity of several phthalimide derivatives in the golden hamster. *Toxicol. Appl. Pharmacol.* 16:24-34.
- Tomlin, C. (ed.). 1994. The pesticide manual: A world compendium. 10th ed. (Incorporating the Agrochemicals handbook.) British Crop Protection Council and Royal Society of Chemistry, Thornton Heath, UK.
- USEPA (U. S. Environmental Protection Agency). 1984. Health and environmental effects profile for captan. EPA/600/X-84/253. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH.
- . 1985. Captan: special review position document 2/3. EPA-540/9-87-121. Office of Pesticide Programs, Office of Pesticides and Toxic Substances, Washington, DC.
- . 1986. Pesticide fact sheet number 75: Captan, N-trichloromethylthio-4-cyclohexene-1,2-dicarboximide. EPA 540/FS-87-030. Office of Pesticide Programs, Registration Division, Washington, DC.
- . 1987. Guidelines for the preparation of office of water health advisories. Environmental Criteria and Assessment Office, Cincinnati, OH.
- . 1989. Ambient water quality advisory, Captan. USEPA, Office of Water Regulations and Standards, Criteria and Standards Division, Unpub.
- Xu, H.H., and K.M. Schurr. 1990. Genotoxicity of 22 pesticides in the microtitration SOS chromotest. *Toxic. Assess.* 5(1):1-14.

Reference listing:

Canadian Council of Ministers of the Environment. 1999. Canadian water quality guidelines for the protection of agricultural water uses: Captan. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

For further scientific information, contact:

Environment Canada
Guidelines and Standards Division
351 St. Joseph Blvd.
Hull, QC K1A 0H3
Phone: (819) 953-1550
Facsimile: (819) 953-0461
E-mail: ceqg-rqge@ec.gc.ca
Internet: <http://www.ec.gc.ca>

For additional copies, contact:

CCME Documents
c/o Manitoba Statutory Publications
200 Vaughan St.
Winnipeg, MB R3C 1T5
Phone: (204) 945-4664
Facsimile: (204) 945-7172
E-mail: spcme@chc.gov.mb.ca