



Carbofuran is a systemic acaricide, insecticide, and nematicide used on corn, alfalfa, sorghum, potatoes, sugar beets, canola, sunflowers, and mixed vegetables. Other names and registered trademarks include Furadan, Curaterr, Yaltox, Bay 70143, NIA 10242, and ENT 27164 (Thompson 1979; Worthing and Walker 1983).

Information is available concerning the fate and persistence of carbofuran in flooded soils used for rice cultivation. The degradation of carbofuran in flooded soil is essentially a hydrolytic reaction producing carbofuran phenol, although this chemical hydrolysis may be catalyzed or mediated by the microflora of the flooded soil (Venkateswarlu and Sethunathan 1978). Anaerobic conditions in flooded soils apparently enhance the hydrolysis of carbofuran to carbofuran phenol and 3-hydroxycarbofuran. Further degradation of these metabolites to carbon dioxide and water requires aerobic conditions and is primarily accomplished by the microbial community.

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

### Water Quality Guideline Derivation

The Canadian water quality guideline for carbofuran for the protection of livestock water (CCME 1989) was developed prior to the implementation of the CCME protocol (CCME 1993) and, therefore, does not follow the protocol.

### Livestock Water

Information specifically related to carbofuran in livestock water supplies could not be found. Most studies indicate that mammal and bird poisonings are a result of direct ingestion of carbofuran granules or contaminated food rather than the result of ingestion of contaminated water.

Acute oral toxicities (14-d LD<sub>50</sub>) for birds range from 238 µg·kg<sup>-1</sup> for the duck *Dendrocygna bicolor* (Tucker and Crabtree 1970) to 38 900 µg·kg<sup>-1</sup> for the domestic chicken (*Gallus gallus*) (Finlayson et al. 1979). Oral toxicities (as a single lethal dose) in mammals range from 2000 to 34 500 µg·kg<sup>-1</sup> for mice and rats, respectively (Finlayson et al. 1979).

A feeding study using milk cows and silage containing carbofuran (83–147 mg·kg<sup>-1</sup> of silage or 3 g·d<sup>-1</sup>) produced only limited symptoms of muscular contraction after the first feeding. Thereafter symptoms were barely noticeable (Miles et al. 1971). Using the data (Miles et al. 1971) on body weight, the rate of carbofuran ingestion was 4.72 mg·kg<sup>-1</sup> bw per day. Assuming an average daily water requirement of 160 L per cow (CCREM 1987) and a body weight of 635 kg (Miles et al. 1971), the concentration of carbofuran in water necessary to attain an intake of 4.72 mg·kg<sup>-1</sup> per day would be 18.7 mg·L<sup>-1</sup>. This concentration of carbofuran cannot, however, be considered a NOEL, as minor symptoms of carbofuran poisoning were observed after the first feeding and significant differences of voluntary silage intake were noted between control cows and cows receiving carbofuran at 3 g·d<sup>-1</sup> (Miles et al. 1971).

The maximum acceptable daily intake concentration for humans (90 µg·L<sup>-1</sup>) is based on extensive data (a 2-year laboratory study of carbofuran intake by rats). The NOEL from this study was 0.01 mg·kg<sup>-1</sup> per day (Health and Welfare Canada 1987). Although the 90 µg·L<sup>-1</sup> value would conceivably be safe for livestock of greater body weight than humans, small animals might be at risk. Available data suggest that sensitive bird species might

Table 1. Water quality guidelines for carbofuran for the protection of agricultural water uses (CCME 1989).

| Use              | Guideline value (µg·L <sup>-1</sup> ) |
|------------------|---------------------------------------|
| Irrigation water | NRG*                                  |
| Livestock water  | 45                                    |

\*No recommended guideline.

not be protected at a level of  $90 \mu\text{g}\cdot\text{L}^{-1}$ . An oral  $\text{LD}_{50}$  of  $0.42 \text{ mg}\cdot\text{kg}^{-1}$  for redwinged blackbirds (*Agelaius phoeniceus*) indicates a considerably higher degree of sensitivity to carbofuran for birds than for mammals (Schafer et al. 1973). This study showed that 27.3 mg of carbofuran ingested orally would be lethal to half of the population of blackbirds over 14 d. To introduce a margin of safety, the value of  $90 \mu\text{g}\cdot\text{L}^{-1}$  was reduced by half to obtain a water quality guideline of  $45 \mu\text{g}\cdot\text{L}^{-1}$  for the protection of livestock (CCME 1989).

## References

- CCME (Canadian Council of Ministers of the Environment). 1989. Appendix V—Canadian water quality guidelines: Updates (September 1989), carbofuran, glyphosate, and atrazine. 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 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.]
- CCREM. (Canadian Council of Resource and Environment Ministers). 1987. Canadian water quality guidelines. Prepared by the Task Force on Water Quality Guidelines.
- Finlayson, D.G., J.R. Graham, R. Greenhalgh, J.R. Roberts, E.A.H. Smith, P. Whitehead, R.F. Willes, and I. Williams. 1979. Carbofuran: Criteria for interpreting the effects of its use on environmental quality. Nat. Res. Coun. Canada, Publ. NRCC 16740. Ottawa.
- Health and Welfare Canada. 1987. Guidelines for Canadian drinking water quality 1987. 3d ed. Prepared by the Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial Advisory Committee on Environmental and Occupational Health.
- Miles, J.T., B.J. Demott, S.A. Hinton, M.J. Montgomery, and S.E. Bennet. 1971. Effect of feeding carbofuran on the physiology of the dairy cow and on pesticide residues in milk. J. Dairy Sci. 54(4): 478–480.
- Schafer, E.W., Jr., R.B. Burton, N.F. Lockyer, and J.W. DeGraziom. 1973. Comparative toxicity of seventeen pesticides to the quail, house sparrow, and red-winged blackbird. Toxicol. Appl. Pharmacol. 26:154–157.
- Thomson, W.T. 1979. Agricultural chemicals. Book I. Insecticides. 1979–1980 revision. Thomson Publications, Fresno, CA.
- Tucker, R.K., and D.G. Crabtree. 1970. Handbook of toxicity of pesticides to wildlife. U.S. Fish Wildl. Serv. Resour. Publ. 84. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.
- Venkateswarlu, K., and N. Sethunathan. 1978. Degradation of carbofuran in rice soils as influenced by repeated applications and exposure to aerobic conditions following anaerobiosis. J. Agric. Food Chem. 26(5):1146–1151.
- Worthing, C.R., and S.B. Walker (eds.). 1983. The pesticide manual: A world compendium. 7th ed. The British Crop Protection Council, Croydon, UK.

## Reference listing:

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

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