Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses

DINOSEB

Dinoseb is a herbicide whose registration has been retained in Canada only for critical need uses such as control of cane in raspberries in British Columbia and weed control in beans and peas in British Columbia and the Atlantic provinces.

The rate of volatilization of dinoseb may depend on soil acidity, temperature, surface soil moisture, the method of application, and the type of formulation (Kaufman 1976). Cohen et al. (1984) reported a volatilization half-life of 26 d. The significance of volatilization has been evidenced by the killing of plants by dinoseb vapours (Davis et al. 1954). Photodegradation is a major fate process, with half-life values of <1–30 h for plant and soil surfaces (Matsuo and Casida 1970; Hawkins and Saggers 1974; Dinoseb Task Force 1985). The atmospheric photooxidation half-life of dinoseb was estimated to be between 12.2 and 122 h (Syracuse Research Corp. 1989).

The adsorption of dinoseb is influenced by the composition of the soils, the ambient temperature, and the soil pH (Kaufman 1976). A study reported K_d values of <5 in four soil types (Dinoseb Task Force 1985). In the model presented by Gustafson (1989), dinoseb would be classified as a "leacher" based on its water solubility and K_{oc}, but Gustafson classifies it as a "transition" compound because contradictory evidence exists as to its leaching potential.

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

Water Quality Guideline Derivation

The Canadian water quality guidelines for dinoseb for the protection of agricultural water uses were developed based on the CCME protocol (CCME 1993) with modifications.

Irrigation Water

The literature suggests that the susceptibility to pre-emergence applications of dinoseb is correlated with seed size (Barons and Watson 1969). Plants with large seeds were generally more tolerant of dinoseb than small-seeded plants. Differences between families were also evident, with the legumes being the most resistant and mustards and solanoids (e.g., eggplants, tomatoes, peppers) being the most sensitive (Schroeder and Warren 1971).

To take into account the variability in the toxicity of dinoseb to terrestrial nontarget plant species, family final acute values (FFAVs) were estimated for three crop groups: cereals and hays, legumes, and other crops. From the data compiled by Schroeder and Warren (1971), the FFAVs were calculated by taking the geometric mean of the species I_{50} values (concentration that caused a 50% reduction in the fresh weight of both shoots and roots) for the two most sensitive species in each group. The resulting FFAVs were 4.63, 9.29, and 1.62 $kg·ha^{-1}$ for cereals and hays, legumes, and other crops, respectively. These values were divided by an uncertainty factor of 10 and the irrigation rate of 10^7 $L·ha^{-1}$ per year to arrive at the SMATC for each crop group. The resulting SMATCs are adopted as the guideline for that group; namely 46 $µg·L^{-1}$ for cereals, tame hays, and pastures; 93 $µg·L^{-1}$ for legumes; and 16 $µg·L^{-1}$ for other crops. The lowest SMATC of 16 $µg·L^{-1}$ is recommended as the Canadian water quality guideline for irrigation water (CCME 1992).

Livestock Water

Studies with laboratory animals revealed that dinoseb has the potential to cause cataracts (Gosselin et al. 1981; Hayes 1982), male sterility (Brown 1981), and damage to the immune system (Dandliker et al. 1980).

Data on acute toxicity to mammals range from 9 to 356 $mg·kg^{-1}$ per day (McCormack et al. 1980; USEPA

Table 1. Water quality guidelines for dinoseb for the protection of agricultural water uses (CCME 1992).

Use	Guideline value ($µg·L^{-1}$)
Irrigation water	16*
Livestock water	150

*Crop-specific based on sensitivity.

1986). The NOEL for mammals ranges from 3 to 15 mg·kg^{-1} per day (Giavini et al. 1986b; Leist 1986a, 1986b; USEPA 1986). Acute LD_{50}s for birds range from 11.5 mg·kg^{-1} per day for mallard duck to 515 mg·kg^{-1} per day for ring-necked pheasant (USEPA 1986).

Long-term exposure (>200 d) of mice and rats to dinoseb resulted in adverse effects on the testes (Brown 1981) and decreased weight in pups (Irvine 1981). This study resulted in a LOEL of 1.0 mg·kg^{-1} per day and a NOEL of 0 mg·kg^{-1} per day for both mice and rats.

Teratogenic effects of dinoseb in rats and rabbits include skeletal abnormalities in fetuses from exposure during various stages of gestation (Giavini et al. 1986a, 1986b; Leist 1986a, 1986b). For rabbits, a NOEL and a LOEL of 3 and 10 mg·kg^{-1} per day, respectively, were reported based on fetal neural tube defects and skeletal abnormalities (Leist 1986a, 1986b).

Information available on the acute toxicity of dinoseb to mammals (Frøslie 1976; USEPA 1986) indicates that toxicity is relatively similar across broad taxonomic groups. The available information on the effects of dinoseb on mammals can, therefore, be used to calculate TDI levels for each species. The TDIs are calculated by dividing the geometric mean of the LOEL and NOEL by an uncertainty factor of 10. For rats, mice, and rabbits the TDIs are 0.1, 0.1, and 0.55 mg·kg^{-1} per day, respectively. Calculation of the geometric mean of these TDIs results in a TDI for mammals of 0.18 mg·kg^{-1} per day. Assuming the sensitivities of ungulates and rodents are similar (as suggested by limited acute toxicity data), this generalized TDI is multiplied by the ratio of the animal body weight to water intake for a dairy cow to yield an RC of 740 µg·L^{-1} per day. To account for exposure to dinoseb from sources other than water, the lowest RC is multiplied by an apportionment factor of 0.2 to give a water quality guideline of 150 µg·L^{-1} for the protection of livestock (CCME 1992).

References

Barons, K.C., and A.J. Watson. 1969. Dinoseb (DNBP) a truly versatile herbicide. Down Earth 7:10–12.

Brown, D. 1981. Dinoseb: A 100-week oral (dietary) toxicity and carcinogenicity study in the mouse. Hazelton Laboratories Europe Ltd., Otley Road, Harrogate, HG3 1PY, England. Unpub. (Cited in USEPA 1986.)

CCME (Canadian Council of Ministers of the Environment). 1992. Appendix XI—Canadian water quality guidelines: Updates (April 1992), dinoseb, triallate, and trifluralin 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.]

Cohen, S.Z., S.M. Creeger, R.F. Carsel, and C.G. Enfield. 1984. Potential pesticide contamination of groundwater from agricultural uses. In: Treatment and disposal of pesticide wastes. ACS Symposium Series 259 R.F. Krueger and J.N. Seiber, eds.

Dandliker, W.B., A.N. Hicks, S.A. Levison, K. Stewart, and R.J. Brawn. 1980. Effects of pesticides in the immune response. Environ Sci. Technol. 14(2):204–210.

Davis, F.L., F.L. Selman, and D.E. Davis. 1954. Some factors affecting the behavior of dinitro herbicides in soils. Proc. South. Weed Conf. 7:205–210.

Dinoseb Task Force. 1985. Determination of the mobility of dinoseb in selected soils by soil TLC. Prepared by Hazelton Laboratories America, Inc. Report Number 6015-192 (Tab 1). (Cited in USEPA 1987.)

Frøslie, A. 1976. Methaemoglobin reduction and NADH-dependent methaemoglobin reductase activity following DNBP- and nitrite-induced methaemoglobinemia in sheep. Acta Pharmacol. Toxicol. 38:17–23.

Giavini, E., M.L. Broccia, M. Prati, and C. Vismara. 1986a. Effect of method of administration on the teratogenicity of dinoseb in the rat. Arch. Environ. Contam. Toxicol. 15:377–384.

———. 1986b. Induction of teratogenic effects in the rat fetuses with dinoseb. Teratology 33(2):A19. Abstract.

Gosselin, R.E., R.P. Smith, and H.C. Hodge. 1981. Clinical toxicology of commercial products. Williams and Wilkins, Baltimore.

Gustafson, D.I. 1989. Groundwater ubiquity score: A simple method for assessing pesticide leachability. Environ. Toxicol. Chem. 8:339–357.

Hawkins, D.R., and V.H. Saggers. 1974. The fate of dinobuton and dinoseb on growing apples. Pestic. Sci. 5: 497–504.

Hayes, W.J. Jr. 1982. Pesticides studied in man. Williams and Williams Press, Baltimore.

Irvine, L.F.H. 1981. A three generation reproduction study of the effects of dinoseb in rats. Hazelton Laboratories Europe Ltd., Harrogate, England. Unpub. (Cited in USEPA 1987.)

Kaufman, D.D. 1976. Phenols. In: Herbicides: Chemistry, degradation, and mode of action, Vol. 2, P.C. Kearney and D.D. Kaufman, eds. Marcel Dekker, New York.

Leist, K.H. 1986a. Embryotoxicity study with dinoseb technical grade (Code: HOE 026015 OH ZD98 0004) in the rabbit oral administration. Submitted to Dinoseb Task Force by Hoechst Aktiengesellschaft, Pharma Forschung Toxicologies, D 6230 Frankfurt/Main, Federal Republic of Germany. (Cited in USEPA 1986.)

———. 1986b. Embryotoxicity study with dinoseb technical grade (Code: DDS 071085) with Wistar/Han rats (Kfm: WIST, outbred, SPF quality). Study submitted to Dinoseb Task Force by Hoechst Aktiengesellschaft, Pharma Forschung Toxicologies, D 6230 Frankfurt/Main, Federal Republic of Germany. (Cited in USEPA 1986.)

Matsuo, H., and J.E. Casida. 1970. Photodegradation of two dinitrophenolic pesticide chemicals, dinobuton and dinoseb, applied to bean leaves. Bull. Environ. Contam. Toxicol. 5(1):72–78.

McCormack, K.M., A. Abuelgasim, V.L. Sanger, and J.B. Hook. 1980. Postnatal morphology and functional capacity of the kidney following prenatal treatment with dinoseb in rats. J. Toxicol. Environ. Health. 6:633–643.

Schroeder, M., and G.F. Warren. 1971. Relative sensitivity of several plants to dinoseb. Weed Sci. 19(6):671–674.

Syracuse Research Corp. 1989. Chemical fate rate constants for SARA Section 313 chemicals and superfund health evaluation manual chemicals. EPA 68-02-4254. (Versar Task 176). Prepared by Syracuse Research Corporation, Chemical Hazard Assessment Division, Syracuse, New York. USEPA Office of Toxic Substances, Washington, DC.

USEPA (U.S. Environmental Protection Agency). 1986. Pesticide products containing dinoseb: Notices. Federal Register 51(198):36634–36661. Washington, DC.

———. 1987. Dinoseb: Health advisory. USEPA, Office of Drinking Water, Washington, DC.

WSSA (Weed Science Society of America). 1983. Herbicide handbook. 5th ed. WSSA, Champaign, IL.

Reference listing:

Canadian Council of Ministers of the Environment. 1999. Canadian water quality guidelines for the protection of agricultural water uses: Dinoseb. 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-rcqe@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: spccme@chc.gov.mb.ca

Excerpt from Publication No. 1299; ISBN 1-896997-34-1

Aussi disponible en français.