Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses

TEBUTHIURON

Tebuthiuron ($C_9H_{16}N_4OS$) is a nonselective, soil-applied herbicide registered for use on noncrop areas such as permanent pastures, railway roadbeds, the base of transmission towers and poles, roadsides, and highway rights-of-way. It is applied to the soil as a broadcast treatment for total vegetation control and affects woody plants, broadleaf weeds, grasses, and brush.

Tebuthiuron's low adsorption coefficient (log K_{ow} = 1.79) indicates that adsorption by soils is limited. Adsorption increases with organic matter content and with increasing acidity, with a maximum adsorption at a pH of 2 (Chang and Stritzke 1977; Weber 1980a, 1980b).

Tebuthiuron has a groundwater ubiquity score (GUS) of >2.8, indicating a high potential to leach through agricultural soil. Mobility was found to be affected by the pH, water content, water flow, and type of the soil (McRae 1991). Silvoy et al. (1986) reported that increased clay content enhanced mobility.

Persistence of tebuthiuron depends on soil properties, moisture level, temperature, precipitation, and presence of microbiota. The half-life of tebuthiuron is in the range of 12–15 months (Rainey and Magnussen 1976). Moisture is an important factor in mediating the persistence of tebuthiuron in soils. Up to 42% of the herbicide applied was still present after 11 years on lands where the mean annual rainfall is low (<430 mm). Nine years after application, up to 73% was found at depths of 60–90 cm (Johnsen and Morton 1989).

Complete removal of tebuthiuron from soil is mainly due to microbial degradation. Microbial degradation declines as soil moisture and temperature decrease (Emmerich et al. 1984).

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

Water Quality Guideline Derivation

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

Irrigation Water

A study on five species of grass reported a NOEAR and a LOEAR of 0.4 and 1.1 $kg \cdot ha^{-1}$ a.i., respectively, for the regrowth of mature kleingrass and coastal Bermuda grass (Baur et al. 1977).

Among four species of cereals, wheat was the most sensitive, with NOEAR and LOEAR values of 0.045 and 0.09 $kg \cdot ha^{-1}$ a.i., respectively, based on stunted growth and burns (Waldrep 1988).

A study of six other crop species reported NOEAR and LOEAR values for radishes, cabbages, and cucumbers of 0.045 and 0.09 $kg \cdot ha^{-1}$ a.i., respectively. The smallest EC_{50} value reported was 0.16 $kg \cdot ha^{-1}$ a.i. for cabbage, based on weight (Waldrep 1988).

The geometric means of the LOEARs and the NOEARs for each nontarget crop species for which adequate data were available were divided by an uncertainty factor of 20 to determine the acceptable application rates (AARs). These AARs were then divided by an irrigation rate of 1.2×10^7 $L \cdot ha^{-1}$ to calculate the SMATC. The SMATCs

Table 1. Water quality guidelines for tebuthiuron for the protection of agricultural water uses (CCME 1995).

Use	Guideline value ($\mu g \cdot L^{-1}$)
Irrigation water	$0.27^{*\dagger}$
Livestock water	130^{*}

*Interim guideline.
†Cereals, tame hays, and pastures.

were sorted into the two groups of crops irrigated in Canada: cereals, tame hays, and pastures, and other crops. Enough data were available only for the cereals, tame hays, and pastures group, with the lowest SMATC (wheat) of 0.27 $\mu g \cdot L^{-1}$ being adopted as the Canadian interim water quality guideline for irrigation (CCME 1995).

Livestock Water

Studies indicate that tebuthiuron generally exhibits moderately acute toxicity in mammals. The LD_{50}s ranged from 286 $mg \cdot kg^{-1}$ per day for the New Zealand white rabbit (Todd et al. 1972) to 644 $mg \cdot kg^{-1}$ per day for Wistar rats (Todd et al. 1974).

Chronic studies have reported LOEL values ranging from 80 to 250 $mg \cdot kg^{-1}$ per day for rats (Griffing and Todd 1974; Todd et al. 1976) and 50 $mg \cdot kg^{-1}$ per day for beagles (Todd et al. 1985). NOELs of 40 and 25 $mg \cdot kg^{-1}$ per day were reported for rats (Todd et al. 1976) and beagles (Todd et al. 1985), respectively. In a reproduction study by Todd et al. (1975), the LOEL was 45 $mg \cdot kg^{-1}$ per day for rats, when developmental effects were the endpoints.

Studies on the fate of tebuthiuron after ingestion indicate that the herbicide and its metabolites do not bioaccumulate to a significant extent in mammals. (Hoffman et al. 1975; Morton and Hoffman 1976). Studies indicate that the herbicide is partially metabolized and rapidly excreted by ungulates (DowElanco Canada 1993).

Only one species of ruminant livestock has been studied (Van Duyn et al. 1976). Ingestion of the herbicide at 3 $mg \cdot kg^{-1}$ per day in their feed for 162 d caused an increase in heart weight and a reduction in weight gain and feed utilization in heifers and steers. The geometric mean of the LOEL and the NOEL from this study was divided by an uncertainty factor of 10 to calculate the TDI. Multiplying the TDI for cattle by the most conservative ratio of the animal body weight to water intake (leghorn chicken) resulted in the RC. To account for exposure to tebuthiuron 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 130 $\mu g \cdot L^{-1}$ for the protection of livestock (CCME 1995).

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