Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses

TRIFLURALIN

Trifluralin ($C_{13}H_{16}F_3N_3O_4$) is used to control a wide range of annual grasses and broadleaf weeds, canola (rapeseed), sunflowers, root crops, vegetable crops, flowers, woody nursery stock, and established shelterbelts (OMAF 1989). Trifluralin is usually preplant incorporated due to its volatility (Maguire et al. 1988). Trade names for trifluralin registered in Canada include Treflan, Triflurex, Co-op Garden Weed Preventer, Heritage Selective Granular Herbicide, Rival, and Fortress (Agriculture and Agri-Food Canada 1997).

Trifluralin appears to act as a mitotic poison affecting root growth (Ashton and Crafts 1973; Poe et al. 1988). As trifluralin is primarily used as a soil-incorporated herbicide, its target is the plant root system. Trifluralin may also affect other metabolic reactions such as lipid synthesis (Sparchez et al. 1987). Trifluralin also inhibits energy-dependent calcium uptake in plant mitochondria at concentrations less than those interfering with tubulin polymerization (Hertel and Marme 1983).

The various processes governing the persistence and fate of trifluralin in the environment include volatilization, photodegradation, and microbial degradation. Generally, cool, dry climates favour greater persistence than warmer, more moist conditions (Jensen et al. 1983; Weber 1990). The absence of a soil microbial community also appeared to increase persistence in soils (Mostafa et al. 1982).

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

Water Quality Guideline Derivation

The interim Canadian water quality guideline for trifluralin for the protection of livestock water was adopted from the Canadian guideline for drinking water quality (Health and Welfare Canada 1989; Health Canada 1996) in 1992 following the principles fomalized in the protocol (CCME 1993). For further information, see CCME (1992).

Livestock Water

Trifluralin exhibits low acute oral toxicity to mammals and birds with LD_{50} values for mice >5 $mg \cdot L^{-1}$ (USEPA 1984, 1987). Doses equal to or greater than the LC_{50} equivalent of 1.8 $kg \cdot ha^{-1}$ reduced embryo growth of mallards *(Anas platyrhynchos)* and produced abnormalities in morphology at 18 d (Hoffman and Albers 1984).

A 90-d feeding study using female rats produced a NOAEL of 25 $mg \cdot kg^{-1}$ per day, based on increased liver weights of the progeny. A NOAEL of 100 $mg \cdot kg^{-1}$ per day resulted from a 729-d trifluralin ingestion study using rat growth rate, mortality, and food consumption as effect criteria. A 2-year trifluralin ingestion study produced a NOAEL of 30–37 $mg \cdot kg^{-1}$ per day in rats and 40 $mg \cdot kg^{-1}$ per day in mice. No increase in vomiting or liver-to-body weight ratios was observed in dogs fed 10 $mg \cdot kg^{-1}$ per day during a 3-day continuous trifluralin ingestion study (USEPA 1987).

A LOAEL of 2.5 $mg \cdot kg^{-1}$ per day was derived from a 90-d study of male rats in which increases in α,α,α-1 and α,α,α-2 and β-globulins were monitored in the blood (USEPA 1987). Histopathological changes in mouse kidney were observed after ingestion of trifluralin at 14, 140, and 1400 $mg \cdot kg^{-1}$ per day for 140 d (Akay 1986).

Low gastrointestinal tract absorption of a single oral dose of 100 $mg \cdot kg^{-1}$ bw was indicated by 11–14% excretion in the bile after 24 h (Emmerson and Anderson 1966). Approximately 78% of an oral dose of 100 $mg \cdot kg^{-1}$ was eliminated from rats via feces, while the remainder was eliminated in the urine (Emmerson and Anderson 1966).

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

Use	Guideline value ($\mu g \cdot L^{-1}$)
Irrigation water	NRG*
Livestock water	45†

*No recommended guideline.
†Interim guideline.

A lactating cow was administered 1 mg·kg^{-1} ^{14}C-labelled trifluralin for 39 d followed by 1000 mg·kg^{-1} for 13 d. Within 6 d, 99% of the ingested radioactivity was recovered in the urine. (Golab et al. 1969). A 26-d experiment with two lactating goats revealed that 17.8 and 81.2% of the trifluralin and metabolites were eliminated in the urine and feces, respectively (Golab et al. 1969).

Dose-related increases in hepatocellular carcinomas and alveolar adenomas were observed in female mice exposed to 33 or 62 mg·kg^{-1} per day trifluralin in the diet for 1.5 years (USEPA 1984; 1987).

Teratological studies using rabbits reported a NOAEL of 225 mg·kg^{-1} per day for maternal and reproductive effects. Higher doses of 500 and 800 mg·kg^{-1}·per day caused anorexia and cachexia in the females and aborted litters at dosages of 225 mg·kg^{-1} per day (USEPA 1987). Exposure of female mice to trifluralin (doses of 1.0 mg·kg^{-1}) on each of gestational days 6–15 resulted in a significant (19%) increase in skeletal abnormalities in their progeny at 62 d postpartum (Beck 1981).

Additional data related to the long-term ingestion of trifluralin by livestock via drinking water are required before the development of a guideline value. In the interim, the procedure recommended in the protocol (CCME 1993) of adopting the guideline value for human drinking water supplies is followed to develop an interim Canadian water quality guideline for livestock water. An interim Canadian drinking water quality guideline for trifluralin of 45 µg·L^{-1} has been proposed (Health and Welfare Canada 1989; republished without change in Health Canada 1996); therefore, this is also recommended as an interim livestock water guideline (Health Canada 1996; adoption updated 1998).

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