



Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses

CYANAZINE

Cyanazine ($C_6H_{13}CN_6$) (CAS 2175-46-2) is a selective systemic triazine herbicide that inhibits photosynthesis (Tomlin 1994). It is used for general weed control in dry bulb onions and corn. (Agriculture and Agri-Food Canada 1997). The common names for cyanazine include Bladex, Fortol, and Payze. Cyanazine may be formulated with atrazine as Blazine, with MCPA as Blagal, or with butylate, metolachlor, or dicamba (OMAF 1988).

Translocation of cyanazine to surface waters results from direct deposition of spray or from vapour drift or precipitation. Surface runoff and groundwater intrusions from treated lands also carry cyanazine to watercourses (Smith et al. 1982; Pionke et al. 1988). Losses of soil-applied triazine herbicides such as cyanazine are dominated by movement in the water phase as opposed to movement with eroded soil sediment (Baker et al. 1976; Leonard et al. 1979; Johnson and Baker 1982, 1984).

Soil degradation of cyanazine results from both chemical and biochemical processes, but the primary route of cyanazine degradation in soil is through microbial activity (USEPA 1987). Under field conditions, losses by either photodecomposition or volatilization are minimal (WSSA 1983; USEPA 1987).

Data on the aquatic fate of cyanazine are limited. The USEPA (1988) indicated that cyanazine persistence in water was not known and that the aquatic half-life had not yet been determined. Bioaccumulation in water should be negligible as suggested by the low $\log K_{ow}$ (3.68) (Banerjee et al. 1980). Volatilization to the atmosphere is not a major fate process for cyanazine loss from water (Smith et al. 1982).

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

Water Quality Guideline Derivation

The interim Canadian water quality guideline for cyanazine for the protection of irrigation water was adopted from the Ontario Ministry of the Environment's

water quality guideline (OMOE 1984). The interim Canadian water quality guideline for cyanazine for the protection of livestock water was developed in 1990 following the principles formalized in the CCME protocol (CCME 1993).

Irrigation Water

No information was found on the presence of cyanazine in irrigation water and its phytotoxic effects on nontarget plants. The OMOE (1984) reported that triazine herbicides have been observed to injure seedling crops at a concentration of $0.5 \mu\text{g}\cdot\text{L}^{-1}$. The OMOE (1984), therefore, recommended that irrigation water have residues of triazine herbicides below the $0.5 \mu\text{g}\cdot\text{L}^{-1}$ limit to avoid crop damage. In the absence of other information, the suggested limit of $0.5 \mu\text{g}\cdot\text{L}^{-1}$ (OMOE 1984) has been adopted as an interim water quality guideline for cyanazine in irrigation water.

Livestock Water

Toxicity tests with laboratory animals and wildlife have shown that cyanazine is moderately toxic to mammals and is a potential but weak teratogen. The LD_{50} by oral ingestion to rats is $334 \text{ mg}\cdot\text{kg}^{-1}$ (WSSA 1983). From teratology studies, the NOEL for rat ophthalmia was $10 \text{ mg}\cdot\text{kg}^{-1}$ per day; the NOEL may be $<1 \text{ mg}\cdot\text{kg}^{-1}$ per day for liver-induced hernia (abnormalities of the diaphragm as a result of liver protrusion) (Wnuk et al. 1987; USEPA 1988). For rat growth effects, the NOEL is $3 \text{ mg}\cdot\text{kg}^{-1}$ per day, and for rabbit maternal and fetal toxicity, $1 \text{ mg}\cdot\text{kg}^{-1}$ per day (USEPA 1988). Pregnant rats fed 5, 25, or $75 \text{ mg}\cdot\text{kg}^{-1}$ per day cyanazine on days 6 through 15 of gestation, had maternal and developmental toxicity NOAELs $<5 \text{ mg}\cdot\text{kg}^{-1}$ per day (the lowest dose tested),

Table 1. Water quality guidelines for cyanazine for the protection of agricultural water uses (CCME 1990).

Use	Guideline value ($\mu\text{g}\cdot\text{L}^{-1}$)
Irrigation water	0.5*
Livestock water	10*

*Interim guideline.

while the teratogenic NOAEL was 5 mg·kg⁻¹ per day. Maternal body weight reductions and decreased food intake were observed at all dose levels, and alterations in skeletal ossification sites in the offspring were reported for all treatment groups. Maternal or developmental toxicity, however, was not observed in Sprague-Dawley rats exposed to dose levels up to 30 mg·kg⁻¹ per day.

Summaries of exposure tests for cyanazine can be found in the cyanazine health advisory published by the USEPA (1987). During short-term exposure tests, a single oral dose of a 75% wettable powder formulation of cyanazine fed to 5-month-old rats produced a maximum NOAEL of 1 mg·kg⁻¹. Serum protein and potassium concentrations increased with 25 mg·kg⁻¹, and serum osmolality increased at 5 mg·kg⁻¹. In a 4-week oral toxicity study, rats receiving diets containing 0.05, 0.5, or 5 mg·kg⁻¹ per day had a decrease in body weight and food intake with a LOAEL of 0.05 mg·kg⁻¹ per day. A 13-week study with cyanazine given orally to 5- to 7-month-old beagle dogs at concentrations of 1.5, 5, or 15 mg·kg⁻¹ per day caused mainly emesis; the NOAEL was 5 mg·kg⁻¹ per day. In rats, the 13-week NOAEL ranged from 0.05 mg·kg⁻¹ per day for increased liver weight in females to 1.25 mg·kg⁻¹ per day for reduced kidney weight in males. During long-term exposures, 2-year studies with dogs and mice produced NOAELs of 1.25 and 7.5 mg·kg⁻¹ per day, respectively. In the dogs, doses of 5 mg·kg⁻¹ per day caused emesis and led to reduced growth rate and serum protein. In the mice, effects observed at 37.5 mg·kg⁻¹ per day included increased female mortality and increased relative brain weight and liver weight.

Cyanazine is rapidly absorbed from the alimentary tract of treated animals. It is metabolized in the rat mainly through a primary N-de-ethylation step followed by conjugation with glutathione in the liver to later yield mercapturic acids in the urine (Crayford and Hutson 1972). This occurs without any cleavage of the *s*-triazine ring. Crayford and Hutson (1972) found that the LD₅₀ values for the metabolites of cyanazine were >1000 mg·kg⁻¹ in the rat. Walker et al. (1974) also demonstrated through acute and long-term toxicity studies with rats that the major metabolites of cyanazine were less toxic than the parent compound.

Feeding studies with cows have also been conducted (USEPA 1987). No accumulation of cyanazine was seen in 21-d feeding trials with cows. Concentrations of the parent compound in the brain, liver, kidneys, muscle, and fat were at lower levels than the amount of cyanazine in the feed. When 0.2 µg·g⁻¹ was fed to the cows for 21 d, the detectable cyanazine residues were <0.05 µg·g⁻¹ in these

tissues (USEPA 1987). In cows fed 5 µg·g⁻¹ cyanazine for the same period of time, the concentration in milk was reported to be 0.022 µg·g⁻¹. Because these results are from feeding studies rather than from cyanazine in drinking water, a guideline for livestock drinking water is difficult to derive. It is therefore suggested that the human drinking water guideline of 10 µg·L⁻¹ (Health and Welfare Canada, 1989; republished without change in Health Canada 1996) be adopted as an interim water quality guideline for livestock water. (CCREM 1987).

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