



Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses

CARBARYL

Carbaryl ($C_{12}H_{11}NO_2$) (1-naphthyl-N-methylcarbamate, CAS 63-25-2) is a carbamate insecticide sold under the trade name Sevin. This white crystalline solid is slightly soluble in water ($120 \text{ mg}\cdot\text{L}^{-1}$ at 20°C). Acting as both a contact and a systemic (stomach) poison, carbaryl controls over 150 major pests in a wide variety of crops, including sweet and field corn, cereal grains, legumes, turf, pastures, forest and shade trees, and fruit and vegetable crops. It also controls lice, fleas, ticks, and flies on poultry and livestock and in farm buildings (Agriculture and Agri-Food Canada 1997). In 1995, there were 195 products registered for use in Canada that contained carbaryl (PEPSIS 1995).

Boberschmidt et al. (1989) reviewed the fate of carbaryl in plants and animals. Carbaryl is absorbed by dermal, gastrointestinal, and respiratory routes in mammals, but is readily excreted by most animals. For example, within 24 h of treatment with radio-labeled carbaryl, rats, pigs, sheep, cows, chickens, gerbils, guinea pigs, mice, and dogs excreted 30–94% and 1–15% of the dose in urine and feces, respectively.

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

Water Quality Guideline Derivation

The Canadian water quality guideline for carbaryl for the protection of livestock water was developed based on the CCME protocol (CCME 1993).

Livestock Water

In mammals, carbaryl inhibits cholinesterases (ChE) and aliesterases leading to cholinergic effects (Mount and Oehme 1981). In most cases, these effects are reversible, however, inhibition of aliesterases is less readily reversed than that of cholinesterases (Mount and Oehme 1981). Acute and chronic toxicity data are available for several mammalian species, three of which are livestock (dog,

pig, and rabbit) species. The LD_{50} s for mammals ranged from $100 \text{ mg}\cdot\text{kg}^{-1}$ for cats and mice to $2000 \text{ mg}\cdot\text{kg}^{-1}$ for monkeys (Boberschmidt et al. 1989). The LD_{50} for pigs is $>1500 \text{ mg}\cdot\text{kg}^{-1}$. The NOEL for pigs fed carbaryl throughout a gestation cycle is $4 \text{ mg}\cdot\text{kg}^{-1}$ bw per day (Earl et al. 1973), while the LOEL for reduced litter size and increased stillbirths in pigs is $8 \text{ mg}\cdot\text{kg}^{-1}$ bw per day (Smalley et al. 1969). Rabbits and mice fed $150 \text{ mg}\cdot\text{kg}^{-1}$ bw per day over the course of a reproductive cycle had decreased weight gain and increased maternal mortality (Murray et al. 1979).

Acute and chronic toxicity data are also available for numerous bird species, including two livestock (chickens and ducks) species. The LD_{50} for most birds, including female mallard ducks (*Anas platyrhynchos*), was $>1000 \text{ mg}\cdot\text{kg}^{-1}$ (Schafer 1972; Hill et al. 1975). Chronic toxicity tests showed no mortality among chickens fed $180 \text{ mg}\cdot\text{kg}^{-1}$ bw per day as a mixture of kaolin powder and Sevin for 60 d, but 100% mortality occurred after 35 d at $540 \text{ mg}\cdot\text{kg}^{-1}$ bw per day (Nir et al. 1966). Overall, birds appear more tolerant to carbaryl than mammals.

To develop a water quality guideline for carbaryl, a TDI was calculated for each livestock species for which acceptable toxicological data were available. The TDI is the geometric mean of the LOEL and the NOEL divided by an uncertainty factor of 10. A TDI of $0.57 \text{ mg}\cdot\text{kg}^{-1}$ per day was calculated for pigs having a LOEL and NOEL of $8 \text{ mg}\cdot\text{kg}^{-1}$ per day and $4 \text{ mg}\cdot\text{kg}^{-1}$ per day, respectively, for decreased reproduction (Earl et al. 1973). An RC was calculated by multiplying the TDI by the ratio of body weight (bw) to water intake rate (WIR). Lactating sows have a bw/WIR ratio of 9.4, giving an RC of $5.4 \text{ mg}\cdot\text{L}^{-1}$. To account for exposure to carbaryl from sources other than water, the lowest RC is multiplied by an apportionment factor of 0.2 to give a water quality

Table 1. Water quality guidelines for carbaryl for the protection of agricultural water uses (CCME 1997).

Use	Guideline value ($\mu\text{g}\cdot\text{L}^{-1}$)
Irrigation water	NRG*
Livestock water	1100

*No recommended guideline.

guideline of 1.1 mg·L⁻¹ (1100 µg·L⁻¹) for the protection of livestock (CCME 1997).

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