

# Acute and Chronic Toxicity of Imidacloprid to the Aquatic Invertebrates *Chironomus tentans* and *Hyalella azteca* under Constant- and Pulse-Exposure Conditions

Sarah J. Stoughton · Karsten Liber ·  
Joseph Culp · Allan Cessna

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**Abstract** The toxicity of imidacloprid, a nicotinic mimic insecticide, to the aquatic invertebrates *Chironomus tentans* and *Hyalella azteca*, was first evaluated in static 96-hour tests using both technical material (99.2% pure) and Admire<sup>®</sup>, a commercially available formulated product (240 g a.i. L<sup>-1</sup>). The 96-h lethal concentration (LC)50 values for technical imidacloprid and Admire<sup>®</sup> were 65.43 and 17.44 µg/L, respectively, for *H. azteca*, and 5.75 and 5.40 µg/L, respectively, for *C. tentans*. Admire<sup>®</sup> was subsequently used in 28-day chronic tests with both species. Exposure scenarios consisted of a constant- and a pulse-exposure regime. The pulse exposure lasted for four days, after which time the animals were transferred to clean water for the remaining 24 days of the study. Assessments were made on both day 10 and day 28. In the *C. tentans* under constant exposure, larval growth on day 10 was significantly reduced at 3.57 µg/L imidacloprid, the lowest-observed-effect concentration (LOEC). The no-observed-effect concentration (NOEC) and LOEC for the 28-day exposure duration (adult survival and emergence) were 1.14 and greater than 1.14 µg/L, respectively; the associated LC50 and LC25 were 0.91 and 0.59 µg/L, respectively. The LOEC for the pulse treatment was greater

than 3.47 µg/L, but the day 10 LC25 was 3.03 µg/L. In the *H. azteca* tests, the day 10 and 28 constant exposure, as well as the day 28 pulse exposure, LOEC (survival) values were similar at 11.95, 11.46, and 11.93 µg/L, respectively. The day 10 and 28 constant exposure effective concentration (EC)25s (dry weight) were also similar, at 6.22 and 8.72 µg/L, respectively, but were higher than the pulse-exposure day 10 LOEC and EC25 (dry weight) values of 3.53 and 2.22 µg/L, respectively. Overall, *C. tentans* was more sensitive to acute and chronic imidacloprid exposure, but less sensitive to a single pulse, than *H. azteca*. Chronic, low-level exposure to imidacloprid may therefore reduce invertebrate survival and growth, but organisms are able to recover from short-term pulse exposure to similar imidacloprid concentrations if the stressor is removed after four days.

Imidacloprid, 1-((6-chloro-3-pyridinyl)methyl)-*N*-nitro-2-imidazolidinimine (C<sub>9</sub>H<sub>10</sub>ClN<sub>5</sub>O<sub>2</sub>), is a nicotine mimic (nicotinoid insecticide) that belongs to a group of insecticides referred to as the chloronicotinyl group (Kidd and James 1991; Cox et al. 1997; Tomlin 1997). It produces toxicity by binding to and overstimulating nicotinic acetylcholine (ACh) receptors on the postsynaptic membranes of neurons (Kidd and James 1991; Song et al. 1997; Tomlin 1997). Imidacloprid has both stomach (systemic) and contact action, and is effective against a wide variety of insect pests, including the Colorado potato beetle, *Leptinotarsa decemlineata*. In Canada, this pesticide is used on potato, tomato, lettuce, canola, and other vegetable crops, as well as for control of fleas on domestic cats and dogs (Cox 2001). In crop production, imidacloprid can be

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S. J. Stoughton · K. Liber (✉)  
Toxicology Centre, University of Saskatchewan, 44 Campus  
Drive, S7N 5B3 Saskatoon, SK, Canada  
e-mail: karsten.liber@usask.ca

J. Culp  
National Water Research Institute, Environment Canada,  
Fredericton, NB, Canada

A. Cessna  
National Water Research Institute, Environment Canada,  
Saskatoon, SK, Canada