

## EFFECTS OF ATRAZINE AND CYANAZINE ON CHLORPYRIFOS TOXICITY IN *CHIRONOMUS TENTANS* (DIPTERA: CHIRONOMIDAE)

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**Abstract**—Toxicities of two triazine herbicides (atrazine and cyanazine) and an organophosphate insecticide (chlorpyrifos) were evaluated individually and with each herbicide in binary combination with chlorpyrifos using fourth-instar larvae of the aquatic midge, *Chironomus tentans*. Chlorpyrifos at 0.25 g/L resulted in an effect in less than 10% of midges in 48-h acute toxicity bioassays. Neither atrazine nor cyanazine alone at relatively high concentrations (up to 1,000 g/L) caused significant acute toxicity to *C. tentans*. However, atrazine and cyanazine caused significant synergistic effects on the toxicity of chlorpyrifos when midges were exposed to mixtures of atrazine or cyanazine (10, 100, 1,000 g/L) with chlorpyrifos (0.25 g/L). At fixed concentrations (200 g/L) of the herbicides, toxicity of chlorpyrifos was enhanced by 1.8- and 2.2-fold by atrazine and cyanazine, respectively, at the 50% effective concentration levels. Although atrazine and cyanazine are not effective inhibitors of acetylcholinesterase (AChE) in vitro, the synergism of the two triazine herbicides with chlorpyrifos was associated with increased in vivo inhibition of AChE in midges. We observed a positive correlation between the degree of inhibition of AChE and the concentration of atrazine or cyanazine in the presence of a fixed concentration of chlorpyrifos. It is possible that these herbicides may affect cytochrome P450 enzymes to confer synergistic effects on the toxicity of chlorpyrifos.

**Keywords**—Atrazine Cyanazine Chlorpyrifos Acetylcholinesterase *Chironomus tentans*