

Toxicity of the sugar cane herbicides Diuron and Tebuthiuron in zebrafish (*Danio rerio*) early-life stages

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Herbicides are widely used in agriculture and are known as a diffuse source of pollution of surface water and groundwater. The impact of herbicides use on non-target organisms is little known although mutagenic and genotoxic effects in fish exposed to herbicides have already been observed. Sugarcane is the predominant crop cultivated in the state of São Paulo, Brazil, with an area comprising approximately five million hectares. In the present study, the toxicity of diuron and tebuthiuron, two herbicides widely used in sugarcane cultivation, was evaluated using the Fish Embryo toxicity Test (FET), with *Danio rerio*, a tropical cyprinid used in toxicological research. The endpoints monitored included pigmentation, otholith, yolk absorption, pericardial oedema, tail deformation, hatching, coagulation and death. Five concentrations of each chemical were tested, ranging from 0.001 to 0.08 g L⁻¹ of Diuron; and from 0.1 to 0.6 g L⁻¹ of Tebuthiuron. At concentrations over 0.02 g L⁻¹ of diuron and 0.24 g L⁻¹ of tebuthiuron, exposed embryos presented a general development delay, pericardial oedemas, tail deformities and a delay in yolk absorption. Despite the low acute toxicity of diuron and tebuthiuron (LC_{50-96h} = 0.024 (0.022 - 0.026) g L⁻¹ and LC_{50-96h} = 0.35 (0.17 - 0.53) g L⁻¹, respectively) observed for zebrafish early-life stages, deleterious effects at sublethal level could be observed. The endpoints used on this study allow a better understanding of the toxicity and mode of action of these two herbicides, suggesting that, chronic effects due to long term exposure to the herbicides can be very important, leading to significant alterations in the organisms and consequently disrupt the functioning of aquatic ecosystems. Thus, as these chemicals are widely used in the field, an evaluation of risk should be performed based on the monitoring of sublethal parameters in organisms belonging to several trophic levels.

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