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Effects of Glyphosate on Immune Responses and Haemocyte DNA Damage of Chinese Mitten Crab, *Eriocheir sinensis*

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Abstract: As a broad-spectrum organophosphorus herbicide, glyphosate is widely utilized around the world. The toxic effects of glyphosate on Chinese mitten crab, *Eriocheir sinensis*, were assessed using immunotoxicity and genotoxicity biomarkers in this study. The results showed that 24 h and 96 h LC_{50} values of glyphosate for *E. sinensis* were estimated as 461.54 and 97.89 mg/L, respectively, and the safe concentration was 4.4 mg/L. According to the results above, glyphosate was applied at concentrations of 0, 4.4, 9.8, 44 and 98 mg/L, for 96 h in the exposure experiment. Total haemocyte count (THC) and percentage of granulocytes decreased significantly following 6 h exposure to each concentration of glyphosate and tended to gradually stabilize after 12 h except in 4.4 mg/L, which rapidly recovered to a normal level in 12 h. Phagocytic activity in all treatments decreased dramatically at 6 h and maintained stability until the 96-h mark. Comet tail has been observed early at 24 h in each treatment, and the comet ratio and percentage of DNA (% DNA) in the tail increased as the exposure experiment progressed. Immune-related enzyme activity varied during the experiment. Acid phosphatase (ACP) and alkaline phosphatase (AKP) activities in 44 and 98 mg/L treatments decreased significantly after 48 h exposure, while AKP activities in all concentrations increased markedly at the beginning of exposure. The superoxide dismutase (SOD) and peroxidase (POD) activities increased significantly after 6 h exposure to 44 and 98 mg/L of glyphosates but decreased at 24 h. In addition, the β-glucuronidase (β-GD) activities in the 9.8, 44 and 98 mg/L groups, increased after 6-h exposure and were significantly higher than those in the control at 96 h. These results indicated that glyphosate has evident toxic effect on *E. sinensis* by immune inhibition that is possibly due to the haemocyte DNA damage and a sharp decline in haemocyte numbers, which subsequently induced changes in activities of immune-related enzymes and haemocyte phagocytosis.

Key words: Glyphosate; THC; DHC; immune-related enzyme; DNA damage; *Eriocheir sinensis*

1.Introduction

As a broad-spectrum organophosphorus herbicide, glyphosate-based herbicides, such as the commercial formulations Roundup and Rodeo, are utilized globally and used in both agricultural areas and aquatic waters for weed control[1]. Glyphosate is considered to have low toxicity to