TOXICOLOGICAL EFFECTS OF FASTAC INSECTICIDE (ALPHA - CYPERMETHRIN) TO DAPHNIA MAGNA AND GAMMARUS PULEX

V. Yordanova, T. Stoyanova, I. Traykov, B. Boyanovsky
Department of Ecology and Environmental Protection, Faculty of Biology, Sofia University, Sofia, Bulgaria
Corresponence to: Teodora Stoyanova
E-mail: stoyanova.t.l@gmail.com

ABSTRACT

Fastac is a widely used in field pest control insecticide, belonging to the group of synthetic pyrethroids. These insecticides are highly toxic to many aquatic and terrestrial organisms. The purpose of the study was to evaluate the acute toxicity of Fastac on Daphnia magna Straus and Gammarus pulex (L.). The 48h - EC50 for Daphnia magna was estimated to be 0.8 µg/l and 24h - LC50 for Gammarus pulex – 0.3 µg/l. The low solubility of the Fastac resulted in higher toxicity toward Gammarus pulex probably due to its adsorption into the sediments.

Keywords: Acute toxicity, Daphnia magna, Fastac insecticide, Gammarus pulex, Synthetic pyrethroids

Introduction

Fastac is the trade name of alpha - cypermethrin (mixture of (1 R cis) S and (1 S cis) R isomers of cypermethrin). It is a synthetic pyrethroid pesticide. Pyrethroids are widely used in field pest control and are among the most potent insecticides known (10). They usually have high toxicity to a wide range of water column and benthic aquatic organisms (5).

The pyrethroid insecticide Fastac with active substance 100 g/l alpha - cypermethrin has a wide spectrum of impact and is used to control a wide range of pests, particularly Lepidoptera and Coleoptera in citrus, cotton, forestry, fruit, rice, soybeans, tomatoes, vegetables, grapes and other crops. In public health it is used to control cockroaches, mosquitoes, flies and other insect pests. Fastac has a high acute toxicity to many aquatic and terrestrial organisms (2), (5), (6), (13). The insecticide acts by preventing transmission of nerve impulses, by blocking the passage of sodium ions through channels in nerve membranes, thus preventing signals passing down axons.

The effect of synthetic pyrethroids is generally assessed through acute and chronic tests. Daphnia magna has been widely used to evaluate short and long term toxicity of pesticides (4), (8), (11).

The aim of the present study is to evaluate the acute toxicity of Fastac insecticide on Gammarus pulex (L.) and Daphnia magna Straus.

Materials and methods

The Fastac insecticide and Daphnia magna Straus were kindly provided to us from Norwegian Institute for Water Research (NIVA), Oslo. We used initial solution of Fastac in acetone with concentration of alpha - cypermethrin 10 mg/l, because the insecticide has a low solubility in water. The initial solution was diluted and the concentration of acetone in all test solutions and in the control didn’t exceed 0.01 ml/l. The concentrations of alpha - cypermethrin, which we tested, were in the diapason 0.05 – 2 µg/l.

The acute toxicity was estimated as lethal concentrations that affect 50% of the test organisms within the prescribed period of time (LC50). LC50 was determined by graphic interpolation based on the rate of mortality in probit units and the logarithm (log) of insecticide concentration. To avoid negative values, we added 1 to all concentrations prior to log transformation of the data. The LC50 value was derived after antilog and subsequent subtraction of 1.

The following methods were applied:

- Determination of acute toxicity with Gammarus pulex (L.) (1), (11) – zoobenthos species in fresh water basins, belonging to class Crustacea, order Amphipoda. Gammarus were collected from Slatinska River, Sofia and were acclimatized in laboratory before testing (14).

They were exposed for 24 hours in a series of concentrations of Fastac (0.05; 0.1; 0.5; 1; 2 µg/l). Each treatment was replicated five times and 24 h – LC50 was estimated.
Determination of acute toxicity with *Daphnia magna* Straus (3), (7) – zooplankton species in fresh water basins, belonging to class *Crustaceae*, order *Cladocera*. *Daphnia* neonates (less than 24 h old) were exposed for 48 hours in a series of concentrations of Fastac (0.05; 0.1; 0.25; 0.5; 1; 2 µg/l). Two preliminary tests and two final tests with five replicates were performed and 48 h – LC50 was estimated.

**Results and Discussion**

The results from *Daphnia magna* tests are presented in Fig. 1. Average 24 h – LC50 is 1.9 µg/l, with coefficient of variation of 0.07 and standard deviation of 0.1. Average 48 h – LC50 is 0.8 µg/l, with coefficient of variation of 0.5 and standard deviation of 0.4.

Fig. 1. Dependence of *Daphnia magna* mortality in probit units on Factac concentration (log) after 24h (▲) and after 48h (■)

Stephenson, 1982, estimated the acute toxicity of alpha-cypermethrin using toxicity tests under static conditions (daily renewal of test solutions) to be 1.1 µg/l (24 h – LC50) and 0.3 µg/l (48 h – LC50). These values are lower than the one estimated in the present work, in which tests were conducted without media renewal.

The results from the tests with *Gammarus pulex* are presented on Fig. 2 and showed 24 h – LC50 to be at 0.3 µg/l. So far we couldn’t find any data in the literature for alpha-cypermethrin acute toxicity to *Gammarus pulex*. On the other hand (11) tested the acute toxicity of the main compound – cypermethrin, and reported 24 h – LC50 for *Daphnia magna* and 24 h – LC50 for *Gammarus pulex* to be 2 µg/l and 0.2 µg/l, respectively. The results are close to the present results.

Fig. 2. Dependence of *Gammarus pulex* mortality in probit units on Factac concentration (log) after 48h (■)
for Fastac toxicity and the reason is that alpha - cypermethrin (Fastac) is a mixture of (1R cis) S and (1S cis) R isomers of cypermethrin.

The acute toxicity results show that *Gammarus pulex* is more sensitive to Fastac than *Daphnia magna*. Similar results are also reported by (9) and (11) about the toxicity of cypermethrin. We could suggest that, the low solubility of Fastac in water leads to its adsorption into the sediments. *Gammarus* as benthic organisms, are placed in direct contact with the substrate, respectively with the adsorbed insecticide. Studies involving monitoring of pyrethroid levels in aquatic systems need to take into account the hydrophobic nature of those compounds.

Fastac sublethal effects are in lower concentration diapason than the lethal effects (14). According to (14) the harmless concentration of alpha - cypermethrin is 0.01µg/l. The same author determines that high toxicity effect to some insecticides (including Fastac) leads to inhibition of basic vital functions of *Daphnia* (the most powerful filtrators in the zooplankton) and to acceleration of the processes of eutrophication in many water basins.

Water quality is essential for sustaining health of aquatic organisms. Pollution of water basins come mostly from agriculture. Many pesticides, as well as the synthetic pyrethroid insecticide Fastac, are used for pest control. There delivery into the surface water via runoff may contribute to acute or long lasting chronic toxicological effects.

The selected test organisms show high sensitivity to Fastac insecticide. The Fastac is more toxic to the benthic dwellers, as *Gammarus*, due to its lower solubility in water, which suggests its adsorption onto the suspended solids and accumulation into the sediments.

**Acknowledgements**

We acknowledge the help of Prof. Hessen D.O. from the Norwegian Institute for Water Research (NIVA), for consulting the toxicological analyzes.

**REFERENCES**

12. **Stephenson R.R.** (1982) WL85871 and cypermethrin: a comparison of their acute toxicity to *Salmo gairdneri, Daphnia magna* and *Selenastrum capricornutum*, Shell Research, Sittingbourne, SBGR 81.277