

Summary Master Thesis

Combined effects of esfenvalerate and heavy metals on *Daphnia magna*: From laboratory investigation to legal countermeasures in Germany

Introduction

The rapid, continuous decline of biodiversity due to anthropogenic impacts can be observed worldwide and in a wide range of ecosystems. Of all the threatened habitats, freshwater systems are some of the most affected. The stressors include but are not limited to eutrophication, shore straightening measures, introduction of invasive species and pollution through the use of plant protection products (PPP) or heavy metals. Among these, pollution, predominantly that by synthetic pesticides (especially pyrethroids), has been identified as one of the main threats to biodiversity. To protect non-target organisms from PPP, a highly elaborated tiered risk assessment with ecotoxicological experiments has been established in the EU to determine whether or not a specific substance can be authorised. However, this process only takes single toxicants into consideration, disregarding that organisms can be threatened not only by a single pesticide, but also by a combination of several stressors. Moreover, the resulting limit values, the so-called “regularly acceptable concentrations” (RAC) are frequently exceeded in nature. Thus, this thesis aims at investigating how the combination of specific pollutants (the pyrethroid esfenvalerate and the heavy metals lead and chromium) affect aquatic test organisms. Additionally, it takes a look at the current legislation in Germany to see how non-target organisms are protected from pollution.

Research questions

Q1: How do sublethal and lethal concentrations of the insecticide esfenvalerate affect the mortality of the aquatic invertebrate *Daphnia magna* (water flea) if individuals are also exposed to sublethal dosages of lead

(Pb) and chromium (Cr)?

Q2: How do sublethal and lethal concentrations of the insecticide esfenvalerate affect the reproduction of *Daphnia magna* when individuals are also exposed to sublethal dosages of Pb and Cr?

Q3: How are legal measures protecting aquatic organisms from insecticide and heavy metal pollution through agricultural activities in Germany and what are possible improvements?

Methods

To do so, this thesis first gives an overview over relevant legislation in the EU and Germany regarding these substances. Due to the limited scope of this work, the main focus will lie on agriculture related pollution. Moreover, a series of acute toxicity experiments are conducted.

The experiments are conducted in the laboratory of the Helmholtz Centre for Environmental Research (UFZ) in Leipzig with the pyrethroid insecticide esfenvalerate and the heavy metals Pb and Cr (VI). First, the test organisms, the aquatic invertebrates *Daphnia magna*, are bred for the experiment. The new-born daphnids (age <24h) are then transferred into individual 80mL wide-mouth bottles, which are contaminated for 24h with different concentrations of esfenvalerate and heavy metals. A wide range of insecticide concentrations (0; 0,01; 0,0316; 0,1; 0,316; 1,0; 3,16 µg/L) is chosen. With the exception of the highest two, i. e. 1,0 µg/L and 3,16 µg/L, these concentrations cover the spectrum of those detected in the field. However, since it is interesting to see, whether there might be antagonistic effects between the different substances, the higher dosages of 1,0 µg/L as well as 3,16 µg/L are also included. After a pretest, the sublethal Pb concentration of 98 µg/L and the Cr (VI) concentration of 100 µg/L were chosen. These doses are lower than most of the ones used in previous studies in order to see if even these sublethal concentrations have an effect. Surviving daphnids and later their offspring are counted. Each experiment has a total duration of 21 days and is repeated thrice.

Results

Mixtures of pyrethroids and other pollutants, such as heavy metals, may act in an antagonistic or synergistic manner on non-target organisms. This multi-stressor influence should be considered in environmental risk assessment. Additionally, limit values for surface waters regarding the total amount of all PPP and limit values for dissolved Cr(VI) could be implemented. Moreover, the tiered risk assessment process could be revised, i. e. by abolishing higher tiers, to better protect the aquatic environment.

Keywords: acute toxicity, pyrethroids, Pb, Cr(VI), EU PPP risk assessment