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Perspective

Synthetic Pyrethroids' Toxicological Effects on Non-Target Aquatic Organisms

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INTRODUCTION

Synthetic Pyrethroid (SP) pesticides are widely employed in agricultural and non-agricultural applications worldwide. Their toxicity to mammals is modest; nonetheless, they have a high toxicity to invertebrates, fish and amphibians, including vulnerable species, harming ecosystem health and biodiversity. This report covers current global research on SP toxicity on non-target aquatic animals and examines current biomonitoring ways to identify their effects on aquatic ecosystems. SPs' toxicological effects on aquatic macroinvertebrates have been demonstrated in laboratory, mesocosm and field investigations over the last decade. Toxicity of SPs for aquatic creatures varies substantially between species, emphasizing the significance of monitoring toxicity in all main aquatic groups.

However, there is a lack of data and additional research is needed to determine how sediment-bound SPs influence less researched aquatic taxa such as zooplankton, amphibians and fish. Detecting toxicant-induced stress in aquatic habitats can reveal how SPs affect individual individuals and the community. Toxicity thresholds for all aquatic groups, such as invertebrates, fish and amphibians, should aid in assessing the biological risks of SPs in order to influence regulations and management activities to safeguard aquatic ecosystems.

DESCRIPTION

Synthetic Pyrethroids (SPs) are widely used as insecticides in residential and agricultural areas, as well as for pest control in landscape maintenance in parks, animal husbandry (in pet shampoo and veterinary medicine to treat crustacean parasites), ornamental plants and public health to control mosquito-borne diseases. They have been included in approximately 3,500 registered products, including personal care items such as shampoo and mosquito repellents, as well as pet care items. Their usage has increased over the last decade, as has the use of more harmful and persistent pesticides such as organophosphate and carbamate insecticides, which are more acutely toxic to birds and mammals than SPs. They have grown to be one of the three most often used pesticides worldwide, with the global SP market valued at $1,633 million in 2016.

SPs are utilized in pest management products such as termite treatment in Australia and Argentine ant (*Linepithema humile*) control in the United States. They are also employed in some mosquito eradication programmes and several African countries utilize pyrethroids to treat mosquito nets as a malaria control measure. Synthetic pyrethroids are also utilized in insect repellents and fog applications to combat dengue viruses. However, the effectiveness of these chemicals is dwindling due to the rapid emergence of resistance among mosquitos.

Despite the fact that SPs are used globally, detailed data on their use and detection are limited in many nations and regions, particularly in developing countries with little environmental restrictions and monitoring programmes. Because of the extensive usage of SPs and their persistence in the environment for several months, SPs are now found in aquatic ecosystems throughout the world. As a result, numerous studies have been conducted to establish the toxicity of SP insecticides and their impact on non-target creatures, especially endangered species.

The goals of this review are to identify the effects of SPs on non-target aquatic animals and to comprehend existing biomonitoring methodologies for detecting their effects on aquatic ecosystems.

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There are numerous diagnostic procedures for determining where SPs are having an environmental impact. Many of these techniques are discussed in this paper, as well as how they might be utilized to detect the presence of SPs in water.

Factors affecting toxicity

Synthetic pyrethroids affect both the peripheral and central nervous systems, changing the kinetics of voltage-sensitive sodium channels and delaying channel closure. The sensitivity of sodium channels to pyrethroids, the temperature coefficient of pyrethroid effects on sodium channels and the reversibility of sodium channels following pyrethroid toxication are the three key parameters that determine the toxicity of pyrethroids to an organism. Synthetic pyrethroids are more hazardous to macroinvertebrates than to mammals because they have a lower body temperature, which considerably lowers enzymatic detoxification processes and sodium channels that are more sensitive to pyrethroids.

Temperature, exposure circumstances and the availability of suspended sediments are all physical factors that influence the toxicity of SPs. Water temperature, for example, are inversely related to SP toxicity (negative temperature coefficient), therefore they are more harmful to aquatic animals in lower water temperatures in water bodies cooler than conventional laboratory temperatures. In general, the temperatures used in routine laboratory toxicity tests are higher than those seen in real aquatic habitats.

CONCLUSION

Results are concluded as; laboratory testing may underestimate SP toxicity in the natural environment. Suspended sediments can limit the bioavailability of SPs in the aqueous phase to aquatic species. Werner and Moran demonstrated that the presence of suspended sediment (200 mg/L) lowered the aquatic toxicity of SPs to *Ceriodaphnia dubia* by a ratio of 2.5-13.

Multiple brief exposures to a single pyrethroid concentration during a given time period may not have the same harmful effect as one continuous exposure over the same time period. High magnitude, short duration exposures may be sufficient to generate population level effects, but low magnitude, long duration exposures may have no effect at all.