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Review Article

Effect of Imidacloprid in Aquaculture: A Review

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ABSTRACT

The use of imidacloprid as pesticides for pest control in agriculture has continued to raise concerns to stakeholders in aquaculture because of the negative impacts on non-target organisms, especially aquatic life forms and their environment. This review stated the application of imidacloprid, methods of application, the effects of application, and the strategies for evaluation in the aquatic environment and the aquatic organisms. The study showed that aquatic organisms were more susceptible to the chemical. Therefore, the application of imidacloprid were noticed to be harmful to aquatic organisms.

Keywords: Pesticides; Imidacloprid; Aquaculture; Biological effects

INTRODUCTION

Pesticides are any substance used for controlling, preventing, destroying, repelling, or mitigating a pest. In most instances, the pest is an unwanted weed, insect, fungus, nematode, or rodent. Pesticide usage has become a necessary evil in developing countries and has increased several-fold where agriculture is anticipated to be the backbone of the economy.

Consequently, extensive application of pesticides poses potential risks to the biodiversity of freshwater aquatic environments because of their bioaccumulation and intrinsic toxicity [1]. Agricultural runoff, leaching to surface and groundwater and spray drift are assumed as the major entry routes which contribute to the addition of pesticides in water bodies [2].

Imidacloprid

Imidacloprid is a systemic insecticide belonging to a class of chemicals called the neonicotinoids which act on the central nervous system of insects. The chemical works by interfering with the transmission of stimuli in the insect nervous system. Specifically, it causes a blockage of the nicotinergic neuronal pathway. Imidacloprid is widely used for pest control in agriculture. Other uses include application to foundations to prevent termite damage, pest control for gardens and turf, treatment of domestic pets to control fleas [3].

Application of imidacloprid

Imidacloprid is used to control sucking insects, some chewing insects including termites, soil insects, and fleas on pets. In addition to its topical use on pets, imidacloprid may be applied to structures, crops, soil, and as a seed treatment [4]. Uses for individual products containing imidacloprid vary widely. Always read and follow the label when applying pesticide products.

Signal words for products containing imidacloprid may range from caution to danger. The signal word reflects the combined toxicity of the active ingredient and other ingredients in the product. See the pesticide label on the product and refer to the NPIC fact sheets on signal words and inert or "other" ingredients.

LITERATURE REVIEW

Application methods

Neonicotinoids enter the environment through various application methods. However, the two primary methods are seed treatment and spraying [5]. Each method allows the chemical constituent contained in the compound to directly reach the soil. However, depending on the characteristics of the crop and application method, only 1.6% to 28% will be

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absorbed by the crop, while the rest will remain in the soil and/or be transported to aquatic environments [6]. Anaerobic conditions, pH, Ultraviolet (UV) light, temperature, and biological activities are environmental conditions that greatly influence the fate and transport of neonicotinoids [7]. The major transport routes of neonicotinoids to aquatic environments is surface runoff with a small portion of soluble or insoluble fractions transported through snowmelt [8].

Effects of imidacloprid

Human health: The effects of imidacloprid on human health depend on the dose, duration, and frequency of exposure. The effects may also depend on the health of a person and environmental factors. People who might orally ingest acute amounts would experience emesis, diaphoresis, drowsiness and disorientation. This would need to be intentional since a large amount would need to be ingested to experience a toxic reaction [9].

On aquatic species: Aquatic invertebrates are particularly susceptible to pesticides. They cannot avoid exposure by moving to uncontaminated places, especially with water soluble compounds [10]. In a population study that estimated chronic toxicity to the water flea, ceriodaphnia dubia, 0,3 ppb of Imidacloprid resulted in a population reduction of 19% compared to a control. This concentration is below the environmental concentration of 17,4 ppb expected by the United States Environmental Protection Agency (EPA) [10].

Feeding by gammarus pulex and body lipid content decreased after exposure to a constant imidacloprid concentration of 15 ppb. Moreover, the individuals stopped moving and feeding after 14 days of constant exposure and the level of mortality increased dramatically.

Effect on aquatic insects

Mayfly larvae of epeorus longimanus and chironomus diilutae showed a high acute sensitivity to imidacloprid and to its product Admire® Anderson, et al. while crane fly larvae (*Tipula* sp.) and stonefly nymphs (pteronarcis dorsata) turned out to be very resistant [11].

Effect on crustaceans

Sensitivity varies very much between the different crustacean species [12]. For the majority of crustaceans the acute toxicity is high; ceriodaphnia dubia showed a high vulnerability for the compound imidacloprid and hyalella azteca for Admire® [13]. Other species have higher tolerance for imidacloprid for instance young crayfish procambarius clarkia.

DISCUSSION

Effect on fish

Only a small number of species have been tested for imidacloprid. Fish embryos as well react to the compounds only at higher concentrations. In Japanese medaka Oryzias latipes fry, however, deformities were found at doses of over 1,1 µg / L of imidacloprid. This could mean that fry are more vulnerable than embryos.

Even at low levels, imidacloprid can change feeding and respiration rates of aquatic in sectlarvae of many species. This could have consequences for growth, reproduction and survival for the single individuals, for the population, and finally for the ecosystem, as insect larvae are competitors or prey for other species.

Low imidacloprid levels reduced activity and led to uncontrolled muscular contractions, which can hinder feeding and growth of aquatic insects and insect larvae, such as the diptera species chironomus riparius and simulium vittatum: Growth, development rates and emergence ratio of chironomus riparius were significantly reduced by exposure to low concentrations of imidacloprid.

Strategies for evaluating pollutants in aquatic environment

Bioassay technique: Bioassay technique has been the cornerstone of programmes on environmental health and chemical safety. The application of environmental toxicology studies on non-mammalian vertebrates particularly fish is rapidly expanding, for the evaluation of the effects of environmental contamination by noxious compounds.

Genotoxic evaluation: Genotoxic evaluation of pollutants in fish is of great concern because of their potential adverse effects on human health after consumption. There is also a great susceptibility of the liver of fish to be damaged as a result of its primary role of metabolism of these foreign substances. Liver damage alters the lactate dehydrogenase and glutamic oxaloacetic transaminase activities which are two of the most important liver function test enzymes. Thus toxicity tests or studies are essential for determining sensitivity of animals to toxicants and also useful for evaluating the degree of damage to target organs and the consequent physiological, biochemical and behavioral disorders. Thus, to supplement risk assessment studies of these pesticides, it is important to obtain. Information on their toxicity and effects on some local species.

Ecotoxicological monitoring assessment: For sustainable fish production in Nigeria, the ecotoxicological monitoring programmes need to incorporate proper management programmes for pesticides use and disposal in aquatic habitat. And fish serves as an excellent ecotoxicological model for assessment of risk and testing toxicity and indicator of contamination of aquatic bodies.

CONCLUSION

The application of imidacloprid were noticed to be harmful to aquatic organisms as reported. The chemical reportedly caused damages to the internal organs of the fish and other aquatic organisms, and impaired growth. The study showed that aquatic organisms were more susceptible to the chemical.

RECOMMENDATIONS

The use of imidacloprid should be monitored and controlled. And the manufacturing industries should look into ways of reducing its potency in order to safeguard the non-target organisms such as fish, while maintaining its effectiveness as pesticide. Similarly, proper advocacy on the dangers of pesticides should be continually conducted to farmers and other stakeholders.

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