A Review on Adverse Effects of IGR Insecticides on Ecosystem

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Abstract

Insect growth regulators (IGRs) are primarily intended to manage the populations of insect pests and disease vectors. However, it is well recognised that such substances can disrupt hormones in a range of animal species through a variety of biochemical pathways. Pesticides and other pollutants cause problems by interfering with hormones and chemical messengers. Because hormones are released by endocrine glands, these substances are known as hormone disruptors or endocrine disrupting chemicals. The purpose of this article is to conduct a review of insect growth regulators (IGRs) application in the control of crop pest insects, based on processes and the negative impact on sustainable ecosystems.

Keywords: IGRs, Non-target Organisms, Ecosystem

Introduction

In modern times, population has expanded dramatically, necessitating a higher rate of agricultural productivity. In this case, indiscriminate pesticide usage has an impact on the abiotic and biotic environment, as well as the ecosystem's biological impact. Insect growth regulators are used as pesticides in the agriculture industry. Insect growth regulators (IGRs) are chemicals that prevent insects from growing, developing, or metamorphosing[1]. Synthetic analogues of insect hormones like ecdysoids and juvenoids, as well as non-hormonal chemicals like precocenes (Anti JH) and chitin synthesis inhibitors are examples of IGRs. They are designed to be both commercially successful and environmentally friendly. As a result, IGR pesticides are deemed specialised to target insects with minimum effect on non-target organisms, and were created specifically to reduce undesired effects on man, wildlife, and the environment, as well as to be compatible with modern pest management methods[2].

A wide range of organisms that are interrelated and interdependent by synergistic and symbiotic relations inhabits the soil. Populations of soil organisms show large variations, which is related to the soil type [3,4]. There are few reports available to demonstrate the harmful effects of IGRson non-target organisms, soil ecosystem health, and aquatic ecosystem (attached to agricultural field). Therefore, the aim of this article is to carry out a review of IGRs use in the control of insects considered crop pests, based on the analysis of mechanisms and the adverse effect on the sustainable ecosystems. The study gathered a total of 27 references and, among them some are specifically about the potential of IGRs in insects considered crop pests. The information includes studies ranging from classic works dating from 1968 to studies of 2020.

Effects on non-target invertebrates

The effect of pesticides on non-target organisms has been a matter of debate for researchers worldwide. There are many reports on the killing of various non-target species [5,6,7,8]. Pesticides show the extreme effect on the aquatic ecosystem, animal and plant biodiversity and terrestrial food webs. It is estimated that less than 0.1% of pesticides applied to crop reach to the target pest [9] and more than 99% of applied pesticide have the potential to impact non-target organisms and it percolates deep into the soil ecosystems including the water-table [10].

We have been aware of the negative effects of IGR through various scientific experiments and research works. The first use of IGRs against stored-product pests was reported by Thomas and Bhatnagar-Thomas [11], but they have only been tested on a small number of insect species [12]. In an experiment conducted by L. Deng et al. [13]on female wolf spiders *P. piratoides* in Beijing, we came to know about the negative effect of Buprofezin (IGR) which is very much used as pesticide in paddy fields of China. Generally, Buprofezin is used to kill Homopteran insects. *P. piratoide*s,are plentiful in rice fields. It was reported that, eggs of female spiders that have been treated with Buprofezin LD10 and LD50 are less frequently to hatch than the controlled group. The abdomen length was altered in Spiderlings from LD10 (Buprofezin) treated female spider of *P. piratoides* than the controlled group. There was a decrease in egg production rate in LD10 and LD50 treated female spiders. And mortality rate is higher prior to molting, throughout molting and after molting in treated spiders. Buprofezinalso have a negative effect on predation rate of *P. piratoides*. Predation rate have an inversely proportional relation with the dose of Buprofezin. M.E.I.Badawy et al. [14] found that IGR lufenuron was more hazardous to mature earthworms than buprofezin and triflumuron in another trial. A decrease in AChE and GST activities paralleled the dose-dependent effect on growth reduction. Studies demonstrated by Wang et.al. [15] showed that the selected IGR insecticides namely Buprofezin , Chlorfluazuron, Hexaflumuron and Tebufenozide have relatively low intrinsic toxicity to E. fetida, compared with the other insecticides tested.

The effect of another IGR, chlorfluazuron (IGR) on land snail, *Eobaniavermiculata*, was studied by S.A.Mobarak[16], revealed that chlorfluazuron was more toxic when used as a contact than as bait and caused deformityin the organs of reproductive system of snails compared with untreated animals. It produced extreme swelling of the penis, vagina, sperm oviduct, and albumen gland, as well as the absence of eggs in the ovotestis. Broad-spectrum insecticides such as IGRs, as well as a number of other agronomic and ecological factors, had a considerable impact on ant and beetle diversity [17].
In comparison to traditional pesticides, IGRs do not produce immediate knockdown or mortality in insects, but long-term exposure to these compounds effectively halts population expansion due to the effects indicated in both the parents and progeny [12].

According to M. Sarwar, [18]IGRs only control the immature stages of insects, but if the adult stage must also be controlled, it will be necessary to apply another insecticide such as an adulticide.

Nevertheless, choose a formulation that necessitates a unique application method. If the IGR is sprayed as a spray, for example, it would be better if the adulticide was applied as an aerosol or smoke, killing the adults quickly and leaving little residue to select for resistance in surviving immature. Insect pest suppression in organic agriculture with approved oils and IGR is used on a regular basis in organic agriculture to limit destructive pest populations [19].

Effects on water ecosystem:

The majority of aquatic habitats around agricultural land are regularly flooded with herbicides, insecticides, and weedicides used in agricultural field. IGRs were found to be hazardous to aquatic organisms in studies conducted on aquatic ecosystems. Research has been done by Y. Liu et al., [20] on *Daphnia magna* as model organism for understanding the adverse effect of Buprofezin on water ecosystem. Buprofezin's toxicity on *Daphnia magna* was assessed using OECD guidelines after both chronic and acute exposures. Chronic toxicity was assessed, according to them, by assessing factors such as development and reproduction, which were all severely affected, and body length was more sensitive than other detected parameters. Buprofezin has a negative effect on the progeny of parental daphnids, and this effect cannot be reversed in a short amount of time.

R.L.Norland and M.S.Mulla[21] experimented with a variety of arthropod prey and predator species in experimental ponds treated with lGR and Altosid. They discovered that Altosid caused death in the mayfly *Callibaetispacificus*Seeman's early and late instars. Mayflies were eradicated from ponds under repeated treatment over the colder winter months, while numbers in check ponds remained low and contributed little to total biomass. The influence of IGR on the mayfly population was lessened as water temperatures rose. Treatment had no effect on the ostracod, *Cyprinotus sp.*, which was a substantial prey component. The larval dytiscid beetle *Laccophilussp*., a key predator, was eradicated from the treated waters. During one phase, this loss accounted for 84 % of the predator biomass. Throughout the investigation, Odonata naiads were the second most common predator. The IGR had little effect on these naiads, which preyed intensively on mosquitoes and ostracods. A.Ali and M.S.Mulla [22] found that IGR, Diflubenzuron, severely damaged populations of planktonic, nektonic, and benthic invertebrates. A common pyrethroid like bifenthrin, according to H.A.Rogers et al.,[23] can change aquatic and terrestrial ecosystem function at the regional scale.

Discussion

Despite the fact that IGR insecticides are claimed to have great specificity for insect pests and minimal toxicity to non-target organisms, a few authors have shown biological adverse effects of IGRs on non-target taxa, implying ecological ramifications. There are reports that showed ill effects of several IGRs ongrowth and reproduction in worker bumblebees *Bombusterrestris* [24], in housefly *Muscadomestica*[25], and also in soil Ecosystem, through the effect on Collembola*Folsomia candida* [26], a soil micro-arthropods and in earthworm, *Eiseniafetida* [15]. But comparable information is lacking on ecologically important soil animals like Collembola, earthworms etc. In our laboratory,

toxicity screening showed negligible lethal effect of IGRs on *Cyphoderusjavanus*, but tissue nutrient levels and digestiveenzyme activities were adversely affected [27].

However, the length was the most affected feature among the features studied for analysing the detrimental consequences of IGRs. More research is needed, however, to determine the specific effect of different types of IGRs on non-target species at the molecular level, which will aid in studying their reproduction, growth, development, and survival. Though we have only looked at the effects of IGRs and pesticides on a few non-target organisms such as snails, earthworms, soil microorganisms, and water microorganisms, more research should be done in this area to find ways to reduce the toxic effects of IGRs and pesticides on the environment and ecosystem because recovery is difficult.

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