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Effect of endocrine disruptor pesticides on non target pollinator-honey bee.

Efecto de los pesticidas disruptores endocrinos en abejas polinizadoras no diana.

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ABSTRACT

Endocrine disrupting chemicals (EDCs) are substances that disturb the endocrine system's normal function, potentially causing sickness or deformities in organisms and their progeny. Pesticides are commonly employed to destroy undesired organisms in crops, public places, houses, and gardens, as well as to treat parasites medicinally.Many have been identified as Endocrine disruptors (EDs) or are suspected of being EDs. Pesticides applied to agricultural or horticultural land crops were the predominant, if not exclusive, source of pesticide exposure for honey bees and the source of hive product contamination until the early 1980s. Pollinators, such as honey bees, are responsible for the successful reproduction of over 87 percent of flowering plant species, making them critical to ecosystem health and agricultural productivity.

Key words: pesticides, honey bee, endocrine disrupting chemicals, hormones.

RESUMEN

Los disruptores endocrinos (EDC, por sus siglas) son sustancias que alteran la función normal del sistema endocrino y pueden causar enfermedades o deformidades en los organismos y su descendencia. Los pesticidas se emplean comúnmente para destruir organismos no deseados en cultivos, lugares públicos, casas y jardines, así como para tratar parásitos con medicamentos. Muchos han sido identificados como disruptores endocrinos (DE) o se sospecha que son ED. Los pesticidas aplicados a los paisajes agrícolas u hortícolas fueron la fuente predominante, si no exclusiva, de exposición a pesticidas para las abejas melíferas y la fuente de contaminación de los productos de la colmena hasta principios de la década de 1980. Los polinizadores, como las abejas melíferas, son responsables de la reproducción exitosa de más del 87 por ciento de las especies de plantas con flores, lo que las hace fundamentales para la salud del ecosistema y la productividad agrícola.

Palabras clave: plaguicidas, miel de abeja, disruptores endocrinos, hormonas.

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INTRODUCTION

Since green revolution the industrialized countries has concentrated on accelerating the agricultural productivity by various means (Briggs, 2009). Use of pesticides was one of the main and effective method acceptable for the farmers and increased intensive farming. Pesticides are a broad spectrum of chemicals applied on agricultural fields and house premises that target the organisms which are of great menace to humans. Pesticides' principal impacts are extremely beneficial to human health. They do, in fact, aid in the control of agricultural pests and plant disease vectors, as well as human and cattle disease vectors and nuisance organisms, as well as creatures that harm other human activities and structures. They also ensure higher food production, a safe and secure food supply, and a variety of other secondary benefits (Cooper & Dobson, 2007).

Even though the initial benefits were good the disadvantages was found to be more deleterious as these chemicals persist in soil, air and aquatic ecosystems. Pesticide drift occurs when pesticides travel away from their application site unintentionally. When fumigants (gases), dusts, or liquid pesticides are administered as a fine mist, drift is more likely to occur (Briggs, 2009). Drift is also more likely to occur on windy days and when temperatures are very high. These chemicals thus reaches non-target groups of organisms (invertebrates and vertebrates) and accumulate in tissues which was left unnoticed initially. The insect pollinators which play a major role in crop propagation are also seriously affected by pesticides. Pesticides have an impact on organisms' endocrine systems, which regulate and coordinate all bodily functions (Cooper & Dobson, 2007).

Pesticides are agricultural endocrine disruptors. EDCs (endocrine disrupting chemicals) are chemicals that interfere with the normal functioning of the endocrine system in both wildlife and humans. Colborn coined theterm "endocrine disruptor" in 1991, and the International Programme on Chemical Safety (IPCS) of the United Nations Environment Programme (UNEP) and the World Health Organization (WHO) followed suit in 2002 and 2012 (WHO, 2022; De Coster & van Larebeke, 2012) According to their origin, the endocrine disruptors are classified into the following types Table -1. Industrial endocrine disruptors are used broadly on industrial basis, agricultural are mainly used in agricultural fields for controlling pests and weeds, residential is used in human residing areas for the purpose of sanitization and controlling pests and pharmaceutical- paraben is used in the cosmetics, pharmaceutical products and even food products to increase its shelf life.

Table-1 Classification of Endocrine disruptors

Industrial	Agricultural	Residential	Pharmaceutical
Dioxins	Pesticides	Phatlates	Parabens
PCBs	Insecticides	Polybrominated	
Alkylphenols	Herbicides	Biphenyls	
	Phytoestrogens	Bisphenol A	
	Fungidices		

The hormones produced and released by the glands in the endocrine system regulate nearly all of the body's operations. Hormones assist body's activities, including metabolism, growth and development, emotions,

mood, sexual function, and even sleep, to work together. Polypeptide and protein hormones cannot enter cells due to their chemical makeup. Rather, they interact with cell surface receptors. The connection causes biochemical changes in the cell's membrane or inside, affecting the cell's activity and function (Fig 1).

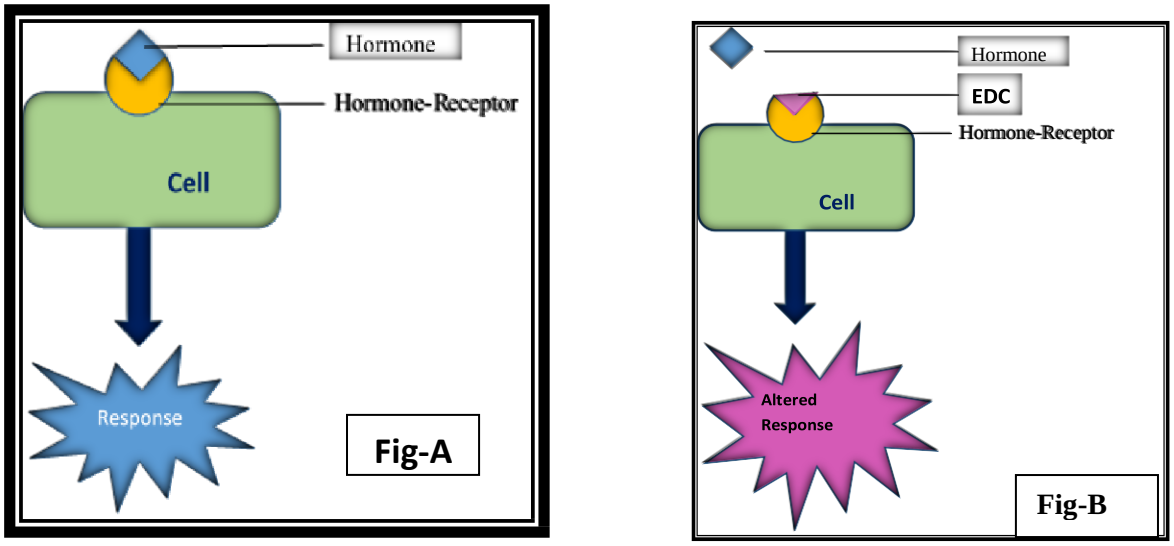

Fig. 1. Comparison of Mechanism of action of hormone and endocrine disrupting chemicals(EDC)

ENDOCRINE DISRUPTOR PESTICIDES

Endocrine disruptors function by: (i) Mimicking the action of a naturally-produced hormone, such as estrogen ortestosterone, and thereby setting off similar chemical reactions in the body; (ii) Blocking the receptors in cells receiving the hormones (hormone receptors) thereby preventing the action of normal hormones; or (iii) Affectingthe synthesis, transport, metabolism and excretion of hormones, thus altering the concentrations of natural hormones Fig. 2. (Kabir et al., 2015; Colborn et al., 1993; Monneret, 2007).

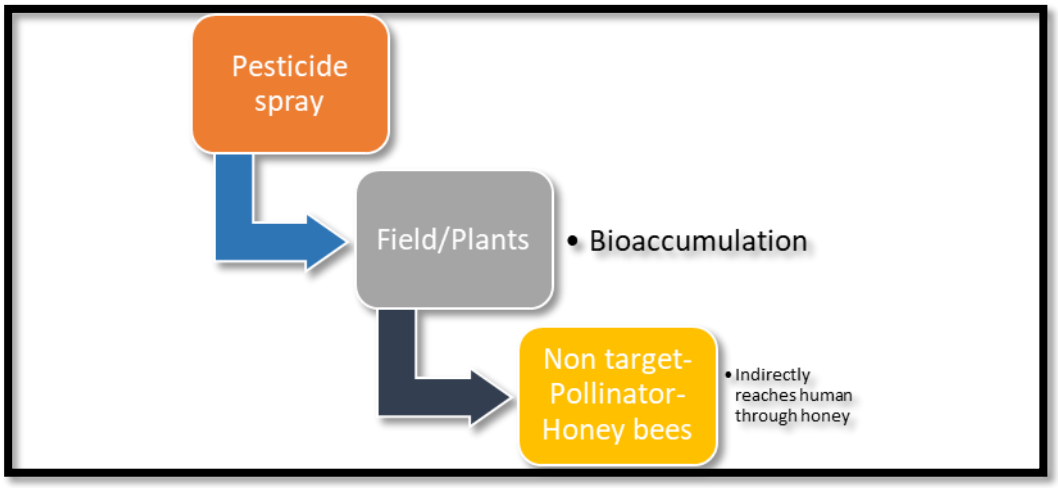

Fig. 2. Mechanism of pollutants on non target pollinator honey bees.

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POLLINATORS AND EDCS

Systemic use of agriculture pesticides is designed to target herbivorous pest insects. Honey bees, like all insects, are vulnerable to accidental exposure. Pollinators are required for the survival of over 90% of all flowering plants.Honeybees are responsible for approximately a third of agricultural pollination. Pollinators are “a bell weather forenvironmental stress as individuals and as colonies.” Honeybees are the most well-known pollinators in the world,as well as the most commonly managed pollinators, although they are by no means the sole pollinators of all flowering plants. Spraying and seed coating are the two main methods for applying pesticides to crops, both of which have an impact on honey bee exposure. Spraying is usually done from the air, however some people utilize vehicles. EDCs are powerful pesticides, but they can harm honey bees inadvertently either direct topical contact or secondary exposure from contaminated pollen, nectar, or water consumed by bees (Fairbrother et al., 2014; Park et al., 2015; Poquet et al., 2014; Zhu et al., 2015). Eventhough pollinators like bumble bees are also affected by EDCs specific mention is applicable to honey bees as they are pollinating majority of plants both wild and cultivated crops.

PESTICIDE AFFECT POLLINATORS MAINLY BY FOUR MEANS

Lethal effects. Many insecticides are lethal to bees. Bees are highly poisoned by carbamates, organophosphates,synthetic pyrethroids, chlorinated cylcodienes, and neonicotinoids.

Sublethal effects. Pesticide levels that do not kill bees in considerable numbers may nonetheless have an influence on performance, inhibiting processes like olfactory learning, foraging, and reproduction, all of which are important for hive survival.

Synergistic effects. When pesticides are used together, they often have a greater toxicity than when used separately.

Food availability. Herbicides applied in fields, rights-of-way, and woods have a tendency to diminish the quantity of flowering plants. This decreases the amount of food available for native pollinators, making it more difficult for them to survive. Reduced pollination means fewer fruits for birds and other species to eat, which hasramifications across the food chain.

Pesticides used on agricultural crops or commercial blooming plants have major consequences for honey bees, which can be divided into direct and indirect effects. The immediate impacts are severe, causing pollinator death, colony disruption, and navigational difficulties through disrupting endocrine communication routes. Impaired immunological function, reproduction, and queen bee survival are all indirect impacts. Honeybee foraging is reduced as a result of the chemicals' habitat effects. Furthermore, spray-based treatment causes pesticides to spread into the environment and contaminate nearby habitats, such as orchards and fields that aren't being treated (McArt et al., 2017; Simon-Delso et al., 2017). Seed coatings can avoid some off-site objectives as an alternative to spraysby more carefully limiting pesticide delivery to the desired crop. Seed coats, on the other

hand, might cause collateral damage since some pesticides, such as nectar and pollen, stay active in plant tissue Alburaki et al., 2015; Samson-Robert et al., 2017). High-dose pesticide exposure is a known cause of honey bee population decrease; nevertheless, sublethal pesticide exposure poses an unobtrusive hazard to honey bees. It has a deleterious impact on reproduction, immunity, physiology, and cognition, among other things. Sublethal pesticide exposure affects sexual reproduction, egg laying, and larval development from the beginning of the reproductive cycle (Chmiel et al., 2020). In a study conducted Ostiguy et al., (2019), insecticides were found in higher amounts and more frequently than fungicides or herbicides. Bioaccumulation is a serious problem caused by the pesticides in honeybees as many bees forage in a common field and returns to the bee hive. The residues of chemical residues on their body will contaminate the honey and this will indirectly reach the body of humans also. Fig C

The residual toxicity of chemicals as well as length of time they remain on surface, differs from one chemical to the next. As a result, the residual toxicity of pesticides, herbicides and fungicides must be considered when they are administered to plants and fields. To some extent, changing how pesticides are applied will lessen the chance of nontarget pollinators being exposed to these poisons. To reduce the use of EDCs on plants, transdisciplinary partnerships inside and outside the scientific community, involving the knowledge of farmers, agrochemical companies, and policymakers in an expanded peer community, are required (Sponsler et al., 2019).

As conclusion, most pest-control systems can be modified to eliminate or reduce bee poisoning with minimal cost or inconvenience to the grower. Working relationships and familiarising oneself with each other's management approaches assist both beekeepers and producers. Despite the fact that numerous chemicals have been identified as potential EDCs, and some developed countries andinternational organisations have been working to address them since the mid-1990s, there is still a need to raise awareness about the effects of EDC exposure in developing countries and countries in transition.The problem of EDC exposure and its detrimental effects on humans and wildlife, as well as the potentialfor disease, is a worldwide issue that requires global solutions. Endocrine disruptors can interact with hormone-like pathways throughout life. When substances with endocrine-disrupting activity are present throughout development, they will alter the programming of cell and tissue development, and their consequences will be long-lasting.

Conflict of interest: The authors declare no conflict of interest.

Data Availability: All data generated or analysed during this study are included in this article.

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