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A REVIEW STUDY ON PESTICIDE-INDUCED EFFECTS IN FRESHWATER FISH.

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Abstract

Pesticides can be defined as chemical substances which are used to kill, control or repel pests. Chlorinated hydrocarbons are fat-soluble and are trooped into the body. Man is at the top of the food chain/food Web and consumes plants as well as animals and carries small amounts of pesticides and ultimately increases to the danger level. This is called bio-magnification which causes the severe physiological disorder. Toxic effects can be sensed immediately after exposure to a toxicant or when followed by a lag. These effects are determined by the toxicological characteristics of the substance and the ability of the organisms to metabolize it. Histopathology is the study of the structure of diseased or injured cells or a study of pathological change in the microanatomy of tissues is known as histopathology. Fish constitutes a valuable commodity from the standpoint of human consumption. Aquatic pollution undoubtedly has direct effects on fish health, reproduction, and survival. Pesticides are regarded as serious pollutants of the aquatic environment because of their environmental persistence and tendency to be concentrated in aquatic organisms. A change in biochemical constituents in fish gives an indication, helping to understand the type of pollutants and their mode of action. Despite the facts, like other living organisms, fish also has its detoxification mechanism to

encounter the toxic effects; however, if the toxic substance enters the body, certainly damages and weaken the mechanism concerned. The damage may be at a cellular or molecular level, but ultimately it will lead to physiological, pathological, and biochemical changes. The present study generates the data on the pesticides residues levels in grape growing soils of Nashik district, which will be highly useful to create awareness among the farmers about non-judicious and excess application of pesticides.

KEYWORDS: Pesticides, fish, public health, histopathological and biochemical.

INTRODUCTION

Pesticide use has become a necessary evil for developing countries like India, where it is estimated that around 30% of crop yields, worth Rs 60,000, are lost to parasite infestations every year (Internet, 2013). Among others, organophosphate pesticides (OPs) are the most commonly used pesticides worldwide due to their rapid degradation (Eto, 1974). Unfortunately, OPs lack target specificity and can have severe and long-lasting effects on populations of terrestrial and aquatic non-target species, particularly vertebrates (Rahimi, et al., 2006).

The rapid degradation is likely why developing countries, particularly in the Asia-Pacific region, use these chemicals for agricultural and public health purposes, despite reports of health hazards (Dave, 1996 and Li, et al., 1996). Water quality management faces greater challenges today than at any time in its history. In addition to natural pollutants, there are various pollutants in surface water, including several chemical compounds and various products of the industrial and agricultural revolutions. Insecticides are one such group of pollutants, both synthetic and natural, that contribute to environmental problems (Internet, 2012).

The primary route for insecticides to enter aquatic ecosystems in urban areas is through rainstorm water runoff and atmospheric deposition. Another source of water pollution from insecticides comes from municipal and industrial effluents. Most insecticides end up in rivers, lakes, and ponds and are highly toxic to non-target organisms living in natural settings near agricultural fields. Insecticide contamination of surface water is known to have adverse effects on the growth, survival, and reproduction of aquatic animals. In recent years, the increase in fish kills in various streams, lakes, and ponds around the world have drawn researchers' attention to the problems caused by insecticide and pesticide runoff associated with intensive farming practices. Varying concentrations of insecticides are present in many types of effluent and many studies have shown that they are toxic to aquatic organisms, particularly fish species (Talebi, 1998 and Üner et al., 2006).

Fish are particularly vulnerable to water pollution. Therefore, contaminants such as insecticides can significantly damage certain physiological and biochemical processes when entering the organs of fish (John, 2007 and Banaee, et al., 2011). The authors found that different types of insecticides can seriously damage the physiological and health status of fish (Begum, 2004 and Monteiro et al., 2006). Because fish are important sources of protein and fat for humans and pets, fish health is very important to humans. Different types of pesticides are used in agriculture, but their toxicity to fish varies depending on the type of pesticide, and insecticides are generally the most toxic. The main insecticides used are organophosphates, organochlorines, carbamates, pyrethroids, and carotenoids (Sabra, 2016 and Srivastava, et al., 2016). Toxicological research is particularly in demand because a significant portion of the total disease burden in industrialized countries is attributed to environmental factors, including chemicals (Pruss-Ustun, 2011) and because there is a lack of documentation on the health effects of most industrial products. Chemicals (Press, 2009)

EFFECTS OF ROTENONE

There is little information on the effects of rotenone on catfish reproduction. The effect of rotenone on altering neurological behavior and reproductive functions in freshwater catfish, Mystus canvass, was reported by Badruzzaman et al., (2021).

EFFECTS OF HERBICIDES

Herbicides are widely used to control the harmful effects of pests and weeds on agricultural production and fish farms. The herbicide eventually enters various aquatic ecosystems after use and is highly toxic to non-target organisms, including fish. Herbicides can have some impact on the development, growth, reproduction, and behavior of fish (Solomon et al., 2008). It showed a significant decrease in follicle-stimulating hormone (FSH), luteinizing hormone (LH), prolactin (PRL), and testosterone (T) levels and an increase in progesterone concentration after 28 days of exposure of young Clarias gariepinus to a concentration of 2, 5, 25, 250 and 500 μg of atrazine L-1. Histologically, treatment of the ovaries at the lowest concentration (2.5 μg L-1) showed that the atretic oocytes with ruptured membranes invaded a large part of the dead oocytes and empty spaces. In other treatments (25, 250 and 500 μg L-1), interfollicular spaces, vacuolation at oocyte formation and dissolution of oocyte walls were observed, but at the maximum concentration of atrazine (500 μg L-1), the yolk is vesicle rupture has been interrupted and the formation of cytoplasmic lumps in maturing oocytes has been reported (Soni and Verma, 2020).

EFFECT OF SOME PESTICIDES ON HAEMATOLOGICAL PARAMETERS

Hematological parameters such as erythrocyte and leukocyte counts, platelets, etc. have been considered as bioindicators of toxicity in fish after exposure to organochlorine insecticides, organophosphates, carbamates and parathyroid glands (Singh and Srivastiva, 2010). Several authors have reported on the influence of pesticides on the hematological parameters of catfish. In fish, the pronephros or cephalic kidney is a fundamental organ that forms elements of blood and is also a reservoir for blood cells (Bielek et al., 1999 and Kondera, 2019). Therefore, the decrease in hematological parameters may be related to the dysfunction of the hematopoietic system of fish. Decreased hemoglobin content in pesticide-treated fish may also be due to an increased rate of hemoglobin degradation or decreased rate of hemoglobin synthesis or organ dysfunction/suppression of hematopoietic, and decreased platelets are associated with a reduction in platelet levels. increased production or destruction of platelets (Prakash and Verma, 2014).

EFFECT OF SOME PESTICIDES ON BIOCHEMICAL PARAMETERS

The toxicity of pesticides on biochemicals such as proteins, lipids, glycogen, etc. has been studied in different fish organs (Srivastava et al., 2016 and Ahmad, 2012). When toxic substances such as pesticides enter the fish body, they damage and weaken its mechanism, resulting in physiological, pathological and biochemical disorders or metabolic disorders. Oxidative stress markers such as superoxide dismutase (SOD), glutathione (GSH), and glutathione-S-transferase (GST) of liver, kidney, gills, gonads, and muscle were also affected by carbofuran treatment. Gills of C. gariepinus under treatment with deltamethrin (Joshi et al., 2002).

IMMUNOSUPPRESSION

The fish immune system is important for defense against a variety of pathogens. The system is very sensitive to homeostatic adjustments through endocrine regulation and is influenced by the biochemical state of the nervous system. Therefore, any alteration of the nervous system and any disturbance of the biochemical homeostasis can weaken the immune system of the fish. On the other hand, insecticides can alter the functioning of the immune system and lead to immune depression, uncontrolled cell proliferation, and changes in host defense mechanisms, including innate immunity and acquired immunity against pathogens. pathogens. Various sublethal insecticides have been recognized as stressors causing immunosuppression in fish (Eder et al., 2009).

BEHAVIORAL CHANGES

Behavioral changes are the most sensitive indicators of potential toxic effects. Behavioral and swimming patterns of fish exposed to various insecticides include changes in swimming behavior, feeding activities, predation, competition, reproduction, and social interactions between species such as aggression (Cong , et al., 2008 and Banaee, et al., 2011).

REPRODUCTIVE DYSFUNCTION

Reproduction guarantees the survival of the fish population. Any change in the environmental parameters or physiological conditions of the fish can affect their reproductive success. Since fish can be exposed to environmental pollutants including insecticides, herbicides, heavy metals and other foreign substances, disruptions to their natural reproductive process can occur. Recent research has shown reproductive system dysfunction in fish exposed to insecticides. The effects of insecticides on the reproductive biology of fish are numerous and include impaired fertility, histological damage to testes and ovaries (Dutta and Meijer, 2003).

Some insecticides are known to be endocrine disruptors (EDCs) which can disrupt the normal functioning of the endocrine system in fish. Adverse effects of insecticides on the hypothalamic-pituitary-gonadal axis may also play an important role in causing reproductive disorders in fish. In fish, chronic insecticide toxicity can alter plasma levels of sex steroid hormones. Although the precise mechanism is not known, insecticides and their metabolites may disrupt the reproductive system by activating or inhibiting key enzymes involved in the biosynthesis of steroid hormones in fish. For example, DDT, endosulfan, methoxychlor and some other insecticides possess estrogenic properties and are capable of disrupting the functions of the endocrine system and causing disturbances in the reproductive system of fish. Exposure of fish eggs and milk to insecticides also reduced the degree of fertilization, hatching and survival of larvae (Arukwe, 2001).

DEVELOPMENT DISORDERS

The study of insecticide-induced developmental disorders consists in emphasizing the associations between toxin concentrations and disturbances in normal development from embryonic to puberty. Therefore, interference with normal development and growth can reduce the fish's chances of survival. Embryos and larvae can be exposed to insecticides directly, through the yolk, or by transferring the parents into viviparous fish (Viant et al., 2006). The most important factors reducing fish growth are disordered feeding behavior, reduced feeding speed, metabolic disorders and wasted energy to cope with the stress caused by insecticide exposure (Tripathi, et al., 2003). The stage can lead to behavioral problems, such as a reduced ability to capture prey after hatching, functional impairments, or slowed growth and eventual death (Kuster, 2005).

In the total geographical area of Nashik 8 district, 65,000 hectares are planted with grapes. About 60-70% of the total seedless grape production is produced in the Nasik district. Out of 15 Taluka in Nasik district, 90% of grape production comes from Nasik, Niphad and Dindori. They are the main grape producers. The percentage use of pesticides for grapes in these areas is higher. Out of 10-12 tons of grapes produced each year, the export rate is only 1% due to the overuse of pesticides that affect the quality of the grapes (Suresh, 2001). The overuse of chemicals has raised questions about the sustainability of agriculture by polluting soil and reducing food quality (Horrigan, et al., 2002). The consumption of pesticides in the vineyards is higher. A plant only retains half of this applied spray as the leaf provides a non-wetting interface for the pesticide. The residual pesticide runs off and contaminates soil and water and affects terrestrial and aquatic life (Wadhwani and Lall, 1972).

CONCLUSION

In the present review, it is obvious that different pesticides present in the aquatic environment can affect the reproductive functions, hematology, and biochemical parameters of catfishes in different ways. The acute toxicity effects and alterations in reproductive functions, blood characteristics and biochemical parameters observed for all pesticides reviewed imply that commonly used pesticides that find their way directly or indirectly into the aquatic ecosystem remain a serious health concern to the fish. Thus, based on the observations on the histological and hormonal alteration of gonadal tissue, changes in RBCs, WBCs, proteins, lipids, glucose, antioxidant defense system following exposure to different pesticides, it can be concluded that pesticides even at sublethal concentrations are highly toxic to fish and impose life-threatening effects on fish. They can decrease the fish population by inducing reproductive dysfunction and by weakening the immune defense mechanisms of the fish.

In the present study, the detection of pesticide residues in the vine-cultivated areas of several villages of Nashik district indicated that the difference in pesticide residues could be related to the fact that the fate of pesticides in the soil is influenced by the physicochemical properties of the pesticide the properties of the soil (presence of clayey materials, organic matter and pH), the climate, biology and the different timing of pesticide application. We must find alternative solutions and stricter regulations. The survey results showed that poorly trained farmers were using highly toxic pesticides. Farmers reported that they did not always use pesticides correctly. These inappropriate practices can lead to environmental contamination from pesticides. This article can help farmers to spray as little pesticide as possible because many pesticides are toxic and more stable, so avoiding these pesticides can reduce the pesticide load in the soil, and also help avoid financial losses for farmers.

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Table 1. Toxicity of the insecticides to different species of fish.

Insecticide	**Species**	**Range of 96h LC_{50}**	**Reference**
Azodrin	Rainbow trout, Bluegill, Channel catfish. Fathead minnow	4.9-50 ppm	Johnson, and Finley, (1980)
Pyrethrum	Coho salmon, Atlantic salmon, Brown trout, Lake trout, Channel catfish, bluegill	13-65 ppb	Johnson, and Finley, (1980)
Trichlorfon	Eel, Rainbow trout, Cutthroat trout, Atlantic salmon, Brown trout, Brook trout, Lake trout, Fathead minnow, Channel catfish, Bluegill, Largemouth bass	0.36-9.2 ppm	Lopes, *et.al.*, (2006)
Chlorpyrifos	Mosquito fish, Bluegill, Fathead minnow, Rainbow trout, Nile tilapia, Goldfish	0.57-3270 ppb	Davey, *et.al.*, (1976)
DDT	Coho salmon, Rainbow trout, Fathead minnow, Channel catfish, Bluegill, Largemouth bass, Black bullhead, Yellow perch	1.5-21.5 ppb	Johnson, and Finley, (1980)
Endosulfan	Striped bass, Bluegill, Rainbow trout, Fathead minnows, Asian swamp eel, Milkfish, Zebrafish	0.1-20 ppb	Mayer, *et.al.*, (1986)