

GLOBAL ENVIRONMENTAL ISSUES

***Scientific Approaches
and Solutions***



**Prof. Bindu Sharma
Dr. D.P. Singh**

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ISSUES:
SCIENTIFIC APPROACHES
AND SOLUTIONS**

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Prof. Bindu Sharma

*Head Department of Zoology
CCS University, Meerut*

Dr. D. P. Singh

*Associate Professor
Department of Zoology
J.V. College, Baraut Baghpat*



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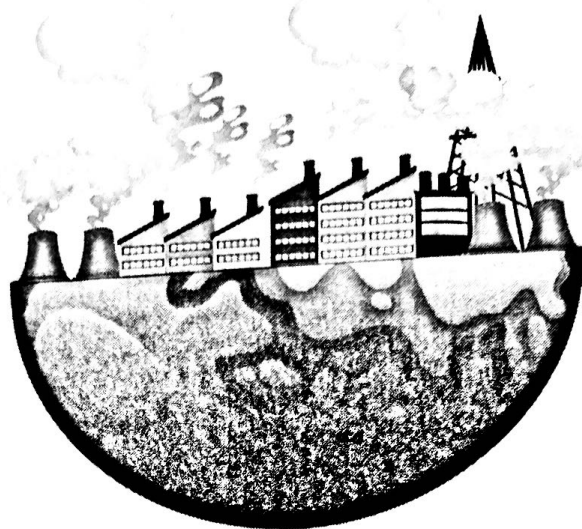
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CHAPTER

A REVIEW ON AGROCHEMICAL INDUCED TOXICITY IN FISHES

Prof. (Dr.) Manju Singh

Department of Zoology

Raghunath Girls' Post Graduate College

Meerut, U.P., India

Email: manjuipc2000@gmail.com

Orcid: 0009-0000-8630-9102

Miss. Tanvi Kashyap

M.Sc. Zoology

Raghunath Girls' Post Graduate College

Meerut, U.P. India

Email: tanvikashyap0121@gmail.com

Abstract

Agrochemicals are widely used chemicals in agriculture to increase crop production and protect plants from pests, weeds, and diseases. Although these chemicals are useful, their excessive and careless use has caused serious pollution of water bodies such as rivers, ponds, and lakes. When agrochemicals enter aquatic environments, they become harmful to fishes and other aquatic organisms. Fish exposed to agrochemicals show reduced growth, poor health, and increased death rates. Important organs like gills, liver, kidneys, and gonads are severely affected, leading to breathing problems, weak metabolism, disturbed reproduction, and reduced survival.

Agrochemicals also cause noticeable behavioural changes in fish, including abnormal swimming, loss of balance, surface breathing, and reduced feeding activity. These changes indicate stress and damage to the nervous and respiratory systems. Besides histopathological, and behavioral changes, these agrochemicals induce alternations in hematological and biochemical parameters.

Keywords

Agrochemicals, Organophosphates, Pyrethroids, Herbicides, Fungicides, Nematicides.

Introduction

Agrochemicals play a vital role in modern agricultural practices by increasing crop yield and minimizing losses caused by pests, weeds, and plant diseases. These chemicals include insecticides, herbicides, fungicides, and fertilizers, which collectively contribute to global food security. Despite their benefits, the widespread and often uncontrolled use of agrochemicals has resulted in severe environmental pollution, particularly affecting aquatic ecosystems. Studies indicate that only a small fraction of applied pesticides reach target pests, while the

remaining portion enters surrounding soil and water bodies through runoff, leaching, and atmospheric drift.

Aquatic organisms, especially fishes, are highly sensitive to pesticide contamination due to their constant exposure to polluted water. Agrochemicals such as chlorpyrifos, malathion, cypermethrin, glyphosate, and atrazine have been reported to cause acute and chronic toxicity in fishes, leading to behavioural disturbances, physiological imbalance, tissue damage, and population decline. Behavioural responses such as erratic swimming, surface gulping, loss of equilibrium, and reduced feeding are among the earliest signs of pesticide stress and reflect underlying neurotoxic and respiratory damage.

Histopathological alterations provide reliable evidence of pesticide-induced toxicity at the tissue level. Organs such as gills, liver, kidneys, and gonads exhibit structural changes including epithelial lifting, necrosis, vacuolization, and degeneration of germ cells, which impair essential physiological functions. Among freshwater fishes, *Oreochromis niloticus* (Nile tilapia) is widely used as a model organism due to its ecological and economic importance. Recent studies reveal that exposure to glyphosate and malathion significantly affects the vitality, behaviour, and survival of this species, indicating serious ecological risks associated with pesticide pollution. Therefore, the present work aims to synthesize available information on agrochemical induced toxicity in fishes, focusing on behavioural, histopathological, and vitality changes.

Agrochemicals : An Overview

Agrochemicals are an integral component of modern agriculture systems and have played a significant role in enhancing crop productivity and ensuring global food security. The term agrochemicals broadly refers to chemical substances used in agriculture

to manage pests, weed, and plant diseases, as well as to improve soil fertility and crop growth.

Although agrochemicals are useful in agriculture, their excessive and careless use has created serious environmental problems. Many studies show that a large proportion of these chemicals does not remain confined to agricultural fields. Instead, they are transported to surrounding environments such as soil, rivers, ponds, and lakes through surface runoff, leaching into groundwater, and spray drift, leading to contamination of aquatic ecosystems. Agrochemicals entering the aquatic environment cause serious damage to fishes, including death, reduced reproduction, and decline in fish populations. Continuous exposure may also affect human health through polluted water and food consumption. However, different types of agrochemicals induce toxicity in different species of fishes.

Table 1: Different types of Agrochemicals inducing toxicity in fishes.

Types of Agrochemicals	Sub-group	Examples	Major Toxic Effects on Fishes	References
Insecticide	Organophosphates	Chlorpyrifos, Malathion, Parathion, Diazinon	Inhibit acetylcholinesterase enzyme causing neurotoxicity, erratic swimming, loss of balance, respiratory distress, muscle spasms, and mortality	<i>Tilak et al., 2020; Kumar et al., 2022; Singh & Mishra, 2023</i>
	Pyrethroids	Cypermethrin, Lambda cyhalothrin, Deltamethrin	Highly toxic, disrupt sodium ion channels; cause convulsions, mucus secretion, rapid opercular movement, high mortality and paralysis	<i>Saha et al., 2021; Adeyemi et al., 2024</i>

Herbicides	—	Gluphosate, Atrazine, pendimethalin, 2,4-D	Gill irritation, reduced oxygen uptake, oxidative stress, liver and kidney damage, impaired growth, hormonal imbalance, impaired growth and reproduction	Kumar & Kaur, 2021; Mesnage et. al., 2022; Patel et. al., 2004
Fungicides	—	Thiram, Carbendazim, Mancozeb	Induce reactive oxygen species (ROS); oxidative stress, gill necrosis, liver regeneration, altered blood parameters, reproductive impairment	Sharma et. al., 2021; Das & Mukherjee, 2023
Acaricides / Nematicides	—	Dicofol, Fenamiphos	Neurotoxicity, oxidative stress, metabolic disturbances, abnormal behaviour, tissue damage	Rao et. al., 2022; Banerjee et. al., et. al., 2024
Formulated / Mixed Agrochemicals	—	EC Formulations combination products	Often more toxic than pure compounds; synergistic effects, severe tissue damage, increased mortality, ecological imbalance	Tilak & Veeraiiah, 2020; Sharma et. al., 2025

Histopathological Alterations Due to Pesticides Induced Toxicity in Fishes

Histopathological refers to microscopic changes in tissue caused by toxic substances. In fishes, exposure to pesticides, even sub-lethal concentration, leads to severe structural damage in vital organs such as gills, liver, kidneys, and gonads. These changes serve as sensitive biomarkers of pesticides-induced stress and aquatic pollution.

Pesticides exposure induces pronounced histopathological alterations in fishes, reflecting tissue-level damage resulting from toxic stress. The gills are the primary target organ due to their direct contact with contaminated water. Common alterations include epithelial lifting, lamellar fusion, hyperplasia, and necrosis, which severely affect respiratory efficiency and ion regulation.

Histological damage in gonads results in reduced gamete production, altered sex hormones, and reproductive failure. Overall, histopathological alterations provide strong evidence of pesticides-induced toxicity and are widely used as reliable biomarkers for assessing aquatic pollution.

Table 2: Tissue-Level Damage caused by Pesticides in Different Fish Species

Fish Species	Target Organ	Pesticides	Major Histopathological Alterations	Reported Effects on Fishes	Reference
<i>Labeo rohita</i>	Gills	Chlorpyrifos	Lamellar fusion, epithelial lifting, necrosis, hemorrhage	Reduced oxygen uptake and breathing difficulties	Tilak et.al., 2005
<i>Oreochromis mossambicus</i>	Liver	Cypermethrin	Vacuolation of hepatocytes, fatty degeneration, nuclear pyknosis	Disturbed metabolism	Velmurugan B. et.al., 2007
<i>Clarias batrachus</i>	Kidney	Malathion	Tubular degeneration, glomerular shrinkage, necrosis	Impaired excretion and osmoregulation	Banaee et.al., 2013
<i>Channa punctatus</i>	Gills	Endosulfan	Hyperplasia, excess mucus cells, lamellar curling	Respiratory stress and hypoxia	Pandey et.al., 2009

Hematological Alterations Induced by Agrochemicals

Agrochemical exposure causes marked disturbances in the hematological profile of fishes by directly affecting blood cells and blood-forming tissues. Several studies report that pesticides induce reduction in erythrocyte count, hemoglobin concentration, and packed cell volume, indicating pesticide-induced anemia due to hemolysis or inhibition of erythropoiesis. At the same time, altered leukocyte levels are commonly observed, reflecting stress-related immune responses or immunosuppression under chronic exposure. Organophosphate and herbicide toxicity has also been linked with abnormal erythrocyte morphology and disrupted erythrocyte indices (MCV, MCH, MCHC), suggesting impaired oxygen transport and metabolic imbalance in fish. These hematological alterations are considered early and sensitive indicators of agrochemical pollution and are widely used in ecotoxicological assessments of freshwater ecosystems.

Overall, changes in fish blood clearly show that agrochemicals are toxic to aquatic life, and blood parameters are useful indicators to detect pesticide pollution.

Biochemical Changes in Fishes Induced by Agrochemicals

Agrochemicals, particularly pesticides, exert profound biochemical effects on fishes after entering aquatic ecosystems through agricultural runoff. Sub-lethal exposure to these chemicals disrupts energy metabolism, as evidenced by elevated blood glucose levels resulting from enhanced glycogen breakdown to meet increased energy demands under stress. Simultaneously, a significant reduction in total protein content is commonly observed, which may be attributed to increased protein catabolism or impaired protein synthesis caused by toxic stress. Agrochemicals also induce marked changes in hepatic enzyme activities, including aspartate aminotransferase (AST) and

alanine aminotransferase (ALT), indicating cellular damage and loss of membrane integrity in liver tissues. Furthermore, pesticides promote oxidative stress, characterized by increased lipid peroxidation and depletion of antioxidant defense enzymes, leading to structural and functional damage of cells. These biochemical alterations reflect severe metabolic imbalance and organ dysfunction in fishes and are therefore considered reliable biomarkers for evaluating agrochemical toxicity in aquatic organisms.

Behavioural Changes in Fishes induced by Agrochemicals

Behaviour includes swimming patterns, feeding, breathing, and response to stress. Many research studies have shown that pesticides can change the normal behaviour of fishes, even when the amount of pesticides in water is very low. When fish are exposed to pesticides, they often show abnormal swimming such as fast movement, loss of balance or slow and weak swimming. These changes happen because pesticides affect the fish nervous system and disturb normal body functions. Fish also come frequently to the water surface and show fast breathing because pesticides damage the gills and reduce oxygen intake.

Recent research also shows that pesticides disturb social behaviour in fish. Normally, fish live and move in groups, but pesticide exposure causes fish to swim alone and avoid group movement. Reported that pyrethroids pesticides caused fish to become restless at first and later inactive and isolated from groups. In addition, it was found that herbicides like Atrazine and glyphosate can cause long-term behaviour changes in fish, especially when exposure occurs at early life stages. Such fish show reduced exploration and stress tolerance even in adult life.

When *Oreochromis niloticus* (Nile tilapia) is exposed to pesticides like glyphosate (herbicide) or malathion (insecticide), its

normal vitality and behaviour are disturbed. Fish exposed to these pesticides show restlessness, fast swimming, loss of balance, surface breathing, reduced, and lethargy. These changes occur because pesticides damage the nervous system, gills, and energy metabolism of fish.

Overall, these studies clearly show that pesticides affect fish behaviour such as swimming, breathing, feeding, and social interaction. These changes reduce survival and reproduction and disturb the balance of aquatic ecosystems.

Conclusion

It may be concluded that Agrochemicals are helpful for increasing agricultural production, but their uncontrolled use causes serious harm to aquatic ecosystems. When these chemicals enter water bodies, they negatively affect fish health, behaviour and survival.

Agricultural runoff and improper disposal allow pesticides, herbicides, and fungicides to enter rivers, ponds, and lakes, where they exert toxic effects on fishes. The present review clearly highlights that exposure to agrochemicals leads to severe behavioural disturbances, histopathological damage, hematological alterations, and biochemical imbalance in fishes.

Agrochemical-induced toxicity not only reduces fish survival and population stability but also disrupts the ecological balance of aquatic environments and poses potential risks to human health through the food chain. Therefore, strict regulation on agrochemical use, promotion of eco-friendly alternatives, and regular monitoring of water bodies are urgently required. The findings summarized in this review emphasize the need for sustainable agricultural practices to protect aquatic biodiversity and maintain environmental health.

References

1. Adeyemi O. J., et.al., (2024). Neurotoxic effects of pyrethroid insecticides in freshwater fishes. *Environmental Toxicology*. Vol. 39(1), Pg. 45–5.
2. Banerjee S., et.al., (2024). Toxicological effects of nematicides on freshwater fish species. *Aquatic Toxicology*. Vol. 265, Pg. 106712.
3. Banaee M., et.al., (2013). Sub-lethal toxicity effects of pesticides on biochemical parameters in fish. *Toxicology and Industrial Health*. Vol. 29, Pg. 257–266.
4. Das S., et.al., (2023). Reproductive and physiological toxicity of fungicides in freshwater fish. *Journal of Hazardous Materials*. Vol. 443, Pg. 130260.
5. Kumar A., et.al., (2021). Herbicide-induced histopathological and biochemical alterations in freshwater fishes. *Environmental Science and Pollution Research*. Vol. 28, Pg. 21562–21573.
6. Kumar R., Singh A., & Gupta P. (2022). Neurotoxic and behavioural effects of organophosphate pesticides in freshwater fish. *Environmental Toxicology and Pharmacology*. Vol. 89, Pg. 103786.
7. Mesnage R., et.al., (2022). Toxic effects of herbicide formulations on aquatic organisms. *Toxicology Reports*. Vol. 9, Pg. 1096–1105.
8. Pandey S., et.al., (2009). Toxic effects of pesticides on biochemical parameters of freshwater fish. *Journal of Environmental Biology*. Vol. 30, Pg. 235–238.
9. Patel A., et.al., (2004). Effects of herbicides on growth and reproduction of freshwater fishes. *Indian Journal of Experimental Biology*. Vol. 42, Pg. 1021–1026.

10. Rao S., Sharma P., Gupta R., & Singh A. (2022). Neurotoxicity and oxidative stress caused by acaricides in freshwater fishes. *Environmental Toxicology*. Vol. 37, Pg. 214–223.
11. Saha S., Dutta S., & Ghosh R. (2021). Pyrethroid toxicity and behavioural effects in freshwater fish. *Environmental Monitoring and Assessment*. Vol. 193, Pg. 512.
12. Singh P., & Mishra, K. (2023). Behavioural and physiological changes in fishes exposed to organophosphate pesticides. *Aquatic Toxicology*. Vol. 251, Pg. 106292.
13. Tilak K. S., Veeraiah K., & Butchiram M. S. (2005). Toxic effects of pesticides on freshwater fishes with special reference to behavioural and biochemical changes. *Journal of Environmental Biology*. Vol. 26(2), Pg. 417–421.
14. Tilak K. S., Veeraiah K., & Suresh A. (2020). Toxic effects of organophosphate pesticides on freshwater fishes. *Journal of Environmental Biology*. Vol. 41(4), Pg. 985–993.
15. Velmurugan B., Selvanayagam M., Cengiz E. I., & Unlu E. (2007). Pesticide-induced biochemical and histological changes in freshwater fish. *Environmental Toxicology and Pharmacology*. Vol. 23, Pg. 102–109.

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5. Kumar A., et.al., (2021). Herbicide-induced histopathological and biochemical alterations in freshwater fishes. *Environmental Science and Pollution Research*. Vol. 28, Pg. 21562–21573.
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7. Mesnage R., et.al., (2022). Toxic effects of herbicide formulations on aquatic organisms. *Toxicology Reports*. Vol. 9, Pg. 1096–1105.
8. Pandey S., et.al., (2009). Toxic effects of pesticides on biochemical parameters of freshwater fish. *Journal of Environmental Biology*. Vol. 30, Pg. 235–238.
9. Patel A., et.al., (2004). Effects of herbicides on growth and reproduction of freshwater fishes. *Indian Journal of Experimental Biology*. Vol. 42, Pg. 1021–1026.

10. Rao S., Sharma P., Gupta R., & Singh A. (2022). Neurotoxicity and oxidative stress caused by acaricides in freshwater fishes. *Environmental Toxicology*. Vol. 37, Pg. 214–223.
11. Saha S., Dutta S., & Ghosh R. (2021). Pyrethroid toxicity and behavioural effects in freshwater fish. *Environmental Monitoring and Assessment*. Vol. 193, Pg. 512.
12. Singh P., & Mishra, K. (2023). Behavioural and physiological changes in fishes exposed to organophosphate pesticides. *Aquatic Toxicology*. Vol. 251, Pg. 106292.
13. Tilak K. S., Veeraiah K., & Butchiram M. S. (2005). Toxic effects of pesticides on freshwater fishes with special reference to behavioural and biochemical changes. *Journal of Environmental Biology*. Vol. 26(2), Pg. 417–421.
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