CASE SERIES

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A report on *Anabas testudineus* showing disruption of gonads and liver structure by selected insecticide and herbicide: A case series.

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ABSTRACT

Monocrotophos (MCP) and glyphosate (GLY) are used as insecticides and herbicides in agricultural fields. Our study aims to know the toxic effect of these two chemicals at sub-lethal concentrations on adult Anabas testudineus (Walking perch). We observed alterations in the structure of gonad & liver, spawning performance, body structure, and feeding behaviour of Anabas on this two-chemical exposure.

INTRODUCTION

The increasing demand for agricultural products and the resultant commercialization of agriculture have induced a rising use of agrochemicals in India. The shift of agriculture management strategies to the mode of agribusiness emphasized risk management as one of the major challenges in agriculture and allied sectors. Today, many aquatic environments around the world are affected by contaminants from anthropologic activities, mainly agricultural practices in which pesticides are used indiscriminately. Their indiscriminate use might endanger aquatic ecosystems, which are in proximity to agricultural fields. Fish are a good experimental model for toxicological studies as they are relatively sensitive to changes in their surrounding environment including an increase in pollution. The MCP, an insecticide, and GLY, a herbicide are widely used in Odisha, India. MCP controls a range of pests from aphids to caterpillars, mites, moths, stem borers, and locusts on various crops such as cotton, rice, and sugarcane. GLY became the most widely used herbicide worldwide with the introduction of genetically modified (GM) glyphosate-resistant (GR) crops. [1] Along with agricultural fields, glyphosate-based formulas are also applied to control aquatic weeds, [2, 3] particularly invasive species e.g., common reed (Phragmites australis) in the eastern United States. [4] Anabas testudineus is a very important candidate species for diversification and playing a major role in aquaculture production in rural areas of the Indian sub-continent. [5, 6] It has a wide range of geographical distribution due to its exceptional physiological adaptation and air-breathing habit. [7, 8] Information about the adverse effects of agrochemicals on Anabas testudineus was limited. So, our study aims to know the toxic effect of two agrochemicals (MCP and GLY) at various sub-lethal concentrations in commercially important fish Anabas testudineus.

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In this study, the adult Anabas testudineus were exposed to MCP and GLY to know their toxic effect. Here the adult fish were acclimatized for a week after collection and then exposed to 3 sub-lethal concentrations of MCP, 3.5 ppm (1/30th of LC50), 5.3 ppm (1/20th of LC50), and 10.6 ppm (1/10th of LC50) and GLY, 2.6 ppm (1/30th of LC50), 3.9 ppm (1/20th of LC50), and 7.8 ppm (1/10th of LC50) for 45 days. [9] One group was kept as the control without any treatment. The toxicity tests were carried out in duplicate. Here a renewal technique was adopted in which the test solutions were renewed with the same concentration once every 24 hours.[10]

Body deformity (bending) in the caudal portion was found in both male and female fish in the higher sub-lethal concentrations of MCP treated groups (Fig. 1.), but not found in GLY treated groups. Bending in fish may be due to lack of vitamin C content because Vitamin C helps in collagen synthesis and Collagen holds muscles, bones, and other tissues together.

Histological study of testis, ovary, and liver of Anabas was studied in chemical exposed & control groups. Alteration in a histological structure like the disruption of follicular wall, decreased vitellogenesis, and atresia was found in both MCP and GLY treated ovary (Fig. 2.). The rupture in seminiferous tubules and clumping of spermatids were observed in the testis of A. testudineus, when exposed to both MCP & GLY (Fig. 2.).

Dilution of the sinusoid, infiltration of leukocytes, and vacuolation were observed in the liver of Anabas, when exposed to MCP and dilution of the sinusoid & alteration in tissue architecture in case of GLY exposure at higher sub-lethal concentrations (Fig. 3). Reduction in spawning performance (Fertilization and hatching rate) was noticed in both MCP and GLY treated groups (Fig. 4.). Fertilization rate was found 62% and 92% at higher concentrations of MCP and GLY treated fish respectively, but it was 100% in the case of control groups. The hatching rate was 15% and 60% at higher concentrations of MCP and GLY treated fish, but it was 90% in the control groups. Less food was taken by fish at a higher sub-lethal concentration of MCP, but in the case of GLY exposure, fish took food properly.

DISCUSSION

Ovarian damage like decreased vitellogenesis and oocyte atresia was earlier reported in female Channa punctatus after exposure to MCP, [9] which showed similarity with our results. Disruption of follicular wall, decreased vitellogenesis, and atresia was observed in Anabas on exposure to MCP and GLY for 30 and 45 days. [11, 12] Haider and Upadhyaya had found reduced gonad weights and vitellogenesis in female striped catfish (Mystus vittatus) after 12 weeks of exposure to four different organophosphates (malathion, birlane, gardona, and phosdrin). [13] The concentration-dependent decrease in GSI and altered testis structure was reported in Xiphophorus maculatus on 28 days of exposure to nonylphenol. [14] The testis and ovary are major reproductive organs of fish. Testis provides sperm and the ovary produces oocyte for fertilization. So these two chemicals affected the reproduction of fish.

Glycogen vacuolation, fatty infiltration, hemosiderosis, and congested central vein at a concentration of 1.9 to 9 mg/L and severe infiltration of leukocytes, pyknotic & hepatic necrosis at concentrations of 21 and 45 mg/L of GLY were found in the liver of African catfish, Clarias gariepinus.[15] The liver has a wide range of functions like detoxification, protein synthesis, digestion, and excretion. It is also a part of the reproduction of fish as it helps in the synthesis of vitellogenin which is taken up by oocytes during vitellogenesis.[16] This study showed a decrease in fertilization and hatching rate in both chemical exposure groups. Earlier studies on diverse fish species have reported identical results. Reduced fecundity and hatchability were found in the zebrafish when exposed to an organophosphate, dimethoate.[17] Low fertilization and hatching rates lead to a decrease in overall offspring production. Thus, MCP has a more adverse effect on spawning performance than GLY exposure and could significantly influence the reproducing capability of the fish.

This study concluded that MCP adversely affected feeding behavior, but GLY did not affect the feeding behavior of A. testudineus. But, Giaquinto et al. observed a decrease in food consumption in the case of Piaractus mesopotamicus when exposed to the glyphosate-based herbicide.[18]

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CONCLUSION

It is the principal report on the effect of MCP and GLY openness on spawning performance, liver, and gonadal structure of Anabas testudineus. The MCP additionally influenced body structure and feeding behaviour. So these two agrochemicals eventually unfavourably influenced fish wellbeing. Subsequently, the utilization of pesticides ought to be directed and its controlled application in farming fields would limit pollution of oceanic water bodies for the endurance and populace development of the fish alongside other amphibian living beings.

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