

## EFFECTS OF PESTICIDES ON PHOTOSYNTHESIS OF MARINE PHYTOPLANKTON

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### Abstract

Toxicity of pesticides, namely chlorpyrifos, malathion, cypermethrin, lambda-cyhalothrin and buctril were tested on the photosynthetic behavior of marine phytoplankton. The phytoplankton population was exposed to 0.01, 0.03, 0.06 and 0.09 ppm of test pesticides. The toxicity of pesticides stands in the order of lambda-cyhalothrin > chlorpyrifos > buctril > malathion > cypermethrin. The most toxic pesticide was lambda-cyhalothrin having IC<sub>50</sub> value of 0.014 ppm. Toxicity of cypermethrin was less on phytoplankton compared to others.

Global use of agrochemicals in an increasing rate has led to the concern about their impact on ecosystems. Pesticides protect the economically important crops from pathogens but when their residues enter into the aquatic ecosystems, affect non targeted primary producers (Wang *et al.* 2011). Recently large number of pesticide components have been reported from fresh and marine ecosystems releasing toxic molecules (Chevre *et al.* 2006, Gilliom, 2007). Mixtures of pesticides are more toxic than individual pesticide.

Phytoplankton which forms the base of the marine food chain are affected by pesticide residues present in the contaminated sea water (Belden *et al.* 2007). Stevenson and Pan (1999) showed that diatoms being the major component of marine phytoplankton are harmed by the exposure of different pesticides and thus the balance of ecosystem disturbed. Diatoms are bioindicator of pesticides, several researchers demonstrated negative impact of pesticides on cell structure, metabolism and community composition of diatoms (Dorigo *et al.* 2004).

Among pesticides lambda-cyhalothrin affects macroinvertebrates, zooplankton and phytoplankton (Wijngaarden *et al.* 2006). Cypermethrin alter the community composition of phytoplankton, crustacean, rotifer and zooplankton (Rasch *et al.* 2003). In marine ecosystems, growth of *Skeletonema costatum* (Grev.) Cleve, *Scrippsiella trochoidea* (Stein) Loeblich and *Chattonella marina* (Subrahmanyam) Hara & Chihara were inhibited after exposure to cypermethrin (Wang *et al.* 2010). Another pesticide chlorpyrifos affects metabolism of phytoplankton community (Shoaib *et al.* 2012). The present study aims to observe the impact of cypermethrin, lambda-cyhalothrin, chlorpyrifos, buctril and malathion on photosynthesis of phytoplankton in natural environment.

Samples of phytoplankton were collected from Sandspit (24°50.141' N and 066°44.245' E) beach in Karachi, Pakistan. By using phytoplankton net (147 µm mesh Nitex brand nylon bolting cloth) towed for ten minutes in the surface water. The phytoplankton was identified on the basis of their characteristics (Tomas 1997).

Physiological parameters such as temperature, pH and salinity of water was determined. Water temperature: 24°C, pH: 7.7, salinity 36 (part per thousand). A set of triplicate light and dark bottles were used for control. Concentrations (0.01, 0.03, 0.06 and 0.09 ppm) of all the experimental pesticides as mentioned before were prepared in flasks and then was transferred into

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glass stoppered BOD bottles (150 ml). A set of light bottles containing pesticides and phytoplankton were incubated under ambient light (sunlight) for three hours. Another similar set was incubated in a black box. A set of triplicate light and dark bottles were used for control. The gross production of the phytoplankton was measured by Strickland and Parsons (1968). With the help of log log graph inhibitory concentration of pesticides ( $IC_{50}$ ) were determined.

The results of the present work have been plotted in Fig. 1 which shows that chlorpyrifos, cypermethrin, lambda-cyhalothrin, malathion and buctril pesticides suppressed the photosynthetic percentage of phytoplankton. From Fig.1 it is evident that increased concentration of pesticides causes suppression in the photosynthetic percentage of phytoplankton community. Among all the pesticides lambda-cyhalothrin showed maximum suppression in photosynthesis rate as compared

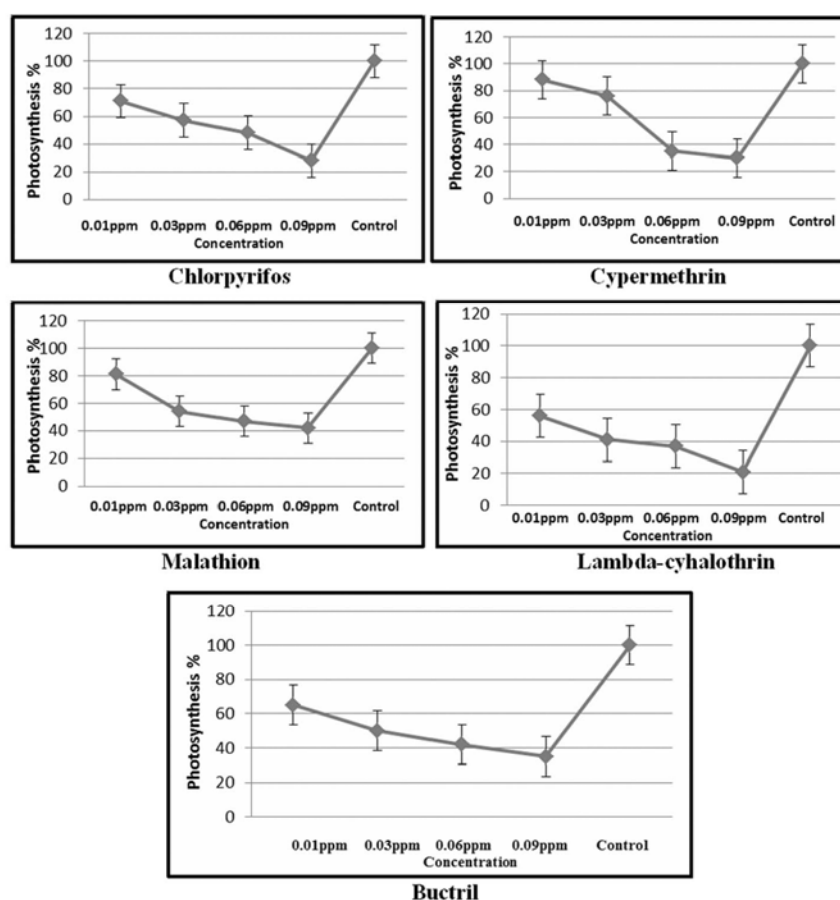


Fig. 1 Effect of pesticides on the photosynthetic percentage of phytoplankton.

to other pesticides. The  $IC_{50}$  (inhibitory concentration) value of lambda-cyhalothrin is 0.014 ppm which indicates the toxicity of this pesticide. The second toxic pesticide was chlorpyrifos having  $IC_{50}$  value of 0.028 ppm following buctril having  $IC_{50}$  value of 0.030 ppm. Malathion stands fourth in toxicity having  $IC_{50}$  value of 0.043 ppm and cypermethrin stands fifth in toxicity having  $IC_{50}$  value of 0.056 ppm (Table 1).

The inhibition of photosynthetic rate in the present study is in good agreement with some previous reports showing inhibitory effects of pesticides on phytoplankton (Delorenzo and Serrano 2003, Mohapatra *et al.* 2003). In the present study, lambda-cyhalothrin (synthetic pyrethroid) showed the highest degree of suppression in the percentage of photosynthetic rate of phytoplankton. Shoaib *et al.* (2011) reported that synthetic pyrethroid pesticide is most toxic to phytoplankton as compared to organophosphate pesticides.

**Table 1. Effect of pesticides on photosynthesis of phytoplankton.**

Pesticides	IC <sub>50</sub> (ppm)	p-value	F-value
Chlorpyrifos	0.028	0.9768	0.0234
Malathion	0.043	0.9924	0.0076
Lambda-cyhalothrin	0.014	0.9878	0.0122
Cypermethrin	0.056	0.9893	0.0106
Buctril	0.030	0.9831	0.0169

Berard *et al.* (2003) reported that triazine and atrazine herbicide showed ecotoxicological effects on communities of microalgae. According to Knauer *et al.* (2010) pesticides directly affect the D1 protein and photo system-II in photosynthesis. More specifically bensulfuron-methyl, butachlor and dimethoate affect PSII and PSI, showing inhibition in the photosynthetic rate and growth of cyanobacteria (Chen *et al.* 2007).

Phytoplankton community displayed a high level of variability in their sensitivity to different concentration of pesticides, which is a prerequisite for the restructuring of community patterns (Blanck 2002). The most toxic pesticide was lambda-cyhalothrin having IC<sub>50</sub> 0.014 ppm and in case of cypermethrin IC<sub>50</sub> was 0.056 ppm. Rasch *et al.* (2003) reported that cypermethrin in 0.01 ppm showed alterations in the species composition of phytoplankton communities. Alteration of the species composition of the autotrophic communities caused indirectly by cypermethrin was observed by Lina *et al.* (2003). Results from cypermethrin pollution in sea waters may lead to a shift in phytoplankton community structure from diatom to harmful dinoflagellate species and potentially stimulate harmful algal blooms (Wang *et al.* 2011). The imbalance of a flora could favor species suppressed by other species, hence producing population explosions and dominance of the planktonic community by noxious groups. Interspecific variations may be due to the chemical composition of pesticides. Number and kinds of esters present in organophosphates and their stereochemistry, spectrum of activity, and toxicology (Reddy and Rao 1992).

The results of the present investigation provide knowledge about the ecotoxicological effects of pesticide stress on the phytoplankton. Chlorpyrifos showed negative impact on biovolume, growth and ultra structure of *Ankistrodesmus gracilis* (Asselborn *et al.* 2015). Mohapatra *et al.* (2003) investigated that chlorophyll a, carotenoids and phycobiliproteins significantly reduced when *Anabaena doliolum* Bhar exposed to cypermethrin. Photosynthetic organisms of marine ecosystem play an important key role in food chain on which majority of organisms depends. Phytoplankton are primary producers of marine ecosystem and if they are disturbed the whole food-web will be affected so there is a need to aware farmers and researchers to move towards some natural methods to control pest.

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