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IMPACT OF FUNGICIDES ON PHOTOSYNTHETIC BEHAVIOR OF MARINE PHYTOPLANKTON

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Abstract

Phytoplankton are the primary producers of marine ecosystem and form the base of food web. If population of phytoplankton are affected by any pollutant such as fungicide the marine organisms are indirectly affected. In current research, the effect of different fungicides on photosynthetic behavior of phytoplankton is examined. Fungicides such as Topsin, Metalaxl, Mencozeb and Benlate were used in this experiment. Benlate is the most toxic for phytoplankton as it suppressed the photosynthetic activity of phytoplankton as compared to other fungicides. There is a need to create awareness among people about toxicity of fungicides on marine phytoplankton to cut down the excessive use of fungicides and use natural methods to control fungal infections on crops.

Key words: Fungicides, Phytoplankton, Topsin, Metalaxl, Mencozeb and Benlate.

Introduction

Phytoplankton are microscopic algae containing chlorophyll and manufacture their own food material like higher plants and mostly known as microalgae, can be found in fresh and saltwater. They are found in photic zone where there is enough light for photosynthesis (Anene, 2003). They are the primary producers of aquatic ecosystems. By the assessment of plankton community, productivity of any water body can be determined. Phytoplankton distribution and abundance data have been employed in the bio-monitoring of marine environment (Davies *et al.,* 2009). Many fungicides are used in agriculture for the control of fungal infection on crops and give better production but they have a negative impact on environment and cause environmental pollution. They not only disturb the biological and chemical activities of targeted organisms but also disturb the non-targeted organisms for example phytoplankton, zooplanktons and rotifers (Lal & Saxena, 1980). Pollutants such as pesticides, heavy metals and hydrocarbons cause toxic effects on marine ecosystem which may alter the species composition of the aquatic environment. Sensitive species may be extinct because of lethal effects of pollutant and sometimes morphological changes occurred in tolerant species. They alter the predation, behavior, competition, available nutrient and oxygen of aquatic environment (Fleeger *et al*., 2003).

Benlate is a systemic fungicide which is toxic to microscopic and larger organisms. It disturbs the reduction division and protein synthesis in organisms. So it is necessary that we should aware people against negative impacts of Benlate (Tomlin, 1994). Mancozeb fungicide is mostly used to control the wide range of fungal diseases in ornamental and cash crops. It is easily dissolvable in water and soil (Anon., 2003a). Metalaxyl is a systemic fungicide mostly used to control *Pythium* and *Phytophthora* in vegetable crops (Hansch, *et al*., 1995). Topsin-M is a systemic fungicide mostly used to control the *Botrytis*, *Anthracnose* and *Cercosporella* spp. in different crops (Siddiqui *et al*., 1999).

Pesticides used in agriculture are regularly detected in aquatic environments throughout the world. One of the major groups of pesticides, the fungicides, constitutes a chemically very diverse group of compounds used against fungal infection in crops, and is in some regions of the world these fungicides are also detected in marine water (Castillo *et al.,* 1997). Tomlin, 2000 reported the lethal effect of fungicides on non target organisms. Swedish Chemicals Agency in 2008 reported that fungicides are more often used after herbicides to protect crops. Azoxystrobin fungicide mostly used to control fungal infection on wide range of crops. From aerial spray they enter into the marine ecosystem (Tomlin, 2000; Bartlett *et al*., 2002). During the rainy season large number of crops susceptible to fungal infection and usage of fungicides is increased and large amount of fungicides enter into sea water from crop field (Anon., 2003b). So, the present study is aimed to study the effect of fungicides such as Topsin, Metalaxl, Mencozeb and Benlate on photosynthetic activities of phytoplankton in natural marine environment.

Materials and Methods

Preparation of chemicals (for toxicity determination): Fungicides namely Topsin, Metalaxl, Mencozeb and Benlate were procured from market. Stock solution of 100 ppm and appropriate working concentrations were prepared in filtered seawater.

Collection of samples: Phytoplankton were collected from Sandspit, Karachi using phytoplankton net (147 µm mesh) towed for five minutes in the surface water. The phytoplankton were identified on the basis of their characteristics (Tomas, 1997). Physiological parameters such as pH (pH meter), temperature (thermometer) and salinity (refractometer) of water were determined. A set of triplicate Light and Dark bottles were used for control and for each treatment. By using Strickland & Parsons (1968) method gross photosynthesis was calculated. With the help of log log graph inhibitory concentration of pesticides (IC_{50}) was determined.

Results

In the present study, four fungicides Topsin, Metalaxl, Mencozeb and Benlate were used to observe their impact on photosynthetic activity of phytoplankton. Physiological conditions of water were recorded as pH 7.7, 36 ppt salinity whereas temperature was 24°C. Photosynthetic percentage of phytoplankton was suppressed by increase in concentration of fungicides. Among all the fungicide Benlate showed most toxic effect on phytoplankton and reduced the photosynthetic activity of phytoplankton (Fig. 1). According to IC_{50} value (0.006 ppm) Benlate stands first in toxicity to phytoplankton. Topsin has 0.011 ppm IC_{50} value and was placed in second number due to its toxicity. Metalaxyl categories in third number having IC_{50} value 0.015 ppm which represent that it has a toxic effect on photosynthesis. The fourth toxic fungicide was Mencozeb having IC_{50} value of 0.048 ppm (Table 1).

Table 1. Effect of fungicides on photosynthesis of Phytoplankton.

Fungicides	$IC_{50\ (ppm)}$	P-value	F-value
Benlate	0.006	0.989	0.010
Topsin	0.011	0.988	0.011
Metalaxyl	0.015	0.996	0.003
Mencozeb	0.048	0.980	0.019

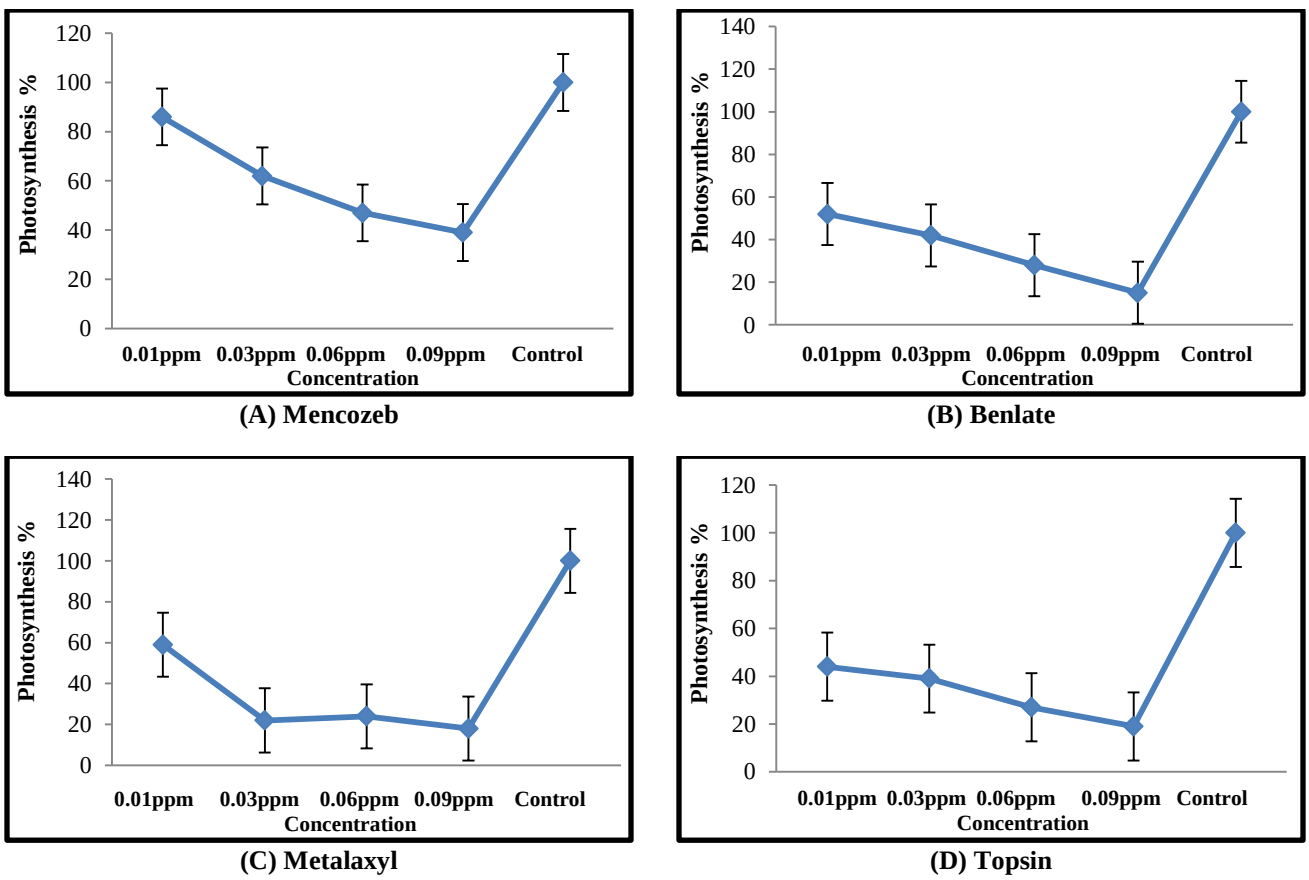

Fig. 1. Effect of fungicides on photosynthetic behavior of Phytoplankton.

Discussion

In the ongoing study four fungicides Benlate, Topsin, Metalaxyl and Mencozeb reduced the photosynthetic behavior of phytoplankton. Similar studies were carried out by Debnath *et al.*, in 2012 that Mancozeb and Bagalol (fungicides), Thiodan and Phorate (insecticides) were toxic and showed lethal effect on cyanobacteria (*Scytonema simplex*, *Nostoc ellipsosporum*, *Tolypothrix tenuis*, and *Westiellopsis prolifica*). In the present study, we observed low IC50 values of phytoplankton after exposure to fungicides. Similarly, Shoaib*et al.*, (2012) reported the IC_{50} of Chlorpyrifoswas found to be 0.074, 0.013, 0.08 and 0.3 ppm on marine cyanobacteria species *Synechocystis aquatilis, Komvophoron minutum, Gloeocapsa crepidinum* and *Gloeocapsa sanguine*.

Schafer *et al.*, (2011) reported that frequent use of dithiocarbamate fungicide for the control of fungal infection from crops indirectly polluted our water resources. Azoxystrobin is a systemic fungicides having lethal effect on non target organisms such as *Daphnia magna* and *Raphidocelis subcapitata* and highly toxic to autotrophic microorganisms.It shows differential toxicity to different organisms (European Commission Peer Review Programme 1997). Phinney & Bruland (1997) reported that Ziram and Maneb fungicides were class of dithiocarbamate increase the absorption of toxic metal for example copper, lead from the sea water into the cytoplasm of the cell. So because of these fungicides different heavy metals in trace amounts are diffused into the microorganisms. Knauer *et al.*, (2010) reported that pesticides directly affected the D1 protein and

photosystem-II in photosynthesis. Chen *et al.,* (2007) found that bensulfuron-methyl, butachlor and dimethoate disturbed the PSII and PSI, and inhibited the photosynthesis and growth of cyanobacterium.

In the present study, low concentrations, of Benlate alter the photosynthetic activity of phytoplankton which shows the toxic effect of it then other fungicides. Similar studies carried by Baird & Delorenzo in 2010 showed that Conazole fungicides might disturb the lipid composition, cell morphology and osmoregulation of cell membrane of *Dunaliella.* Higher concentrations of Azoxystrobin fungicides have been reported from the natural water sources in northern Germany (Berenzen *et al*., 2005). Tomlin, (2000) reported that pesticides and fungicides consisted of synthetic chemicals which not only affected the targeted animals but also disturbed the non-targeted animals and greatly devastated the structure and function of marine ecosystem. Chlorothalonil fungicide is toxic for phytoplankton, zooplanktons, amphibians, gastropods and macrophyte. It alters the marine ecosystem and algal composition of marine environment (McMahon *et al*., 2012).

In the present studies we observed differential in toxicity of fungicides towards phytoplankton. The IC_{50} value for Benlate (benzimidazole fungicide) was 0.006 ppm in toxicity towards phytoplankton. Topsin (thiophanate-methyl fungicide) had 0.011 ppm IC_{50} value. Metalaxyl (Acylalanine fungicide) had IC_{50} value of 0.015 ppm and Mencozeb (dithiocarbamate) IC_{50} value was 0.048 ppm. Similar results were observed by Ikram & Shoaib, (2018) after exposure of different concentration of pesticides to phytoplankton. The differential in toxicity is also reported by Shoaib *et al*., in 2011 that synthetic pyrethroid pesticide was most toxic to *Amphora* and *Navicula*as compared to organophosphates pesticides. Pesticides and fungicides control large number of diseases of crops and increase the production of cash crops but indirectly environmental factors are disturbed such as decomposition processes, energy production, biogeochemical cycling and energy transformation by disturbing phytoplankton and other microorganisms (Saxena & Lal, 1980).

Many researchers studied the ecotoxicology of agrochemicals on micro and macro organisms of marine water (Giddings *et al*., 2002; Daam & Van den Brink, 2007; Ebenezer & Seuki in 2014; Asselborn *et al.,* 2015; Thomas *et al.,* 2020; Li *et al.,* 2021; Kaeoboon *et al.,* 2021). Agrochemicals from field's run-off enter into the marine environment and affect the growth and physiological properties of marine organisms, so there is a need that researchers should introduce new alternative eco-friendly methods which do not disturb natural environment.

Conclusion

Pesticides and fungicides are widely used for controlling pest for increasing production of agricultural products and to control large number of diseases of crops but indirectly they disturb the environment. Current study, clearly demonstrates that low concentrations of Benlate alter the photosynthetic activity of phytoplankton which shows the toxic effect of it then other three fungicides, Topsin, Metalaxyl and Mencozeb. So it's necessary to aware farmers against the side effects of fungicides and use natural methods to control fungal infections.

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