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Acute Toxicity of Pesticide Endosulfan to the Young Ones of the Fish *Channa gachua* (ham.)

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Static acute (96 h) bioassays were conducted on the spawn (4.0 mm) and the fry (15.5 mm) of freshwater fish *Channa gachua* (Ham) and the median lethal toxicity (96 h LC_{50}) of the pesticide endosulfan on the fish were estimated as 9.0 ppm and 22.0 ppm, respectively. When the fishes were exposed from spawn stage up to a period of 30 days in three sublethal concentrations viz. 0.01, 0.02 and 0.05 TU, there was an overall reduction in growth of the fish. While the reduction of growth was greater (up to 58.9%) at 0.05 TU, it was minimum (11.64%) at the medium sublethal concentration of 0.02 TU at the end of 30 days of experimental tenure.

Key words : Acute toxicity, endosulfan, *Channa gachua*, growth

Concern over the effects of pesticides used in agriculture on the non-target aquatic organisms, particularly the fishes, which are having direct trophic relationship with human beings, is increasing day-by-day. A number of investigations have been made on the toxic effects of pesticides on the Indian fresh water fish *Channa punctatus* (Shukla *et al.*, 1987; Bakthavathsalam, 1988; Gopal *et al.*, 1989; Samuel & Sastry, 1989; Verma, 1989; Abidi, 1990; Azharbaig *et al.*, 1990 and Nag, 1992). Limited studies have been made on the other species of *Channa*, i.e. *C. marulis* (Mercy *et al.*, 1996), *C. striatus* (Kulshrestha and Neelam Arora, 1984; Bhaskaran, 1988; Vasanthi *et al.*, 1990; Devi *et al.*, 1991) and *C. gachua* (Khillare & Wagh, 1987; Sultan & Sharma, 1990; Kumar *et al.*, 1996). All the above studies have been carried out either in the adult or in juvenile stages of the fish. The present work was done using very early stages of the fish i.e. the spawn (4.0 -15.5 mm total length) and the fry (15.5 - 28.5 mm) since these young fishes are in the critical phase of recruitment into commercial fishery constituted by the adult fishes.

Materials and Methods

The young ones of *Channa gachua* hatched out in captivity from gravid female fishes collected from the fish culture ponds in the campus were used. The spawn having an average size (total length) of 4.0 mm (±0.4 mm) obtained after 72 h from the time of hatching, were used for the bioassay experiments. The fry obtained after 7 days from the day of hatching, with an average size of 15 mm (±0.5 mm), were also used.

Acute static bioassay experiments were conducted to find out the 96 h median lethal concentration (LC_{50}) of the pesticide endosulfan on the spawn and fry of fishes separately following the method described by APHA (1976) and Mohapatra & Rengarajan (1995). The experiments were conducted in 1 L glass beakers for the spawn and 5 L circular glass troughs for the fry. In each concentration, 10 fishes were exposed and the duplicate experiments were run concurrently in randomized set-up. The water collected from the fish culture ponds of the college (supplied from underground tube well) was

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stored for a couple of days, filtered, oxygenated and used for the bioassays. The range of water temperature, dissolved oxygen content, bicarbonate alkalinity and pH monitored throughout the bioassays and growth estimation experiments were 30 - 32°C, 6 - 7.5 ppm, 105 - 120 ppm and 6.5 - 7.5 respectively.

Commercial grade endosulfan 35 EC endocel (active ingredient of endosulfan 35% m/m) supplied by Excell Industries Ltd., Bombay was used for the bioassays. The stock solutions were prepared as per the standard techniques (APHA, 1976; Mohapatra & Rengarajan, 1995) and the test solutions were not changed throughout the 96 h duration. The fishes were not fed during the bioassay period. The mortality of fishes was observed after 96 h exposure in each concentration and the LC_{50} values were calculated separately for the spawn and fry of the fishes using the method described by Litchfield & Wilcoxon (1949).

The growth of the fishes, exposed for 30 d in three different sublethal concentrations, was determined using the spawn (mean size = 4.5 mm). The sublethal concentrations maintained were 1/20th, 1/50th and 1/80th of 1 toxic unit (TU) of the pesticide (1 TU = 96 h LC_{50}). The fishes, immediately after hatching out, were acclimatized for 3 d in the water (free of pesticides) derived from the stock used for the complete experiment. A set of twenty spawn was stocked in 30 L of water in 50 L capacity fibreglass tanks in a randomized experimental set-up, in duplicate. Water was changed every alternate day with fresh stock solutions of the pesticide. The fishes were fed with finely minced boiled hen egg, finely powdered rice bran and live plankton *ad libitum* and the visible faecal matters were siphoned out once everyday. Aeration was provided for 12 h a day with intermittent gaps. A control was maintained using the same water, but free of pesticide.

Results and Discussion

The acute static bioassay experiments were conducted with the spawn measuring about 4 mm and the fry measuring about 15.5 mm of the fish *C. gachua*, and the median lethal concentrations (96 h LC_{50}) of the pesticide endosulfan critical to the fish were calculated as 9 ppm and 22 ppm, respectively. The lethal effects of various pesticides tested in earlier studies on *C. punctatus* differed very much. The LD_{50} of technical grade lindane ranged from 1.07 to 0.44 mg/l for an exposure period of 3-120 h (Bakthavathsalam, 1988). The 96 h LC_{50} of lindane was 0.0258 ppm as observed by Gopal *et al.* (1989). Samuel & Sastry (1989) determined the LC_{50} (96 h) value for monocrotophos as 10 ppm. The 96 h LC_{50} calculated for the juvenile *C. punctatus* exposed to heptachlor was 0.17 ppm (Azharbaig *et al.*, 1990). Abidi (1990) evaluated the 96 h LC_{50} of endosulfan as 0.015 ppm, while Verma *et al.* (1989) estimated the 96 h LC_{50} of endosulfan as 750 ppm.

The acute toxicity (96 h LC_{50}) of the pesticide endosulfan estimated earlier on *C. gachua* was 0.0016 ppm (Khillare & Wagh, 1987). Sultan and Sharma (1990) observed the first mortality of the fish *C. gachua* at 4 mg/L concentration of endosulfan after 32 h and 100% mortality at 6 mg/L after 72 h. When compared with the above studies, the 96 h LC_{50} values estimated in the present study are higher. The differences in LC_{50} values could be due to the species and pesticide specific interactions between the organisms and the chemicals and/or due to the varying hydrographical parameters of the experimental medium, such as pH, alkalinity, dissolved oxygen content and temperature. Eisler (1970) studied the varying toxic effects of organophosphorus compounds on fish in different pH and alkaline regimes of the test water and inferred that there was a significant reduction in the toxicity with increasing alkalinity. The high alkaline nature of water (up to 120 mm bicarbonate alkalinity) recorded in the present study may be a causative factor for the reduction in toxicity of the pesticide.

The growth of the fish *C. gachua* monitored for a period of 30 d in three sublethal concentrations, viz., 0.05 TU (20% of TU), 0.02 TU (50% of TU) and 0.01 TU (80% TU) were found to be reduced significantly (Fig. 1). At the higher sublethal concentration (0.05 TU) there was a reduction up to 58.9% of growth when compared to the control fishes. At the medium (0.02 TU) and lower (0.01 TU) concentrations of the pesticides, the reduction in growth was up to 11.64% and 39.58%, respectively (Table 1).

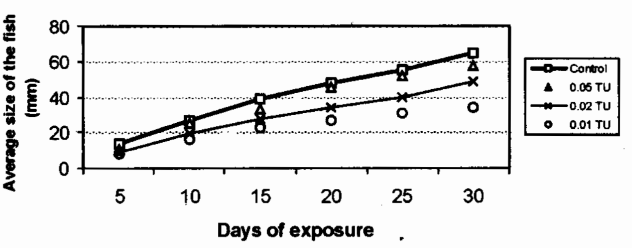

Fig. 1. Growth of *Channa gachua* exposed to three sublethal concentrations of the pesticide endosulfan

In the highest sublethal concentration (0.05 TU) the reduction in growth was apparent right from the beginning of the experiment. Subsequently in the following days also the suppressed growth was observed with a reduction in growth, ranging from 31.0 to 55.47%. In 0.02 TU sublethal concentration there was a greater reduction in the fish growth (49.49%) initially, followed by a recovery trend recording only a minimum reduction in growth of 11.64%. In the lowest sublethal concentration there was a reduction in growth initially followed by a sudden increase (even above that of control fishes). However, from the 10th day onwards the growth started decreasing till the end of 30 d experimental period, and the rate of reduction in growth were not gradual during the latter part of the experimental tenure.

Shukla *et al.* (1987) recorded an increase in growth (weight) of the fish *C. punctatus* when exposed to 2.5 mg/L of malathion and subsequently a reduction in growth during the latter period of experiment conducted up to 31 d. They also observed a reduction in RNA and protein contents of the muscle up to 10 and 15%, respectively, indicating the interference of the pesticide on the metabolism of the fish. The increase in growth observed in the present study during the first phase of the experimental period in the medium and low concentrations of the pesticide may be due to the acceleration in metabolic activities of the animals as also observed earlier by Cantelmo *et al.* (1978) and Chandrasekaran *et al.* (2000). The subsequent decline in growth in medium and low pesticide concentrations was relatively less compared to the fishes affected by the highest sublethal concentration and in direct proportion to the stress caused by the toxicant. Kasinathadurai (1995) investigated the effects of endosulfan and phosphamidan on the growth of the fish *Mastacembelus*

Table 1. Percentage reduction in growth of the fish exposed to three sublethal concentrations of endosulfan in 30 days.

Pesticide concentration	Percentage reduction in growth of the fish after 5 days	10 days	15 days	20 days	25 days	30 days
0.05 TU	56.46	31.00	55.47	56.13	41.71	58.90
0.02 TU	49.49	22.34	35.25	23.62	19.02	11.64
0.01 TU	26.62	-06.07	37.09	40.94	07.61	39.58

armatus and found that both the pesticides reduced the growth of the fish. They also inferred that the reduction in growth caused by endosulfan was more than that of phosphamidan.

When fishes are exposed to toxic stress, their food intake may be reduced and they will have to spend the stored food for their routine metabolic activities resulting in their growth reduction. Otherwise, the decrease in growth may be due to the diversion of more energy to counteract the stress put up against the toxic effects of the pesticide, as suggested by Arunachalam *et al.* (1980) based on their observations on the fish *Mystus vittatus* exposed to carbaryl. Even low concentrations of a pesticide (dieldrin) adversely affected the growth of the fish *Poecilia latippinna* (Lane & Livingston, 1970).

The standard bioassay experiments give an idea about the toxicity of chemicals to the aquatic organisms like fishes. However, concurrent field experiments are essential to confirm the toxic levels of the pesticides on the fish in order to evaluate the possible synergistic effects of various other factors critical to the survival and growth of the fish. Sublethal exposure of mysid crustaceans to organochlorine and carbamate pesticides initially elevated their respiration rate, but subsequently inhibited the growth of the animals (McKenney, 1982,1985). Results of these laboratory studies were confirmed in a field study indicating that physiological measurements of metabolic dysfunction in mysids exposed sublethally to pesticides may be used to predict altered production rates in mysid populations (McKenney, 1986). Similarly, fish yield predictions are also possible in Indian inland waters, once the toxic effects of pollutants critical to the growth and survival of fish are delineated both in laboratory and field conditions.

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