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Effect of Endosulfan and 2,4-Dichlorophenoxy Acetic Acid on the Growth and Gonadal Development of Freshwater Prawn *Macrobrachium lamarrei*

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The freshwater prawn *Macrobrachium lamarrei* was subjected to acute (96 hr) static bioassay toxicity test with the pesticide endosulfan and the herbicide, 2,4-dichlorophenoxy acetic acid and the LC_{50} values were 0.009 ppm and 0.5 ppm respectively. When prawns were exposed for 30 days, under static condition, to five sub–lethal concentrations, viz., 0.008, 0.007, 0.006, 0.005 and 0.004 ppm of endosulfan and 0.4, 0.3, 0.2, 0.1 and 0.05 ppm of 2,4-diclorophenoxy acetic acid, the growth and the gonado-somatic index (GSI) were found to decrease in direct relation to increase in the concentration of the toxicants. However, there was an increase in growth at lower concentrations of endosulfan and acceleration in gonadal development at low concentration of 2,4-dichlorophenoxy acetic acid.

Key words : Pesticide, herbicide, toxicity, *Macrobrachium lamarrei*

Indiscriminate use of chemicals such as pesticides and herbicides pose threat to the aquatic environment through serious water contamination (Cremyln, 1978). Most of the chemicals used in agriculture are not selective, but are generally toxic to many non-target organisms, like fishes, prawns and other desirable forms of life that inhabit the environment (Murphy 1980). A number of studies have been carried out globally on the acute toxicity of pesticides and insecticides and their effects on the behavior, physiology, biochemistry, histopathology and various other aspects in fin fishes and shellfishes including the freshwater prawns. Effects of various pesticides and insecticides on the freshwater prawns have been documented in different regions of India (Pillai *et al.*, 1989; Yadav and Sarojini Nagabhushanam, 1989; Sarojini *et al.*, 1990; Natarajan, *et al.*, 1992; Srinivasan and Bhasker patibandla, 1996; Venugopal *et al.*, 2003).

The freshwater prawn, *Macrobrachium lamarrei* is a medium sized prawn widely distributed all over India and has commercial importance as it is used in fresh or dry forms for human consumption. Studies on the acute toxicity of different pesticides and their impacts on various biological aspects of the prawn are well documented (Shukla and Omkar (1983 a, b), Omkar and Shukla, (1984), Shukla and Shukla (1984), Omkar *et al.* (1984), Omkar and Shukla, (1985 a, b), Mary *et al.* (1986) and Sarojini *et al.* (1986). However, no work has been done on the growth and gonadal development of the prawn except the study on the toxicity of endosulfan and monocrotophos on the survival and growth of the prawn, *M. lamarrei* by Chandrasekaran *et al.* (2000).

The present investigation was carried out with the objective of determining the acute (96 hr) toxicity of the two most common toxicants, i.e., a pesticide,

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endosulfan and a herbicide, 2,4-dichlorophenoxy acetic acid and their effects at sub-lethal levels on the growth and gonadal development of the adult prawn *M. lamarrei, as* this species has some importance as a candidate for aquaculture in the far inland areas of the country.

Materials and Methods

The medium sized female prawns (40 –50 mm; 0.7 –1.0 g) collected from the fish culture ponds in the University campus were used as test animals. The berried females were sorted out and only the females without eggs were used for the bioassay. The uniformly sized prawns were initially acclimatized in plastic pool of 1000 l capacity for five days and the healthy ones were chosen for the experiment. Feeding was done *ad libitum* and aeration was not provided during the acclimation period. Acute static bioassay experiments were conducted to find out the LC_{50} values of the pesticide and the herbicide separately following the methods described by Sprague (1973) and APHA (1976).

The experiments were conducted in glass aquarium tanks of uniform size (30 l), filled with 10 l of water in each tank. The water collected from the pond was filtered and stored for a day or two before being used for the bioassays. Commercial grade pesticide, endosulfan 35 EC endocel (active ingredient of endosulfan 35% M/m) Supplied by Excel industries Ltd., Mumbai and 2,4-dichlorophenoxy acetic acid (34 EC) supplied by Kissan Agro Chemicals, Muzaffarnagar, U.P., were used for the bioassays. Short term (96hr) bioassay experiments were conducted using ten prawns in each tank following the method described by APHA (1976) and Mahapatra and Rengarajan (1995). The stock solution was prepared as per the standard procedure (APHA, 1976) and the test solution was not changed throughout the 96 hrs duration. Feeding and aeration were stopped during the bioassays. Mortality data were collected after 96 hrs of exposure in each concentration and the median lethal concentrations (LC_{50}) were calculated employing the method outlined by Litchfield and Wilcoxon (1949).

The experiment to assess the effects of the pesticide and the herbicide on the growth and gonadal development of the prawns were conducted separately, in duplicate, for 30 days using five sub-lethal concentrations of the pesticide (0.008, 0.007, 0.006, 0.005, 0.004 ppm) and the herbicide (0.4, 0.3, 0.2, 0.1 and 0.05 ppm). The pre-acclimatized prawns in the size range of 0.8 –1.0 g were used for the assessment of growth and gonadal development, respectively. Prawns were exposed to the pesticide and the herbicide in 15 l capacity glass tanks containing 10 l water in each tank. A set of 10 prawns in each tank was maintained. Aeration was provided and feeding was done *ad libitum* throughout the study period using pelletized feed composed of rice bran and mustard oil cake at the ratio of 1:1. Water was changed every alternative day with freshly prepared stock solution. The prawns were weighed using an electronic digital balance (0.001g accuracy). Only the non-berried female prawns were used for the study of gonadal development, since the gonads were too small to dissect out in male prawns. The Gonado-somatic index (GSI) was used as the index of gonadal development and was calculated as follows:

$$GSI = \frac{\text{Gonadal weight}}{\text{Body weight}} \times 100$$

The initial weight of the gonad was recorded by dissecting out some prawns kept as stock animals for the experiment and they belonged to the same size group of the ones used in the experiment. The initial GSI calculated so was assumed to be the initial value for all the treatments of the experiment. After the completion of experiment, the prawns were dissected and the gonads were retrieved to take the final weight of the gonads. The water temperature, pH, dissolved oxygen content and CO_2 content of

the experimental medium were monitored during the study tenure following the standard methods (Jhingran *et.al.*, 1969). The variations in growth and GSI were tested statistically using ANOVA (Downie & Heath, 1970).

Results and Discussion

The 96 hr static median lethal concentration (LC_{50}) of endosulfan and 2,4-dichlorophenoxy acetic acid to the prawns were found to be 0.009 ppm and 0.5 ppm respectively. The earlier studies on the acute toxicity of endosulfan to different species of freshwater prawns revealed that the acute 96 hr LC_{50} values were 0.006 ppm for the post-larvae of *M. rosenbergii* (Natarajan *et al.*, 1992) and 0.005 ppm for the adults of *M. malcolmsonii* (Srinivasan and Bhasker Patibandla, 1996). The 96 hr LC_{50} value estimated for *M. rosenbergii* post-larvae exposed to the organophosphorus pesticide, malathion was 0.013 ppm (Natarajan *et al.*, 1992).

Shukla and Omkar (1984) observed the endosulfan toxicity to *M.lamarrei* and estimated the 96 hr LC_{50} value as 0.0027mg/l. Chandrasekaran *et al.* (2000) observed the 96 hr median lethal concentration of endosulfan critical to the prawn, *M. lamarrei* (size range, 25 –30 mm) as 0.005 ppm. When compared to earlier observations made by various authors for different species of fresh water prawns on their LC_{50} values for different toxicants, the variation in LC_{50} values seems to be dependant on more than one factor, such as the species, the toxicants, the size of the animals and the different environmental parameters during the experimental period. The difference in LC_{50} values of endosulfan between the present and earlier observations may be due to the difference in the size of the test animals, i.e., 40 – 50 mm in the present case and 25-30 mm in the case of previous observation.

In the present study, when the prawns were exposed continuously for 30 days in five sub-lethal concentrations of the pesticide

Table 1. Effect of the pesticide endosulfan and herbicide 2,4-dichlorophenoxy acetic acid on the growth of the prawn *M.lamarrei* (the range of values given in parenthesis)

Endosulfan					2,4 – Dichloro-phenoxy acetic acid				
	Initial weight (mg)	Final weight (mg)	Growth in 30days (mg)	Reduction/ Acceleration in growth (%)		Initial weight (mg)	Final weight (mg)	Growth in 30days (mg)	Reduction/ Acceleration in growth (%)
Control	831 (811-850)	974 (952-981)	143	-	Control	831 (813-856)	974 (951-982)	143	-
Sub - lethal Con. I (0.008 ppm)	843 (823-871)	854 (836-934)	11	92.31**	Sub – lethal Conc. I (0.4 ppm)	837 (810-854)	843 (818-855)	6	95.8
Sub – lethal Conc. II (0.007 ppm)	865 (817-914)	(897) (848-938)	32	77.62***	Sub – lethal Conc. II (0.3 ppm)	853 (823-882)	883 (841-918)	30	79.0**
Sub – lethal Conc. III (0.006 ppm)	871 (853-936)	927 (902-967)	56	60.84**	Sub – lethal Conc. III (0.2 ppm)	866 (829-883)	907 (882-961)	41	71.3*
Sub – lethal Conc. IV (0.005 ppm)	832 (802-856)	977 (903-988)	145	-1.38	Sub – lethal Conc. IV (0.1 ppm)	860 (832-945)	950 (914-986)	90	37.0**
Sub – lethal Conc. V (0.004 ppm)	820 (854-962)	977 (951-987)	157	-9.76	Sub – lethal Conc. V (0.05 ppm)	837 (817-923)	965 (911-988)	128	11.8

Values significant at P<0.05 (*), <0.01 (**) and <0.001 (***) levels.

Table 2. Effect of the pesticide endosulfan and herbicide 2,4-dichlorophenoxy acetic acid on the Gonado Somatic Index (GSI) of the prawn *M. lamarrei* (the range of values given in parenthesis)

Endosulfan				2,4 – Dichloro-phenoxy acetic acid			
	Initial GSI	Final GSI	Reduction in GS I (%)		Initial GSI	Final GSI	Reduction/ Acceleration in GSI (%)
Control	7.8 (7-9)	12 (10-14)	-	Control	7.8 (7-9)	12 (10-14)	-
Sub - lethal Conc. I (0.008 ppm)	7.8	8 (7-10.5)	95.2***	Sub – lethal Conc. I (0.4 ppm)	7.8	10.0 (9-12.5)	47.6**
Sub – lethal Conc. II (0.007 ppm)	7.8	8.2 (7-11)	90.4*	Sub – lethal Conc. II (0.3 ppm)	7.8	10.5 (9-13)	35.7**
Sub – lethal Conc. III (0.006 ppm)	7.8	9.2 (8-11)	66.6**	Sub – lethal Conc. III (0.2 ppm)	7.8	10.9 (9-13.5)	26.1*
Sub – lethal Conc. IV (0.005 ppm)	7.8	9.7 (8.2-11)	54.7**	Sub – lethal Conc. IV (0.1 ppm)	7.8	12.2 (11-13.5)	-4.76
Sub – lethal Conc. V (0.004 ppm)	7.8	10 (9-13)	47.6	Sub – lethal Conc. V (0.05 ppm)	7.8	12.3 (11-14)	-7.14

Values significant at P<0.05 (*), <0.01 (**) and <0.001 (***) levels.

and the herbicide separately, there was a distinct decline in growth and gonadal development of the prawns exposed to higher sub-lethal concentrations. The water temperature, dissolved oxygen content, carbon di-oxide content and pH levels were in the narrow range of 29-31°C, 6.0-7.2 ppm, 1-2 ppm and 6.5-7.5, respectively, during the experimental period of 30 days, and they do not seem to influence any change in the growth and survival of the test animals.

While the control animals showed normal increase in weight in 30 days the prawns exposed to sub-lethal concentrations of endosulfan and 2,4-dichlorophenoxy acetic acid suffered reduction in growth in correlation with the increase in sub-lethal concentrations of the toxicants (Table 1). The reduction in growth was estimated to be the highest in the sub-lethal concentration-I (0.008 ppm), moderate at 0.007 ppm and low at 0.006 ppm of endosulfan. However, in sublethal concentration-IV (0.005ppm) and V (0.004 ppm), there was an increase in growth of the prawns as compared to that of the control (Table 1). In the case of prawns exposed to the sub-lethal concentrations of 2,4- dichlorophenoxy acetic acid, they showed greater reduction in growth in the highest sub-lethal concentration (0.4 ppm) and minimum reduction in the lowest concentration of 0.005 ppm. Chandrasekaran *et al.*, (2000) observed the maximum reduction (45.01%) in growth of the prawn when they were exposed to the highest sub-lethal concentration of endosulfan for 30 days.

In the present study, it was observed that in higher sub-lethal concentrations of endosulfan there was a great reduction in GSI also. The reduction in GSI was not so significant in lower concentrations of the pesticide. However, in the case of 2,4-dichlorophenoxy acetic acid, the prawns exposed to the sub-lethal concentrations 0.1 ppm and 0.05 ppm showed an increase in GSI as compared to that of the control (Table 2). The increase in growth and gonad size in lower concentration of the toxicants may be due to the acceleration in metabolic

activity of prawns in lower sub-lethal concentrations of toxicants as also observed earlier by Cantelmo *et al.* (1978) and Chandrasekaran *et al.* (2000). The reduction in growth of the prawn up to 92.31% and 95.8% and the reduction in gonadal development up to 95.2% and 47.6% due to endosulfan and 2, 4- dichlorophenoxy acetic acid respectively, was observed in this study and it is a matter of concern for water quality management in culturing this species. However, the ill effects of the chemicals are to be confirmed by conducting investigations at the field level *in situ* in the prawns stocked in the ponds.

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