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IMPACTS OF PESTICIDE ON THE PHYSICO-CHEMICAL VARIABLES AND ZOOPLANKTON ABUNDANCE OF *ARGULUS* SP. MÜLLER INFECTED BROOD CARP POND

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Abstract

The study describes the impacts of organophosphate pesticide sumithion on physico-chemical variables and abundance of zooplankton of a commercial brood fish pond where the pesticide was used at monthly intervals to control the infection of *Argulus* sp. Compared to a control brood fish pond, notable differences were found in the monthly range of transparency, DO, free CO_2, hardness, ammonia nitrogen, nitrate-N and in monthly abundance of rotifers, nauplius, copepods, and cladocerans of the treated pond. The monthly range of transparency, pH, DO, free CO_2, alkalinity, hardness and ammonia nitrogen and nitrate-N varied from 15.5 to 29 cm, 7.5 to 9.5, 4.3 to 5.8 mg/l, 12.9 to 20.6 mg/l, 65 to 120 mg/l, 81 to 126 mg/l and 0.4 to 1.5 mg/l, 0.01 to 0.08, respectively in the treated pond, while in the control pond they varied from 22.1 to 30.1 cm, 7.2 to 8.5, 5.9 to 8.3 mg/l, 8.2 to 12.5 mg/l, 102 to 245 mg/l, 159 to 216 mg/l, 0.2 to 0.7 mg/l, 0.02 to 0.04 mg/l, respectively. The monthly abundance of rotifers, nauplius, copepods, cladocerans and ostracods varied from 425 to 1255 indiv/l, 10 to 100 indiv/l, 15 to 55 indiv/l, 5 to 40 indiv/l and 30 to 50 indiv/l in the treated pond, while they varied from 925 to 4320 indiv/l, 150 to 450 indiv/l, 50 to 260 indiv/l, 55 to 220 indiv/l and 20 to 200 mg/l in the control pond. The physico-chemical status and zooplankton abundance of the control pond indicate that the pesticide application considerably deteriorated the quality of water and decreased the zooplankton abundance of treated pond.

Introduction

Larval and adult stages of many aquaculture species grow well on the live animal foods, especially zooplanktonic organisms.(1) Plankton has been identified as the nutritional source available to the fish from nature.(2) In a carp pond, zooplankton have a net positive effect.(3) So, the abundance of zooplankton and water quality are critical factors, which indicate the biological productivity of a pond ecosystem.

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Argulosis, a lethal disease of freshwater fishes caused by the branchiuran ectoparasite *Argulus* sp. become major problems in brood carp rearing ponds of different hatcheries. To combat the Argulosis an array of chemicals and pesticides are being used by the farmers on trial and error basis as Argulosis continues to persist. In addition, these pesticides are easily available from the local retail market, which led to the indiscriminate use by the fish farmers in Bangladesh.(4,5)

So far, a large number of limnological work have been carried out by many researchers in different parts of the world; however in Bangladesh, notable work have been done.(6-14) But, a few work have been done to study the impacts of pesticides on zooplankton in relation to physico-chemical variables of a pond water. Mention may be made to the research(15) in which toxicity of organophosphate pesticides was assessed on the zooplanktons and the results showed that those pesticides were very lethal on them. The present study was aimed to assess the impacts of pesticides on zooplankton as well as on the physico-chemical variables of a pesticide treated pond water compared to a control pond.

Materials and Methods

The study was conducted from January to December, 2002 in two ponds *viz.* one pesticide treated pond with an area of 0.298 ha (Pond No. 3) and one control pond with an area of 0.295 ha (Pond No. 7) at BCDM (BRAC Center for Development Management) hatchery at Rajendrapur near Dhaka city. Both the ponds received water from ground sources and similar amount of fertilizer, lime and feed for fish as required. Both the ponds were of 1.55 m deep. The pesticide - sumithion 50 EC was supplied by Shetu corporation, Dhaka. Pesticide solutions were made by adding the requisite amount of the pesticides, calculated in terms of active ingredient, to pond water. During the study period, 0.125 ppm pesticide was used for six months (January to June, 2002) and 0.250 ppm was used for the next six months (July to December, 2002) as the prevalence of infection was very high in the month of July. Physical variables : temperature was determined by centigrade thermometer, transparency by Secchi disc and chemical variables were measured by using HACH's universal aquaculture testing kit, Model No. FF-2, USA as per instructions provided in the manual. Abundance of zooplanktons were studied by taking two samples from three stations of each pond; one after 6 hours of pesticide application and the other after 7 days of application of pesticide. Samples were collected from the pond by filtering 50 litres of sub-surface water (10 cm below the surface) through the plankton net made of silk bolting cloth No. 25. The filtrate containing the plankton was transferred to a 50 ml plastic bottle and preserved immediately in 5% formalin and the enumeration of the zooplankton was done by using Sedgwick-Rafter

Cell placed in a compound microscope.[16, 17] Zooplanktons were identified following Bhouyain and others.[16-20]

Results and Discussion

Physico-chemical parameters : The physico-chemical variables of the treated and the control pond has been presented in the Table 1. The water temperature in both ponds on the sampling dates ranged from a minimum of 18.70^{0}C in January to maximum of 27.65^{0}C in May having no noticeable variation between the ponds. It was observed that the water transparency (Secchi depth) of the treated pond ranged from 15.5 to 29 cm while it ranged from 22.1 to 30.1 cm in the control pond. The pH values of the treated pond ranged from 7.5 in February to 9.5 in April while it ranged from 7.2 in February to 8.5 in control pond in July showing alkaline nature of the water. Dissolved oxygen (DO) content of the treated pond water varied from 4.3 mg/l in July to 5.8 mg/l in January. The water of control pond was richer in DO, which ranged from 5.9 mg/l in May and 8.3 mg/l in August. Free CO_2 in the treated pond varied from 12.9 mg/l to 20.6 mg/l whereas in the control pond the condition was better (8.2 - 12.5 mg/l). The total alkalinity of water in treated pond fluctuated from 65 to 120 mg/l while in control pond it varied from 102 mg/l (December) to 245 mg/l (June) which indicate better water quality of the control pond. Hardness of water was also higher (159 to 216 mg/l) in the control pond than the treated pond (81 to 126 mg/l). The concentration of ammonia nitrogen in treated pond (0.4 - 1.5 mg/l) was quite higher than that of control pond (0.2 - 0.7 mg/l) indicating better status of the water. The concentration of nitrate N was higher in the treated pond having 0.01 - 0.08 mg/l, whereas in the control pond it ranged from 0.02 - 0.04 mg/l.

Analysis of variance shows that except water temperature and nitrate-N, all other physico-chemical variables were significantly different ($p < 0.05$). It may be mentioned here that the physico-chemical parameters of the underground water used in the ponds before pesticide application ranged between: temperatures 25 - 27^{0}C, pH 7.2 - 8.4 mg/l, DO 6.4 - 7.3 mg/l, free CO_2 11.5 - 14.4 mg/l, alkalinity 105 - 190 mg/l, hardness 155 - 220 mg/l, ammonia nitrogen 0.2 - 0.3 mg/l and Nitrate-N 0.01 - 0.02 mg/l. So, water quality in the pesticide treated pond deteriorated quite significantly while the physico-chemical status of the control pond was more or less in closer range with the supplied water. Overall, the quality of water in the control pond was better than the pesticide treated pond, particularly in respect of transparency, DO, free CO_2, alkalinity, hardness and ammonia nitrogen where no pesticide was used. But later on water quality in the treated pond might have deteriorated due to regular use of pesticides.

Table 1. Monthly fluctuations of physico-chemical variables in treated and control ponds.

Months	Temperature (^{0}C)		Transparency (cm)		pH		DO (mg/l)		Free CO_2 (mg/l)		Alkalinity		Hardness (mg/l)		Ammonia-N (mg/l)		Nitrate-N (mg/l)	
	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C
Jan.	18.90	18.70	15.5	22.1	8.5	7.4	5.8	7.3	18.6	10.5	95	145	90	162	1.4	0.3	0.05	0.02
Feb.	22.50	21.80	27.0	28.0	7.5	7.2	4.5	8.1	21	11.7	93	174	109	192	1.4	0.5	0.03	0.03
Mar.	24.25	24.05	29.0	32.0	9	7.8	5.4	6.9	17	11.0	110	120	95	188	1.2	0.3	0.04	0.02
Apr.	25.80	26.40	28.0	30.1	9.5	8.1	5.6	7.8	16.9	9.3	70	167	102	205	1.2	0.2	0.03	0.02
May	27.65	27.25	24.0	28.4	8.5	7.4	5.4	5.9	17.9	8.2	90	210	89	177	1.3	0.6	0.04	0.03
June	26.60	26.60	23.0	27.7	8	7.9	5.5	7.3	14.5	9.4	105	245	115	198	0.4	0.5	0.01	0.04
July	27.60	27.55	21.2	26.9	8.9	8.5	4.3	6.1	20.6	8.7	65	232	81	216	1.4	0.7	0.08	0.02
Aug.	27.50	27.40	21.5	27.5	8.6	8.2	5.1	8.3	15.1	10.3	90	190	105	159	0.8	0.3	0.02	0.04
Sept.	25.60	25.45	22.7	27.2	8.1	7.9	5.4	7.5	12.9	10.1	115	115	126	186	0.9	0.2	0.02	0.03
Oct.	24.45	24.40	21.1	28.3	8.4	8.0	4.6	7.9	19.3	12.5	76	154	105	175	1.5	0.4	0.06	0.02
Nov.	23.40	23.45	21.3	29.0	8	7.4	4.9	6.2	17.2	9.8	110	175	112	201	1.1	0.2	0.02	0.03
Dec.	20.10	20.10	24.0	27.5	8.2	7.6	5	5.4	16.8	10.1	120	102	118	181	0.6	0.3	0.03	0.03

T = Treated pond (Pond No. 3). C = Control pond (Pond No. 7).

Abundance of zooplankton : The monthly fluctuations of abundance of different zooplanktons have been presented in the Table 2. Rotifers occupied the top position in their abundance being followed by nauplius, cladocerans, copepods and ostracods in both the ponds. The abundance of rotifers in the treated pond was lowest in the month of July (425 mg/l) and highest in the month of April (1255 indiv/l), while it was lowest (925 indiv/l) in the month of August and highest in the month of April (4320 indiv/l) in the control pond. Begum *et al.*[21] observed higher rotifers abundance in a semi-intensively fishpond in April. The abundance of nauplius in the treated pond fluctuated from 10 indiv/l in July to 100 indiv/l in April while in the control pond, the abundance fluctuated from 150 indiv/l in August to 450 indiv/l in February and May.

Table 2. Monthly fluctuations in the abundance of zooplanktons (indiv/l) of treated and control ponds.

Months	Rotifers		Nauplius		Cladocerans		Copepods		Ostracods	
	T	C	T	C	T	C	T	C	T	C
January	950	1825	20	200	25	250	40	225	00	00
February	800	1920	55	450	35	135	45	130	00	200
March	720	1520	25	225	30	50	45	55	00	00
April	1255	4320	100	310	35	145	55	75	50	150
May	865	2710	35	450	40	260	45	145	00	50
June	925	1525	25	350	30	130	50	110	30	50
July	425	1360	10	250	05	125	15	20	00	00
August	220	925	25	150	25	70	40	25	00	00
September	620	1055	20	300	35	120	25	25	00	20
October	555	1210	30	250	15	250	25	110	00	00
November	510	1045	20	400	15	300	35	150	00	50
December	615	1425	15	350	25	320	25	135	00	150
Average	8460	20840	390	3685	335	2155	455	1205	180	805

T = Treated pond (Pond No.3). C = Control pond (Pond No. 7).

The abundance of cladocerans was lowest in July (05 indiv/l) and highest in May (40 indiv/l) in the treated pond while the lowest (50 indiv/l) in March and highest (320 indiv/l) in December in the control pond. Patra and Azadi [22] from Bangladesh and Khan and Siddiqui[23] from India found highest peak of cladocerans in natural water body during winter. The abundance of copepods in the treated pond was highest (55 indiv/l) in the month of April and lowest (15 indiv/l) in the month of July. But the abundance of copepods in the control pond was highest (225 indiv/l) in the month of January and lowest (20 indiv/l) in the month of July followed by slight increase (25 indiv/l) in August and September. Chowdhury *et al.*[24] noted the peak abundance of copepods in January. Ostracods were observed to be a minor group of zooplankton in both the ponds. Ostracods were recorded in the month of April and May in the treated pond while in the control, they occurred in the month of February, April, May, June and December with a peak in February (200 mg/l). Habib *et al.*[25] and Hasan *et al.*[26] observed no ostracods in a natural fish pond in Mymensingh and Dhanmondi lake, Dhaka, respectively while Chowdhury *et al.*[24] found peak abundance of ostracods in April followed by August, January and October in a semi-intensive pond in Dhaka. So, the abundance of ostracods in the control pond resembles to some extent with that of observed by Chowdhury *et al.*[24]

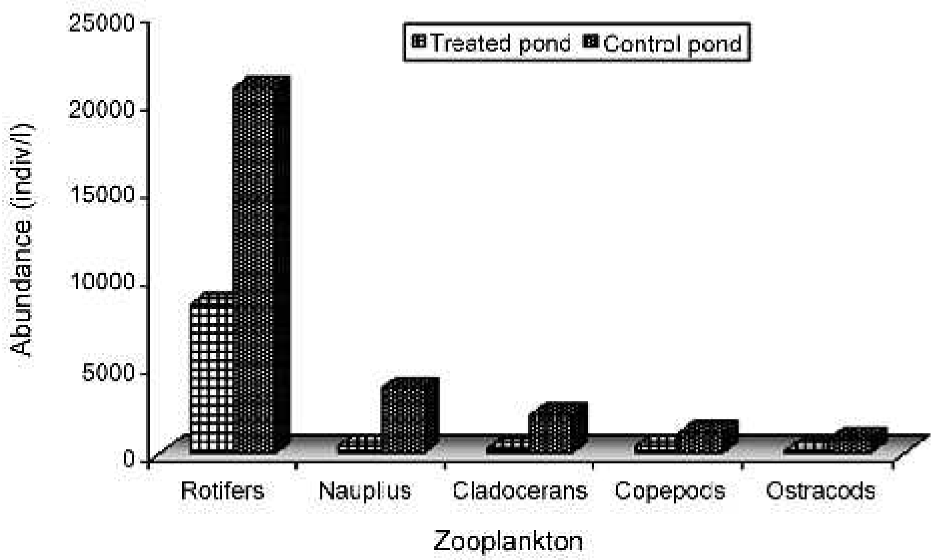

Fig. 1. Fluctuations of zooplankton (indiv/l) in both ponds.

It has been noted that the abundance of nauplius, cladocerans, copepods and ostracods considerably reduced in the month of July when the doses of pesticide were increased from 0.125 to 0.25 ppm. While in the control pond, the abundance of zooplankton fluctuated as like other natural water body. Average fluctuations of zooplanktons of both ponds have been presented in Fig.1 which explains also the differences of different kinds of zooplankton.

From the analysis of variance table (Table 3), it may be concluded that the zooplanktons affected in the degree of nauplius > cladoceransns > rotifers > copepods > ostracods. Prasad and Padmavathi[15] observed that due to the application of organophosphate pesticide cladocerans were first affected followed by rotifers, copepod larvae and their adults. So, from the above discussion, it is clear that the abundance of the control pond was in normal range whether it decreased in the treated pond due to the application of sumithion.

Table 3. ANOVA table for abundance of different kinds of zooplankton of treated and control ponds.

Variables	Sources of variation	SS	df	MS	F (Calculated)	F (Tabulated)
Rotifers	Between groups	6386017.0	1	6386017.0	13.12073	4.300944
	Within groups	10707667.0	22	486712.1		
Nauplius	Between groups	455126.0	1	455126.0	91.74282	4.300944
	Within groups	109139.6	22	4960.89		
Cladocerans	Between groups	141066.7	1	141066.7	33.46807	4.300944
	Within groups	92729.17	22	4214.96		
Copepods	Between groups	24066.67	1	24066.67	11.92604	4.300944
	Within groups	44395.83	22	2017.99		
Ostracods	Between groups	14504.17	1	14504.17	5.4678	4.300944
	Within groups	58358.33	22	2652.65		

As plankton production directly influences the production of fish, the long-term pesticide application should be reduced or discontinued. Pesticide could reduce the plankton abundance as well as destroy the pond ecology which might make the pond unfit for fish production. So, mechanical control measure like use of bamboo splits for destroying eggs of *Argulus* sp. and biological control measure like culturing scale feeder freshwater Chanda fish (*Chanda nama*) with the major carps should be practiced. Also, the toxic effects of sumithion to the major carps should be studied.

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