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Study on the Zooplankton Production in Ponds Under Different Fish Farming System in West Bengal

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ABSTRACT

The present study was designed to estimate zooplankton abundance qualitatively and quantitatively in different Fish-Livestock Integrated Farming Systems (FLIFS) over the Non Integrated Fish-Livestock Farming System (NIFLFS) in Terai region of West Bengal. Three treatments in triplicates for four consecutive years (2008-2011) were studied in Belacoba village of Jalpaiguri district involving nine pond of 0.01hectare (ha) namely, NIFLFS (Control): The aquaculture was not integrated with the animal waste, FLIFS -I: Integration of cattle manure with aquaculture and FLIFS -II: FLIFS-I+ ducks grazing on the ponds. Zooplankton samples were collected bimonthly from the treated ponds for the analysis (qualitatively and quantitatively). Ponds under FLIFS-II and FLIFS-I were found to contain significantly higher concentration of zooplanktons (131±12 no l^{-1} and 128±11 no l^{-1} , respectively) than NIFLFS (27 ± 2 no l^{-1}). The identified zooplanktons were under 4 orders namely copepoda, rotifera, cladocera, and Diaptomus. Dominant groups of the zooplankton available in all the samples were observed to be Copepoda and Cladocera represented by *Cyclops sp.*and *Daphnia sp.*, respectively. Total seven and six species were identified in the FLIFS-II and FLIFS-I, respectively in comparison to the four species in NIFLFS. In the present study the Daphnia was also significantly increased by 32.8% and 31.8% in FLIFS-I and FLIFS-II, respectively, where frequently manure was applied. Again *Bosmina* sp. was observed to be contributing in the FLIFS-II where ducks are grazing and the duck droppings are introduced in the ponds. Hence, it was concluded that utilization of cow dung and duck manure for aquaculture can successfully increase the availability and diversity of the natural food (zooplankton) to support the growing fishes under the integrated fish farming systems followed in the terai region of West Bengal.

Key words: Zooplankton, Integrated Fish Farming, Indian Major Carp, Grass Carp (*Ctenopharyngodon idella*), Organic Manure, West Bengal.

INTRODUCTION

The plankton community is composed of phytoplankton (primary producers) and zooplankton (secondary producers). The phytoplankton presents biological wealth of the water body and form the base of food chain in ponds (Pokorny *et al* 2005). Zooplankton is a principal component of food for omnivorous fish that are usually farmed in extensive aquaculture (Brummett and Noble, 1995). Ekelemu (2010) emphasized on the fact that zooplankton is very important in the food web of open water eco system. Damle and Chari (2011) observed that lack of zooplankton caused poor survival of spawn in nursery ponds. The zooplankton is commonly divided to following groups Rotifers (Rotatoria), Cladocerans (Cladocera) and Copepods (Copepoda). Composition of

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zooplankton is in close relation to farmed fish and the presence of suitable zooplankton species is essential for successful farming (Kalous *et al* 2009).

Abundance of planktons supported large population of fish species, Jhingran (1991) reported that organic manuring results higher zooplankton densities in the ponds. Hence, it can be concluded that zooplankton population improved with the application of the manure maintaining the water quality favourable for fish production. Poultry manures was found to release soluble salts continuously, resulting in high production of zooplankton (Gaur and Chari, 2007). Sasmal *et al* (2008) suggested that duck excreta was good source of nutrients, easily soluble in water and available for plankton production. Ekelemu and Nwabueze (2011) revealed that poultry droppings, compared to cow dung and pig dung, produced more zooplankton. Rahman *et al* (2006) reported that the IMC and Grass Carp prefer to feed on zooplanktons.

In the present study, the quantitative and qualitative analysis of the zooplankton was done focusing on the composition of zooplankton and evaluation for its suitability as food source for (IMC) and Grass Carp within different integrated fish farming system in Terai region of West Bengal.

MATERIALS AND METHODS

The research place, Belacoba, was selected randomly within the Terai region of West Bengal. It was situated in latitude 26°58´N and longitude 88°58´E. The area has a sub tropical humid climate and situated at 43 m above mean sea level having sandy loam soil. The average annual rainfall of this area remains within 2200-2700 mm and average minimum and maximum temperature ranges from 18.50-20.82°C and 28.51- 31.51°C, respectively.

The field experiment was conducted from the month of April to September during four consecutive years from 2008 to 2011, as the ponds in this area were mostly seasonal and shrinking in nature. The water in the pond generally stayed from April to September or October depending on the rainfall. Nine ponds (0.01 ha) with depth of 1.5 to 2 m were selected randomly from the village to carry out different fish farming system. In this study, considering judicious exploitation of all the niches available in the ponds, Composite fish farming (four species culture) was done with Indian Major Carp (IMC) as *Catla catla, Labeo rohita* and *Cirrhina mrigala* and Exotic Carp as *Ctenopharyngodon idella.* The *Ctenopharyngodon idella* (Grass Carp) was considered along with IMC as the semi-digested excreta of herbivorous fish could be utilised to fertilise the water and produce plankton for filter-feeding fish to consume (Martin *et al* 2005).

Three treatments namely, NIFLFS (Non Integrated Fish Livestock Farming System), FLIFS-I (Fish Livestock Integrated Farming System-I) and FLIFS-II (Fish Livestock Integrated Farming System-II) in triplicate. The summary of the treatment designs under different farming systems are given in Table 1.Under NIFLFS the aquaculture was not integrated with any manure and was considered as Control. In FLIFS-I aquaculture was integrated with cow dung. Additional ducks were integrated along with cow dung in FLIFS-II.

Samples of zooplanktons were collected bimonthly from April to September of each year with plankton net made of standard bolting silk cloth (No.21 with 77mesh/cm²). About 10 l of water was collected randomly from selected locations and pooled together for filtering through the plankton net. Collected plankton were concentrated to 20ml, and preserved in 4 per cent formalin for further estimation. Qualitative and quantitative determination of zooplanktons was made under binocular compound microscope (Magnus make) using 1 ml concentrated solution preserved sample. Sedgwick-Rafter Counter Cell was used to count the planktons. The numbers were expressed as number/l. The zooplanktons were identified with the aid of Needham and Needham (1962), Edmondson (1992) and Battish (1992) methods.

RESULTS AND DISCUSSION

Quantitative analysis

The quantitative study of zooplanktons was found to be significantly different in the FLIFS-I , FLIFS-II and NIFLFS. Ponds under FLIFS-II and

Table 1. Summary of the treatment designs under different farming system.

Treatment	NIFLFS(Control)	FLIFS-I	FLIFS-II
Components of farming	**Fish , cow and crop**	**Fish , cow and crop**	**Fish ,cow , duck and crop**
Type of farming	**Non-integrated**	**Integrated**	**Integrated**
No. of ponds	**3**	**3**	**3**
Average size of pond(ha)	0.01	0.01	0.01
Manuring	No manuring	Manuring @ 2600kg/ ha / ten days with cowdung	Manuring @ 2600kg/ ha / ten days with cowdung Manuring
Stocking density of fingerlings/ha	10,000	10,000	10,000
Types of fish stocked	IMC+Grass carp	IMC+Grass carp	IMC+Grass carp
Stocking ratio	3:3:3:1	3:3:3:1	3:3:3:1
Fish feeding schedule (on daily basis)	@ 2% of total body weight with Mustard oil cake and Rice Bran (1:1)	@ 2% of total body weight with Mustard oil cake and Rice Bran (1:1)	@ 2% of total body weight with Mustard oil cake and Rice Bran (1:1)
Type/No. of Cattle per pond	Non descriptive type, 1 lactating cow	Non descriptive type, 1 lactating cow	Non descriptive type, 1 lactating cow
System of cattle rearing	**Extensive**	**Semi extensive**	**Semi extensive**
Feeding schedule of cow	12 hours grazing with 3-4kg paddy straw	6 hours grazing and Concentrate feed and green grass along with paddy straw	6 hours grazing and Concentrate feed and green grass along with paddy straw
System of duck rearing	**Nil**	**Nil**	**Extensive**
Type/No. of ducks per pond	Nil	Nil	Non descriptive type, 20 Ducks of 22 wks of age
Type of crop cultivated	Turmeric plant (Patnai Variety)	Turmeric plant (Patnai Variety)	Turmeric plant (Patnai Variety)
System of cultivation	Separately on agricultural field	On pond dykes utilizing pond bottom soil	On pond dykes utilizing pond bottom soil
Duration of Study	2008-2011(4 years)	2008-2011(4 years)	2008-2011(4 years)
Harvesting of Fish	After 150 days of stocking	After 150 days of stocking	After 150 days of stocking

Table 2. Mean ± SE of zooplankton parameters under different treatment

Parameters	Treatments	Mean ± S.E.
Zooplankton	NIFLFS	27 ± 2[a]
	FLIFS-I	128 ± 11[b]
	FLIFS-II	131 ± 12[b]

Different superscript (a, b and c) bears significant difference in the mean value.

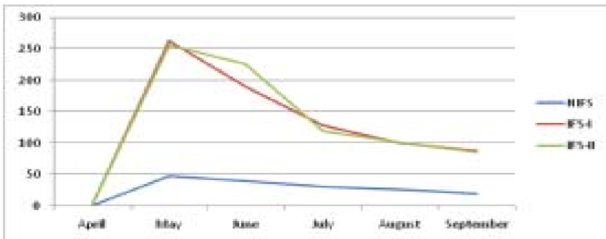

Fig 1. Trend of total Zooplankton production in the pond water during the study period from April to September under NIFLFS, FLIFS-I and FLIFS-II

Table 3. Diversity of zooplankton and the relative abundance in NIFLFS, FLIFS-I and FLIFS-II.

Group	Species	Relative abundance (%)		
		NIFLFS	FLIFS-I	FLIFS-II
Cladocera	*Diaphnia* sp	11.8	44.6	43.6
	Moina sp	19.4	43.3	37.3
	Bosmina sp	0	0	100
Rotefera	*Brachionus* sp	9.8	55.2	34.9
	Keratella sp	0	59	41
Copepoda	*Cyclops* sp	17	43.7	39.9
Diaptomus	*Diaptomus*	0	63.6	36.4

FLIFS-I were found to contain significantly higher concentration of zooplanktons (131±12 no l^{-1} and 128±11 no l^{-1} , respectively) than NIFLFS (27 ± 2 no l^{-1}) as presented in Table 2. This indicates that the organic manures in the ponds had positive effect on zooplankton production. Jha *et al* (2004) also found that application of both cow dung and poultry manure at the rate of 0.26kg/m²/10 d is most suitable for better growth of Koi Carp in tanks through maintenance of better water quality and greater abundance of plankton in the system. There was also significant difference in the mean zooplankton production under different farming system throughout the summer and rainy season. A pattern of sharp increase in the zooplankton production up to May month was observed in all the three treatments (Fig-1). June month onwards the zooplankton count was observed to be decreasing sharply in the rainy season. This may be due to the increased intake of zooplanktons by the growing fishes in the pond.

Qualitative analysis

The qualitative analysis of zooplanktons was done and identified zooplanktons under 4 orders namely Copepoda, Rotifera, Cladocera, and Diaptomus. Dominant groups of the zooplankton available in all the samples were observed to be Copepoda and Cladocera represented by *Cyclops sp.*and *Daphnia sp.*, respectively. The population of the same was observed to be increased in the samples of FLIFS-I and FLIFS-II indicating that manure had favorable effect on the Copepoda and Cladocera. However, Okonji and Obi (1999) in their study agreed that organic fertilizer produced more of the smaller-size zooplanktons (Rotefers, Cladocerons) while inorganic fertilizer favoured the production of larger-sized zooplanktons (Copepods). Rappaport *et al* (1977) reported a general increase in the contribution of Rotifers to zooplankton in ponds manured with chicken droppings and cereals manure but the dominance of Copepods were observed in controls and the ponds receiving liquid cowdung. On the contrary, Dhawan and Kaur (2002) reported a decrease in Cladoceran population with increased organic manure application. Ekelemu and Nwabueze (2011) observed that cow dung produced more Rotifers and poultry droppings produce more Cladocera.

The species diversity of zooplankton and the relative abundance in NIFLFS, FLIFS-I and FLIFS-II are presented in Table-3. Total seven and six species were identified in the FLIFS-II and FLIFS-I, respectively in comparison to the four species in NIFLFS. This result indicates that cow dung combined with duck grazing had positive effect on the diversity of the zooplankton species in the cultured pond which is in agreement with Singh and Sharma (1999). In the present study the Daphnia was significantly increased by 32.8 per cent and 31.8 per cent in FLIFS-I and FLIFS-II, respectively, where frequent manure was applied. *Bosmina* sp. was observed to be contributing in the FLIFS-II where ducks were grazing and the duck droppings were introduced in the ponds. Sasmal *et al* (2008) suggested that duck excreta was good source of nutrients, which were easily soluble in water and available for plankton production.

CONCLUSION

In the present study it was found that ponds under FLIFS-I and FLIFS-II the zooplankton production was significantly higher than NIFLFS. This clearly indicated that utilization of cow dung and duck manure for aquaculture can successfully increase the availability of the natural food to support the growing fishes in the integrated fish farming systems followed in the terai region of West Bengal and thus can help to reduce the feed cost. It was also observed that from April to May there was sharp increase in the availability of the zooplankton but June onwards continuous decreasing trend was followed along with the growing fishes in the cultured ponds. The findings of the present study will help to improve the management strategies of the ponds culture under different farming system so that the input cost can be reduced by the utilization of the farm wastes which interns can control environmental pollution.

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