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Article

Growth evaluation of all male prawn and tilapia in ponds of northern Bangladesh

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Abstract: Freshwater aquaculture is by far the most ancient aquatic living resource production system known in the world. An experiment was conducted to evaluate the growth performance of prawn and tilapia (male) under different sex (male and female) contribution of prawn in polyculture ponds for a period of four months from September 2010 to December 2010. The experiment was designed with 3 treatments like T_1 (All male Tilapia– 4938/ha + All male Prawn 19,753/ha), T_2 (All male Tilapia – 4938 / ha + All female Prawn 19,753/ha) and T_3 (All male Tilapia – 4938/ decimal + all male Prawn 19876 + all female prawn 19876/ha), each with 2 replications. The mean stocking weight of prawn was 2.87 g and that of tilapia was 37.36 g. Total stocking density of prawn and tilapia (24,691/ha), basal fertilization (Cowdung 2470kg/ha, Urea 50kg/ha and TSP 50kg/ha), periodic fertilization (Cowdung 50kg/ha/day, urea 1.25kg/ha/day and TSP 1.25kg/ha/day) and feeding regime (diet containing 30% protein level at the rate of 2-5% of prawn and fish body weight twice daily) were same for all the treatments. Water quality parameters (water temperature, transparency, dissolved oxygen, pH, NH_3-N and alkalinity) were monitored fortnightly and the growth parameters were monitored monthly. Mean values of water quality parameters were found within the suitable range. Treatment T_1 varied more significantly ($P<0.05$) than that of others for the mean values of growth parameters (final weight, weight gain, SGR, survival rate and yield) of prawn and tilapia.

Keywords: weight gain; survival rate; yield; prawn; male

1. Introduction

Semi-intensive culture has been the most common production system for *M. rosenbergii* in Southeast Asia (Lee and Wickins, 1992; D'Abramo and New, 2000). Within the overall agro-based economy in Bangladesh, freshwater prawn farming has become an important subject to the rural peoples for their livelihood, to the enterprises and its development has attracted considerable attention for its export potential and to the researchers for searching new technologies in Bangladesh.

The prawn sector as a whole is the second largest export industry after readymade garments, generating US$ 630.24 million annually and 2.01% of the total value of exports (Export Promotion Bureau, Bangladesh, 2014).

Despite the growth of this sector, a number of issues are important for freshwater prawn farming in Bangladesh including production technology, socio-economic and environmental aspects- all of these are important parameters of sustainability. Mixed culture of all male prawn with all male tilapia is found more feasible over the monoculture technique because monoculture of prawn possesses a number of problems. The production technology of all male prawn with all male tilapia culture is not practiced with a long history as compared to the indigenous technology of *gher* farming developed in southwestern Bangladesh. Stocking density of 15000

monosex tilapia and 20,000 prawn/ha increased the total production and contributed to earn higher profit (Islam *et al.*, 2016). Numerous mono-sex tilapia culture farmer of Thailand have also begun stocking shrimp and/or prawn as an additional species and inversely it is now common place for inland shrimp and prawn farmers to stock tilapia in their culture systems and both instances this development appears to be a response to declining profit margins (in the case of tilapia farmers this is due to inflationary pressure on feedstuffs which modest increases in the market value of the fish had been unable to make up for), and has the added benefit of providing some measure of biological control through the removal of detritus and uneaten feeds (Belton and Little, 2008).
Although having a day-by-day increase of prawn farming units in one of the larger prawn producer country like Bangladesh, the processing units are not getting the satisfactory level of raw materials. This means that efforts are necessary in our research system to increase the prawn farming in pond under different agro-ecological zones (Hossain and Akhteruzzaman, 2006).
It is observed from several studies that prawn farming with carps, tilapia, mola and various fish species was done in different ecosystems. However, ecosystems are not same for all areas. Most of seasonal ponds are located in Northern region of Bangladesh indicating to emphasize in farming of short cycle species in this region. The research work of mono-sex tilapia farming and prawn based poly-culture with surface feeding carps had been done successfully in this region but the research of all male prawn with all male tilapia had not been done. It is also reported that the growth rate of male prawn is higher than female prawn (Hang *et al*., 2006). So, this work will be useful for further development of leading prawn producing country like Bangladesh. Under these circumstances effects of introducing all male prawn in all male tilapia-farming ponds are studied in northern Bangladesh.

2. Materials and Methods

2.1. Location and duration of the study

The experiment was conducted for a period of 04 months from September, 2010 to December, 2010 in experimental pond's (mean water area of 0.00138 ha and depth of 1 m) under the Department of Fisheries, University of Rajshahi. All the ponds were well exposed to sunlight.

2.2. Experimental design

The present experiment was conducted with three treatments of sex combinations of prawn and tilapia namely T_1 (All male tilapia-4,938/ha+ All male prawn 19753/ha), T_2 (All male tilapia- 4,938/ha+ All female prawn 19753/ha) and T_3 (All male tilapia- 4938/ha+ All male prawn 9,876+ All female prawn 9,876/ha) each with two replications. Mean stocking weight of prawn (0.85 g), Tilapia (3.36 g) and total stocking density (24,691/ha) were same for all the treatments.

2.3. Pond management

Aquatic weeds were removed from all the ponds manually. Predatory fish and other unwanted species were removed through repeated netting. Liming was done at a rate of 250 kg/ha before 7 days of fertilization. All the ponds were fertilized with cowdung (2000 kg/ha), urea (50 kg/ha) and TSP (50 kg/ha) as basal dose.
Shelter /refuges in the form of dried branches of bamboo (247number/ha) were provided in all the ponds for the prawn.
All the ponds were stocked with tilapia fingerlings and prawn juveniles after 7 days of basal fertilization. Tilapia (*O. niloticus*) fingerlings were stocked at morning whereas the prawn (*M. rosenbergii*) juveniles were stocked at the evening. Prawn juveniles were collected from BRAC hatchery, Bagerhat and tilapia fingerlings were collected from local fish farmers.
All the ponds were fertilized with cowdung (50 kg/ha), urea (1.25 kg/ha) and TSP (1.25 kg/ha) as a fortnightly basis. Ponds belonging to all the treatments were subjected to the same feeding regime (diet containing 30% protein twice daily at the rate of 5%, 4%, 3%, 2% of body weight of prawn and fish for 1st, 2nd, 3rd and 4th month respectively). Feeding was done two times a day, one was morning and other was evening.
Sampling for monitoring the water quality parameters was done fortnightly within 08:30-09:30 am. Sampling for the growth monitoring of prawn and fishes was done monthly. In each month 10% of the stocked fishes/prawn were caught from each pond with the help of a cast net to monitor the growth of fish/prawn and to adjust the feeding ration.

2.4. Water quality monitoring

A centigrade thermometer within the range of 0°C to 120°C was used to record the water temperature. The temperature of water was recorded by dipping the thermometer at the depth of 20 to 30 cm below the surface. Similar process was followed three times and finally average value was recorded as pond water temperature.

A secchi disc was used for the measurement of water transparency. The secchi dise was slowly lowered into the water on a graduated line and the depth at which it became invisible was noted. The sinking of the disc was always viewed under a sunshade for considerable accuracy in result. The data, thus obtained were expressed as secchi disc depth in cm.

The negative logarithm of the hydrogen ion concentration or pH of pond water was measured by the help of a pH indicator paper (LOGAK, Korea).

Dissolve Oxygen (mg/l) ammonia-nitrogen (mg/l) and alkalinity (mg/l) of water was determined by the help of a water quality test kit (HACH kit, FF-2, USA). The concentration of ammonia-nitrogen was expressed in milligram per liter (mg/l) of water.

2.5. Fish/prawn growth monitoring

The following parameters were used to evaluate the growth performance of fish/prawn under different treatments.

1. Specific Growth Rate (SGR, % bwd^{-1})

$$= \frac{L_n \text{ final weight} - L_n \text{ initial weight}}{\text{Culture period}} \times 100$$ (Brown, 1957).

2. Weight gain (g) = Mean final weight - Mean initial weight.
3. Survival rate (%)

$$= \frac{\text{No of fish harvested}}{\text{No of fish stocked}} \times 100$$

4. Final weight (g) = Weight of fish at harvest
5. Yield (kg/ha) = Fish/prawn biomass at harvest-fish/prawn biomass at stock.

2.6. Statistical analysis

All the data were subjected to ANOVA (Analysis of Variance) using a computer software SPSS (Statistical Package for Social Science). The mean values were also compared to see the significant difference through DMRT (Duncan Multiple Range Test) after Zar (1984). All statistical analysis was considered significant at 5% ($P<0.05$).

3. Results

3.1. Water quality

Variation in the mean water quality parameters are shown in Table 1.

Mean values of water temperature, transparency, pH, dissolve oxygen, ammonia-nitrogen and alkalinity varied from 26.16±0.62°C to 26.16±.53°C, 37.25±0.49 to 38.31±0.27 cm, 7.41±0.05 to 7.52±0.09, 03.07±0.17 to 03.41±0.12 mg/l, 0.024±0.0003 to 0.024±0.0004 mg/l and 129.50±2.87 to140.06±4.21 mg/l respectively. No significant difference was found among the treatments for all the mean values of water quality parameters during the study period.

Table 1. Variations in the mean values of water quality parameters under different treatments during the study period.

Parameters	Treatments		
	T_1	T_2	T_3
Water temperature (°C)	26.69±0.6a	26.16±0.62a	26.66±0.81a
Transparency (cm)	37.25±0.53a	37.25±0.49a	38.31±0.27a
pH	07.44±0.8a	07.52±0.9a	07.41±0.5a
DO (mg/l)	03.07±0.31a	03.07±0.17a	03.41±0.12a
NH_3-N (mg/l)	0.024±0.0004a	0.024±0.0003a	0.024±0.0004a
Alkalinity (mg/l)	140.06±4.21a	137.63±3.39a	129.50±2.87a

3.2. Fish and prawn growth

Variations in the mean values of growth parameters (weight gain and SGR) under different treatments are shown in Tables 2, 3 and 4.

In case of *M. rosenbergii*, weight gain (g/month) varied from 19.69±5.29 (T_1) to 24.45±7.49 (T_3) and that of *O. niloticus*, varied from 60.11±3.89 (T_2) to 63.01±3.58 (T3). No significant difference was found among the treatments for the mean values of weight gain.

In case of *M. rosenbergii*, SGR (%, bwd^{-1}) varied from 2.76±0.63 (T_1) to 2.97±0.53 (T_3) and of *O. niloticus* varied from 1.66±0.51 (T_2) to 1.71±0.53 (T_3). No significant difference was found among the treatments for the mean values of SGR of *M. rosenbergii* and *O. niloticus.*

The final weight (g) of *M. rosenbergii*, varied from 81.73±0.48 (T_2) to 100.65±0.45 (T_1). Significant difference was found among the treatments for the mean value of final weight of *M. rosenbergii*. In case of *O. niloticus*, final weight (g) varied from 278.50±6.50 (T_2) to 289.50±2.50 (T_1). No significant difference was found among the treatments for the mean values of final weight of *O. niloticus.*

The survival rate of *M. rosenbergii*, varied from 60.00±0.50 (T_3) to 80.00±0.25 (T_1). Significant difference was found among the treatments for the survival rate of *M. rosenbergii*. The survival rate of *O. niloticus* varied from 72.50±2.50% (T_3) to 87.50±2.50% (T_1). Significant difference was found among the treatments for the survival rate of *O. niloticus.*

The yield of *M. rosenbergii* varied from 351.03.50±2.11 Kg/ha/yr (T_3) to 578.87±2.67 Kg/ha/yr (T_2). Significant difference was found among the treatments for the yield of *M. rosenbergii*. The yield of *O. niloticus* varied from 1316.48±53.44 Kg/ha/yr (T_3) to 1634.43±62.89 Kg/ha/yr (T_3). Significant difference was found among the treatments for the yield of *O. niloticus.*

The quartile and annual combined yield of *M. rosenbergii* and *O. niloticus* ware found to be varied from 555.84±18.52 Kg/ha/4 months **(**T_3) to 737.77±20.08 Kg/ha/4 months (T_1) and from 1667.52±55.56 Kg/ha/yr **(**T_3) to 2213.31±60.23 Kg/ha/yr (T_1) respectively. Significant difference was found among the treatments for the combined yield of *M. rosenbergii* and *O. niloticus.*

Table 2. Variations in the mean values of different growth parameters of *M. rosenbergii* under different treatments during the study period.

Parameters	Treatments		
	T_1	**T_2**	**T_3**
Prawn			
Weight gain (g)	$19.69±5.29_a$	$23.23±6.67_a$	$24.45±7.49_a$
SGR	$02.76±0.63_a$	$02.96±0.63_a$	$02.97±0.53_a$
Final weight	$100.65±0.45_a$	$81.73±0.48_c$	$95.68±0.43_b$
Survival rate	$080.00±0.25_a$	$65.00±5.00_b$	$60.00±0.50_b$
Yield (kg/ha/4months)	$192.96±0.89_a$	$149.11±10.79_b$	$117.01±0.70_c$
Yield (kg/ha/yr)	$578.87±2.67_a$	$447.32±32.37_b$	$351.03±2.11_c$
Tilapia			
Weight gain (g)	$63.01±3.58_a$	$60.11±3.89_a$	$61.26±4.53_a$
SGR	$01.70±0.54_a$	$01.66±0.51_a$	$01.71±0.53_a$
Final weight	$289.50±2.50_a$	$278.50±6.50_b$	$281.50±1.50_a$
Survival rate	$87.50±2.50_a$	$82.50±2.50_b$	$72.50±2.50_b$
Yield (kg/ha/4months)	$544.81±20.96_a$	$489.51±1.60_{ab}$	$438.83±17.80_b$
Yield (kg/ha/yr)	$1634.43±62.89_a$	$1468.54±4.80_{ab}$	$1316.48±53.44_b$
Combined yield of prawn and tilapia			
Yield (kg/ha/4months)	737.77	638.62	555.84
Yield (kg/ha/yr)	2213.31	1915.87	1667.52

Figures bearing common letter (s) in a row do not differ significantly (P<0.05)

Table 3. Variations in the mean values of different growth parameters of *O. niloticus* under different treatments during the study period.

Parameters	Treatments		
	T_1	T_2	T_3
Weight gain (g)	$63.01\pm3.58_a$	$60.11\pm3.89_a$	$61.26\pm4.53_a$
SGR	$01.70\pm0.54_a$	$01.66\pm0.51_a$	$01.71\pm0.53_a$
Final weight	$289.50\pm2.50_a$	$278.50\pm6.50_b$	$281.50\pm1.50_a$
Survival rate	$87.50\pm2.50_a$	$82.50\pm2.50_b$	$72.50\pm2.50_b$
Yield (kg/ha/4months)	$544.81\pm20.96_a$	$489.51\pm1.60_{ab}$	$438.83\pm17.80_b$
Yield (kg/ha/yr)	$1634.43\pm62.89_a$	$1468.54\pm4.80_{ab}$	$1316.48\pm53.44_b$

Figures bearing common letter (s) in a row do not differ significantly (P<0.05)

Table 4. Combined yield by the different treatments.

Parameters	Treatments		
	T_1	T_2	T_3
Yield (kg/ha/4months)	737.77	638.62	555.84
Yield (kg/ha/yr)	2213.31	1915.87	1667.52

Figures bearing common letter (s) in a row do not differ significantly (P<0.05)

4. Discussion

The results of the present study indicated that the weight gain (g) of *M. rosenbergii* and *O. niloticus* varied from 19.69 g (T_1) to 24.45 g (T_3) and 60.11 g (T_2) to 63.01 g (T_1), respectively. These findings were agreed with Hossain and Akhteruzzaman (2007) who reported the weight gain of *M. rosenbergii* as 14.3g. Findings indicated that SGR (%, bwd^{-1}) of *M. rosenbergii* and *O. niloticus* varied from 2.76 (T_1) to 2.97 (T_3) and 1.66 (T_2) to 1.71 (T_3), respectively. Findings agreed with Hossain and Islam (2006) who reported the SGR (%, bwd^{-1}) value of *M. rosenbergii* varied from 3.99 to 4.26 in three months experimental period. Findings indicated that the final weight of *M. rosenbergii* and *O. niloticus* varied from 81.73 (T_2) to 100.65 (T_1) and 278.50 (T_2) to 289.50 (T_1), respectively. Results agreed with Hossain and Akhteruzzaman (2007) who reported the final weight of *M. rosenbergii* as 88.1g. Results indicated that the survival rate of *M. rosenbergii* and *O. niloticus* varied from 60.00% (T_3) to 80.00% (T_1) and 72.50% (T_3) to 87.50% (T_1). Hossain and Akhteruzzaman (2007) reported the survival rate of *M. rosenbergii* as 75.5%. The yield of *M. rosenbergii* and *O. niloticus* varied from 351.03 Kg/ha/yr (T_3) to 578.87 Kg/ha/yr (T_1) and 1316.48 Kg/ha/yr (T_3) to 1634.43 Kg/ha/yr (T_1), respectively. These results were more or less agreed with the polyculture system reported by Hossain and Akhteruzzaman (2007) who recorded the yield of *M. rosenbergii* as 776 kg/ha for six months experiment. These result were similar with the mono sex and mix sex prawn culture by Ahmed *et al.* (1997) they found 1,590 kg/ha/yr to 1,350 kg /ha/yr respectively. The combined prawn and fish production (kg/ha/yr) varied from 1667.52 (T_3) to 2213.31 (T_1) during the present study. These results were more or less agreed with the monoculture and polyculture system reported by Alfredo Garcia Perez (2000) who recorded the yield of *M. rosenbergii* were 1,367 and 951 kg/ha/yr respectively. The total fish production from the different treatments was almost similar to that of above mentioned scientists. However, the better growth performances with treatment T_1 might be due to the combination of male prawn with male tilapia. This finding strongly agreed with DoF (2010). This research work would be useful for the sustainable aquaculture in Bangladesh as well as other Asian countries.

5. Conclusions

Treatment T_1 (i.e farming of male prawn with male tilapia) was found best in terms of growth performances. That was initial work for all male prawn aquaculture system. Further study is needed to optimize the dietary protein level for the development of farming of male prawn with male tilapia in ponds under northern Bangladesh.

Conflict of interest

None to declare.

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