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Growth and production performance of prawn in an improved culture system

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Abstract: The growth and production performance of freshwater prawn (*Macrobrachium rogenbergii*) were studied in farmers pond at Santhia, Pabna, Bangladesh over 167 days during July to December, 2008. The experiment consisted of three treatments: without feed and fertilizer (T_1), with fertilizer (T_2), and with feed and fertilizer (T_3) each with three replications having average pond area of 18.22 ± 3.46 decimal. Ponds were stocked with prawn and finfish at 26,250 ha^{-1}. Compost, TSP and urea were used as fertilizers in the relevant treatments at the rate of 5.0 kg, 100 g and 150 g dec^{-1}, respectively during pond preparation and thereafter weekly at 2.0 kg, 25 g and 15 g dec^{-1} throughout the study period. Locally available feed was supplied in the respective treatments daily at the rate of 5-10% of body weight of prawn and fish. Water quality parameters did not differ significantly (P>0.05) among the treatments with a few exception, while their seasonal variations were significant (P<0.05). All the growth and production parameters like mean weight, SGR, survival rate and production differed significantly (P<0.01). T_3 yielded about 205% and 79% increased production of prawn (430 kg ha^{-1}) and 133% and 23% of finfish (1921 kg ha^{-1}), respectively over T_1 and T_2. The technology generated in T_3 treatment may be recommended for prawn cultivation.

Key words: Prawn, growth, production, local feed, fertilizer.

Introduction

Bangladesh's economy is dependent on fisheries sector in terms of nutrition, income, employment generation and foreign exchange earnings. In 2006-2007 fiscal year total export earning from fisheries sector was 515.32 million US$. Export of frozen shrimp and prawn comprising about ninety percent of total export earning of fisheries sector of which prawn contributes more than 23% (DoF, 2009). For a long period, catch from wild stock of both marine and freshwater habitat was the main source of shrimp and prawn supply. To increase the foreign exchange earning, irrational development of sea food processing industry created a pressure on raw material supply which pinpointed the need of immediate aquaculture development. Bangladesh is considered as one of the most promising country in respect of freshwater prawn (golda) culture. As a result, aquaculture activities have been initiated with fertilizers and formulated feed for having higher production. The Government of Bangladesh is also trying to achieve higher growth in this sector. Primarily some positive results in economy have been achieved. However, there is a little work about the production performances of prawns in carp-prawn polyculture system. Although, polyculture of finfish is an age-old practice in Asia. Iinclusion of freshwater prawn in finfish polyculture is recently being tried and found promising (Kunda *et al*., 2008). The finfish selected to culture with prawn in the present study were silver carp, *Hypophthalmichthys molitrix*, which can prevent algal bloom (Hepher and Pruginin, 1981), and can increase food resources for prawn and benthophagous fish through its faecal pellets (Milstein, 1992); catla, *Jibelion catla*, the fastest growing species among the three Indian major carps, which is a surface and mid-water feeder (Jhingran, 1991) and silver barb (punti), *Puntius gonionotus* is an omnivore species. The present paper embodies with the growth and production performance of prawn and fish in an improved culture system.

Materials and Methods

Study site and period: The study was carried out in nine farmers' pond at Chondah village of Santhia upazila under Pabna district. Before commencing trial, a thorough discussion was made with the pond owners and nine of them agreed to spare their pond for this research purpose. The study was conducted during July to December 2008 for a period of 167 days.

Experimental Design: The study was conducted in nine ponds designated as T_1 (Control- without feed and fertilizer), T_2 (With fertilizer) and T_3 (With feed and fertilizer). The details of each experiment are as follows:

Treatments	Fry size	Stocking density dec^{-1}	Stocking density ha^{-1}
T_1(Control- without feed and fertilizer) T_2 (With fertilizer) T_3 (With feed and fertilizer)	Golda 3 to 5 cm and others 7-10 cm	Golda: 80 Catla: 10 Silver carp: 10 Punti: 05	26,250

Pond preparation: Primarily pond water was drained out and the bottom soil was sun-dried and pond dikes and other parts were repaired manually. After proper drying, bottom soil was ploughed and leveled. After two weeks, dirty materials were removed from the bottom and lime ($CaCO_3$) was applied at the rate of 250 kg ha^{-1}. Ponds were provided with independent spillage. After preparing the ponds, the rain water was allowed to enter into the ponds and reaches up to an approximate depth of around 1.5 meters. Then all concerned ponds were fertilized with compost (mixture of chopped and sun dried green plants-88%, cow dung/poultry droppings-10%, urea-1% and lime-1%) 1,250.0 kg ha^{-1}, urea 37.5 kg ha^{-1} and TSP 25.0 kg ha^{-1}. Prawn and finfish were reared 5-7 days after fertilization.

Sources of prawn and finfish fries and stocking: Prawn and finfish fry were collected from local nursery owners on prior contract basis and stocked after sufficient acclimatization with pond water. The mean weight of prawn juveniles, and silver carp, catla and punti fry was 4.50 ± 0.43, 17.82 ± 1.08, 21.38 ± 1.55 and 10.61 ± 1.21 g,

respectively. The stocking density of prawn and fish altogether was 26,250 ha^{-1}.

Food and Feeding Management: In T_2 and T_3, the ponds were fertilized weekly with compost, urea and TSP at 2.0 kg, 25 g and 15 g dec^{-1} throughout the study period. Moreover, feed made of locally available ingredients at the rate 5-10% body weight of prawn and finfish were supplied daily in T_3. Feeding started from the second week of stocking. Half of the daily ration was supplied at dawn and rest half before dusk with the help of feeding trays. A total of 2 feeding trays were placed, one on the bottom and another at 1.5 feet depth of water of each pond. The feed were adjusted based on monthly sampling. The ponds were monitored regularly. The details for 1.0 kg feed prepared of locally available ingredients are presented in Table 1.

Table 1. Amount of various ingredients (dm. basis) for 1 kg of locally made feed

Ingredient	Protein content (%)	Dose (%)	Required amount (g)	Protein (%) in feed
Fish meal	56.61	25	250	14.15
Mustard oil cake	30.33	25	250	8.33
Wheat bran	14.17	40	800	5.82
Flour	17.78	10	100	1.78
Minerals	-	-	1 spoonful	-
Total		100	1000	30.08

Water quality management: On an average, water depth was maintained around 1.0 m throughout the study period and in case of necessity water was filled with deep tube-well. The physico-chemical conditions such as pH, temperature, dissolved oxygen (DO), alkalinity and transparency of ponds water were measured throughout the study period. Monthly sampling was conducted in between 09:00 -12:00 hrs. Physical and chemical analysis was performed on the spot. Temperature and DO was measured by an YSI digital DO meter (Model 58), water pH was determined by a digital pH meter (Model-HANNA-HI-9142), total alkalinity was determined by titrimetric method (Stirling, 1985).

Growth and survival of prawn and finfish: In order to study growth and survival rate, data were collected monthly. Prawns and fish were collected from each pond on a random basis using a cast net of 10 square meters effective area with 10 mm mesh size. The prawn and fish weight was taken in gram using a portable electronic balance. Survival rate was estimated by the following formula:

$$\text{Survival (\%)} = \frac{\text{Total population}}{\text{Total no shrimp stocked}} \times 100$$

The total population during sampling was calculated by the following formula:

$$\text{Total Population} = \frac{\text{Average no of sample}}{\text{Area of the net}} \times \text{pond area}$$

(Area of net = πr^2, where, r = radius of net)

For final survival rate (%), the average number of prawn and fish per kg was estimated and then the total number of prawn and fish was determined. Finally, survival rate was calculated. Specific growth rate (SGR) was determined in terms of body weight according to the following formula:

$$\text{SGR (\% bw.d}^{-1}) = \frac{LN(W_1) - LN(W_0)}{t_1 - t_0} \times 100$$

Where, W_1 = mean wt (g) at time t_1, W_0 = mean wt (g) at time t_o, t_o = starting time (stocking day), and t_1 = final time (sampling day).

Harvesting of prawn and fish: Final harvesting was made on 14 December, 2008. Prior to harvesting some water was released from the ponds. After draining out of water to a certain level, prawn and fish were partially harvested by a seine net and finally all prawn and fish was harvested through draining out of pond water compltely.

Statistical analysis: For the statistical analysis of the data, a one-way ANOVA and DMRT were done using the SPSS (Statistical Package for Social Science) version-12.0. Significance was assigned at the 0.05% level. Duncan's test was used to tests the results of multiple ranges for comparisons of averages.

Results and Discussion

Water quality parameters: Temperature, transparency, pH and dissolved oxygen (DO) concentration and alkalinity of pond water did not vary significantly among the treatments (Table 2). However, there were significant time effects on temperature, transparency and DO. The highest temperature was recorded in the second week of August (33.9 ºC) and the lowest in the second week of December (21.8 ºC). Water pH ranged from neutral to alkaline level (7.1 to 9.5).

Table 2. Mean values (± SD) of some water quality parameters

Parameters	N	T_1	T_2	T_3
Temperature (ºC)	54	29.21 ± 2.25	29.23 ± 1.24	29.22 ± 3.24
Transparency (cm)	54	34.26 ± 6.57	34.77 ± 3.51	35.46 ± 2.41
pH range	54	7.2 - 9.5	7.2 - 9.2	7.1 - 9.3
Dissolved oxygen (mg l^{-1})	54	5.73 ± 0.07	5.81 ± 0.07	5.76 ± 0.07
Alkalinity (mg l^{-1})	54	116 ± 6	115 ± 6	115 ± 5

Monthly measurements of alkalinity showed no significant difference ($P>0.05$) among the treatments but time variation was significant. Mean of alkalinity was around 100 mg l^{-1}at the beginning of experiment in last week of July, which rose gradually up to 170 mg l^{-1} in the month of November. Most of the water quality parameters were suitable for aquaculture. Water temperature exceeded optimum range (>32 ºC) for prawn and finfish culture

(Boyd and Zimmerman, 2000) on two sampling dates on July and August. Water transparencies, indicating sestonic food abundance, were found to fluctuate from 25 to 48 cm in different treatments, which are almost within the recommended range (15-40 cm) suggested by Boyd (1982), and similar to the reported values recorded in ponds by Wahab *et al*. (1995). Water pH in different treatments was always found in alkaline range, which is ideal for grow-out phase of *M. rosenbergii* (Boyd and Zimmerman, 2000). Alkalinity of pond water was suitable for the primary production and dissolved oxygen (DO) concentration ranged from 4.01 to 7.72 mg l^{-1} which was within the recommended range for freshwater prawn culture (New, 2002).

Table 3. Comparison of growth and production parameters (mean ± SD, N=3) of prawn in different treatments.

Species/parameters	T_1	T_2	T_3
Freshwater prawn, *Macrobrachium rosenbergii*			
Individual stocking weight (g)	4.42 ± 0.38	4.71 ± 0.45	4.37 ± 0.55
Individual weight at harvest (g)	29.53 ± 4.85^{c}	46.90 ± 1.46^{b}	68.60 ± 3.58^{a}
Survival (%)	25.62	30.27	29.86
SGR (% bw d^{-1})	2.49 ± 0.12^{c}	2.92 ± 0.04^{b}	3.35 ± 0.03^{a}
Production (kg ha^{-1})	141 ± 20^{c}	240 ± 38^{b}	430 ± 55^{a}

Mean values with different superscripts indicate significant difference (P<0.05) based on Duncan's Multiple Range Test (DMRT).

The production of golda in the present study was significantly higher in T_3 followed by T_2 and T_1. Nearly 1.8 and 3 times higher production was obtained in T_3 over T_2 and T_1, respectively. These differences might be resulted from the differences in individual weight attained at harvest due to the variation of inputs supplied. The SGR of prawn between treatments varied significantly, survival rate and individual weight at harvest were significantly higher in T_3. Mortality of prawn occurred in the different treatments that might be due to intra-specific interactions (Martino and Wilson, 1986) and possible cannibalism among prawn (Zimmerman and New, 2000). Feeding habit of cultured species supports the fact that, there was no or very little competition for food among prawn and finfish in this management system. Besides, local feed made by available ingredients were supplemented daily for prawn and organic and inorganic fertilizers were also applied at regular interval for growing natural food. The production of freshwater prawn in the present study ranged from 141-430 kg ha^{-1} during 167 days of culture period with a stocking density of 2 m^{-2} in a polyculture system with finfish. This is comparable to the other reported values in this region. According to Asaduzzaman *et al*. (2006), the average annual freshwater prawn production in Bangladesh is 390 kg ha^{-1} in polyculture systems; while Kunda *et al*. (2008) reported 294-596 kg ha^{-1} of prawn production in 120 days culture period in prawn-small fish mixed culture in the fallow rice fields in Bangladesh with different stocking densities (1.0 - 2.5 m^{-2}) of freshwater prawn.

Table 4. Growth and production parameters (mean ± SD, N=3) of finfish separately as well as combinedly and all species combinedly in different treatments.

Species/parameters	T_1	T_2	T_3
Silver carp, *Hypophthalmichthys molitrix*			
Individual stocking weight (g)	17.98 ± 0.44	16.97 ± 0.50	18.52 ± 1.52
Individual weight at harvest (g)	207.22 ± 17.05^{c}	354.00 ± 16.37^{b}	371.30 ± 51.88^{a}
Average survival (%)	81.46	81.75	82.22
SGR (% bw d^{-1})	3.60 ± 0.08^{b}	4.17 ± 0.06^{a}	4.16 ± 0.16^{a}
Production (kg ha^{-1})	419.13 ± 60.57^{b}	718.42 ± 120.95^{a}	754.38 ± 103.93^{a}
Catla, *Jibelion catla*			
Individual stocking weight (g)	21.43 ± 0.98	20.62 ± 1.51	22.11 ± 2.11
Individual weight at harvest (g)	210.23 ± 30.99^{c}	418.96 ± 10.46^{b}	547.37 ± 34.13^{a}
Average survival (%)	67.97	73.23	74.67
SGR (% bw d^{-1})	3.51 ± 0.16^{b}	4.23 ± 0.05^{a}	4.45 ± 0.11^{a}
Production (kg ha^{-1})	336.07 ± 69.99^{b}	654.15 ± 199.05^{ab}	1096.50 ± 382.48^{a}
Punti, *Puntius gonionotus*			
Individual stocking weight (g)	11.21 ± 1.25	9.44 ± 0.82	11.17 ± 0.76
Individual weight at harvest (g)	65.33 ± 4.51^{c}	99.67 ± 6.11^{b}	173.00 ± 19.47^{a}
Average survival (%)	60.01	71.41	70.89
SGR (% bw d^{-1})	2.73 ± 0.06^{c}	3.26 ± 0.11^{b}	3.70 ± 0.12^{a}
Production (kg ha^{-1})	45.75 ± 10.04^{b}	76.74 ± 27.11^{b}	166.35 ± 58.13^{a}
Finfish combined			
Production (kg ha^{-1})	823 ± 38^{b}	1556 ± 232^{a}	1921 ± 253^{a}
All species (prawn and finfish) combined			
Production (kg ha^{-1})	972 ± 157^{c}	1847 ± 214^{b}	2326 ± 236^{a}

Mean values with different superscripts indicate significant difference (P<0.05) based on Duncan's Multiple Range Test (DMRT).

When compared the production of finfish there was significant difference among the treatments. The carps production during 167 days grow out period ranged from 823-1921 kg per hectare. This production figure of fish was higher than that of 660 kg per hectare in prawn-fish polyculture in Bangladesh (Asaduzzaman *et al*., 2006).

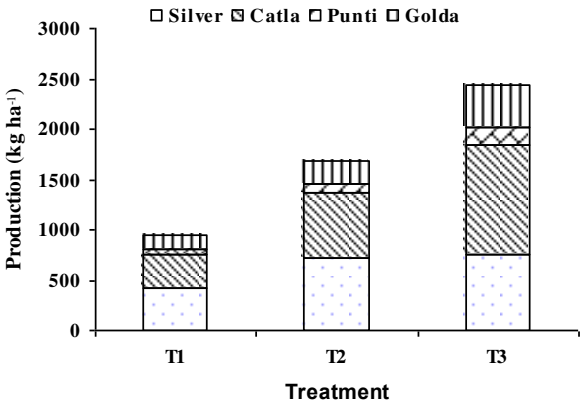

Fig. 1. Contribution of different finfish and prawn in total production.

In most polyculture systems, there is a target species and a minor species. The yield of minor species is usually considered as a bonus to the yield of the target species (Garcia-Perez *et al*., 2000). Freshwater prawn might be considered as the prime species in the study. The prawn production (13 - 19% of total production) was lesser than finfish production (81 - 87%) in terms of biomass, but it resulted in higher economic benefit.

The production of finfish including prawn is more or less same with the same operating cost like only finfish polyculture in farmer's pond, however, the economic return was increased due to prawn inclusion. The technology may be recommended for use by the farmer for higher production as well as higher economic benefits.

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