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PRODUCTION POTENTIAL OF TIGER SHRIMP, *PENAEUS MONODON* BY FERTILIZATION AND REDUCING FEED SUPPLY

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Abstract: Experiment was conducted to assess the potential of increasing production of shrimp, *Penaeus monodon* by enhancing primary production through fertilization and reduc feeding regime. Four treatments *viz*., T1, feeding @ 2% of shrimp biomass from 31~80 days of culture and then 1%; T2, feeding @ 3% of shrimp biomass from 31~80 days of culture and then 2%; T3, feeding @ 2% of shrimp biomass from 31~80 days of culture and then 1% + fertilization; T4, feeding @ 3% of shrimp biomass from 31~80 days of culture and then 2% + fertilization each with three replications were tested. Urea @1.25 ppm and TSP @ 1.50 ppm were applied as fertilizer monthly. After 120 days of culture, mean final weight of shrimp was 11.86±0.35g, 12.08±0.51g, 13.30±0.99g and 14.50±1.14g with the production of 458.36±14.86 kg/ha, 484.93±7.26kg/ha, 536.75±4.81 kg/ha and 592.19±35.05 kg/ha in T1, T2, T3 and T4, respectively. Reduction of feed reduce both growth and production of shrimp. Increase in primary productivity due to fertilization increase production of shrimp to a significant level ($F=32.94$; $p<0.001$). But overall production of shrimp was lower in comparison to other similar studies when higher feeding applied.

Key words: Production, *Penaeus monodon,* Fertilization, Feed supply

INTRODUCTION

Culture practice of brackishwater shrimp, *Penaeus monodon* expanded rapidly and created a remarkable development in the fisheries sector of Bangladesh. One of the most important operational functions in improved shrimp culture system is the provision of supply of adequate good quality and nutritionally complete pellet feed to ensure that the cultured animals attain the desired harvesting size within the targeted time frame. But, excess application of feed deteriorates water quality and makes the culture species vulnerable to disease. Jory (1995a) mentioned that feed management is a major component of pond management and critical for production and feed conversion. Incorrect feed management can lead to diseases and water quality-related problems which adversely affect production. Chanratchakool *et al.* (1994) reported that feed is one of the main inputs of shrimp production system and accounts for 55~60% of the operating costs in an intensive system and approximately 40% of the operating costs in a semi-intensive system. Saha *et al.*, (2006-07) evaluated that among all culture inputs, cost of feed for culture of shrimp was as highest of

57.68~61.23% of all variable costs. International Principles for Responsible Shrimp Farming also emphasized formulation of cost-efficient, high quality and low polluting diets and proper management of the feeding regime to optimize the

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efficient use of feeds in shrimp farming (FAO/NACA/UNEP/ WB/WWF, 2006). So, emphasis should be given to develop an effective feed management technique to make the culture practice cost-effective and environmentally congenial for the growth and survival of the stocked shrimp. But very few studies have been reported on this aspect. *P. monodon* is an omnivorous species. In the natural habitat, juveniles of *P. monodon* feeds mainly on algal material and adults are opportunist feeding on crustacean, annelids, algae and mud (EI Hag 1984). Marte (1980) reported that adult *P. monodon* mainly feeds on slow moving benthic macro invertebrates. They are also scavengers, feeding on any kind of decaying matter available in the habitat (Kungvankij and Chua, 1986). Relationship of primary producers and benthic invertebrates has been studied by Wade and Stirling (1999). Karlson (2010) reported that by feeding on organic matter from settled phytoplankton blooms benthic invertebrates produce food for higher trophic levels and remineralize nutrients that can fuel primary production. Contribution of primary productivity to the growth of different shrimp species has been studied by Reymond and Lagardere (1990), Jory (1995b), Martinez-Córdova *et al*. (1998), Moorthy and Altaf (2002), Martinez-Córdova *et al*. (2003), Gamboa-Delgado (2013) and Bojórquez-Mascareňo ans Soto-Jimėnez (2013). Yutaka and Chen (1994) focused on the utilization of the natural productivity of fish ponds to reduce production costs. In this context, an attempt was made in the present communication to reduce feed application through increasing primary production by fertilization in modified extensive culture system of brackishwater shrimp, *Penaeus monodon.*

MATERIAL AND METHODS

The study was conducted with four treatments with three replications each in twelve experiment earthen ponds of 1000 m^2 each of Bangladesh Fisheries Research Institute, Brackishwater Station, Paikgacha, peonies Khulna following the design given in Table 1.

The ponds were prepared by treating soil with lime (Quick lime:dolomite 3:1) @ 250 kg/ha and then filled with tidal water of adjacent tributary of Shibsa river up to a depth of 1.0 m. Water of the ponds was treated with rotenone @ 1.5 ppm to kill all predatory and weed fishes. and then with dolomite @ 15 ppm to strengthen buffering capacity of water. After three days, the ponds' water was fertilized with urea, TSP, and MoP @ 2.5 ppm, 3.0 ppm 1.0 ppm, respectively to accelerate production of plankton. Fermented molasses were applied to the pond water @ 5ppm to develop colour of water to check penetration of sunlight.

Table 1. Design of the Experiment

Treatments (T)	Particulars
T_1	Feeding @ 2% of shrimp biomass from 31~80 days of culture and then 1%.
T_2	Feeding @ 3% of shrimp biomass from 31~80 days of culture and then 2%.
T_3	Feeding @ 2% of shrimp biomass from 31~80 days of culture and then 1% + *fertilization.
T_4	Feeding @ 3% of shrimp biomass from 31~80 days of culture and then 2% + *fertilization.

*Fertilization: Urea @1.25 ppm and TSP @ 1.50 ppm at monthly interval

After production of sufficient plankton, PCR (polymerized chain reaction) tested post larvae (PL20; average body weight, 0.006 g) of shrimp were stocked to the ponds at a density 5 Nos/m^2 on 08 March, 2012. The stocked shrimps were fed with commercial feed. The used different grades (crumble to pellet) of feed contains 39-45% protein, 3% lipid, 6% fiber, 18% ash and 11% moisture. Protein concentration was higher in feeds used for smaller shrimps. From PL20 to PL50, quantity of feed to be applied was calculated considering a uniform survival of 90% in all ponds and according to the feeding rate given in table 2. After PL50, when average body weight (ABW) of shrimp became 1.5 to 2.5 g, feed was adjusted fortnightly considering body weight of shrimp and same survival, and following the experimental design given in table 1. Feed was applied by spreading.

Table 2. Feeding schedule in the experimental ponds for Postlarvae (PL)

Size of shrimp	Rate of feeding	Feeding frequency (Times/day)
PL20~PL30	150 g/1,00,000 shrimp	3
PL31~PL40	250g/1,00,000 shrimp	3
PL41~PL50	350 g/1,00,000 shrimp	3
PL 50 onwards	1~3% of shrimp biomass following the experimental design	4

Water of ponds ware treated with Dolomite @15 ppm followed by fertilization in ponds of T3 and T4 with a gap of three days in each month following the experimental design (Table 1). To maintain undisturbed ecology of the ponds, no water was exchanged. Only the evaporated water was replenished with the water of the adjacent tributary of Shibsa river. Basic water quality variables *viz.,* depth, temperature, salinity, pH, transparency, dissolved oxygen (DO) and total alkalinity were determined at fortnight intervals following standard methods as mentioned in APHA (1992) and Strickland and Parsons (1968). All variables except DO were measured at noon and DO was measured at 6 a.m. The rates of primary production of the ponds were estimated by *in situ* incubation of water samples in 300 ml BOD bottles as per the standard "Oxygen light and dark bottle method" of Gaarder and Gran (1927) with an incubation period of four hours. The DO content was determined by modified Winkler's iodometric method (APHA, 1992) and the values were converted to carbon using a factor of 0.375 as mentioned by Adoni (1985). After 120 days of culture, shrimps from all ponds were harvested by cast netting and finally by dewatering, and average body weight (total weight/total number of shrimp), survival (%) and production (kg/ha) were estimated and compared. Statistical analyses were done to find out the mean, standard deviation, ANOVA and significance of differences using MICROSTAT statistical software.

RESULTS AND DISCUSSION

Depth of water of all ponds was always maintained at a level of 1m by adding tidal water from adjacent canal. Temperature of surface water of the ponds during culture period from 08 March to 07 July 2013 was 31.0-35.2 ^{o}C. Salinity of water was almost same in all ponds. During stocking, salinity of water of the ponds was 6‰ which increased gradually up to 15‰ at the later part of the culture cycle. This trend in salinity was due to evaporation of water and addition of high saline water from the adjacent canal to replenish the evaporated water. As shown in Fig 1, transparency of water was initially high and decreased with the progress of culture period in all treatments. Overall mean transparency of water was highest of 59.11±13.26 cm in T1 where shrimps were fed with 2% and then 1% feed and no fertilization, followed by 50.11±14.39 cm in T2 where shrimps were fed with 3% and then 2% feed and no fertilization, 43.67±15.45 cm in T3 where shrimps were fed as in T1 and fertilization and 40.44±15.82 cm in T4 where shrimps were fed as in T2 and fertilization, respectively. Higher transparency in T3 and T4 in comparison to that of T1 and T2 might be due to higher primary production (Fig. 2) enhanced by fertilization. pH of water of all ponds was always alkaline and almost same throughout the culture period varying from 8.00 to 9.60. Increase in pH up to 45 days of culture might be due to growth of aquatic weeds in all ponds during this period. Later on, pH started to decrease with the removal of weeds manually. Though concentration of DO decreased with the progress of culture period, morning dissolved oxygen was always >5.0 mg/l which is congenial for the normal growth of shrimp. The alkalinity level (95-150 mg/l) of water of all ponds was sufficient enough to support primary production.

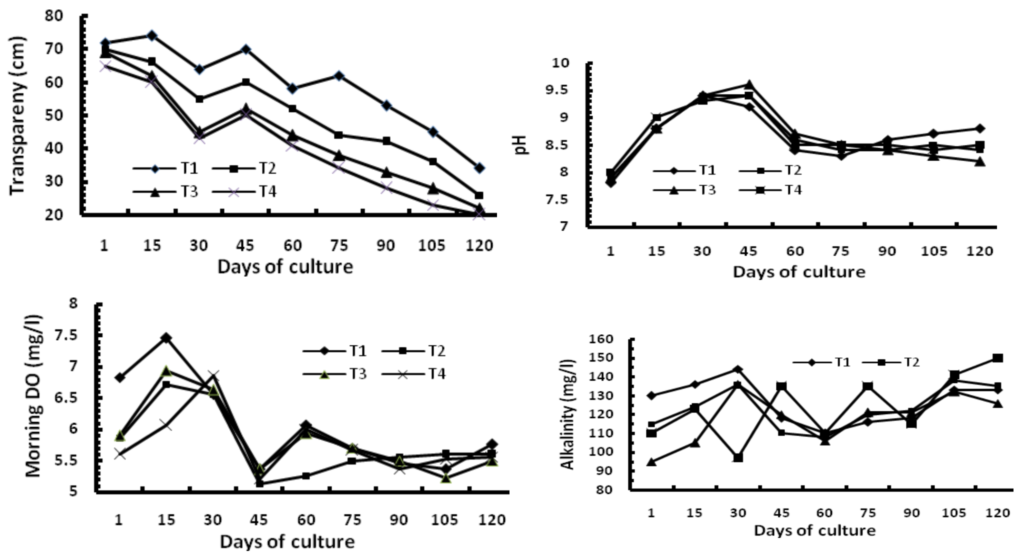

Fig. 1. Gross primary productivity (GPP) and Net primary productivity

Gross primary production (GPP) of the ponds was 0.38-1.5 $gC/m^3/d$, 0.237-1.69 $gC/m^3/d$, 0.83-2.12 $gC/m^3/d$ and 0.63-1.98 $gC/m^3/d$ in T1, T2, T3 and T4, respectively. As shown in Fig. 2, GPP of all treatments increased with the progress of culture period. This might be due to addition of nutrients through recycling of left over feed and excreta of growing shrimp as also reported by Saha *et al.* (1998). Goodwin and Hanson (1974) opined that feed not consumed by the

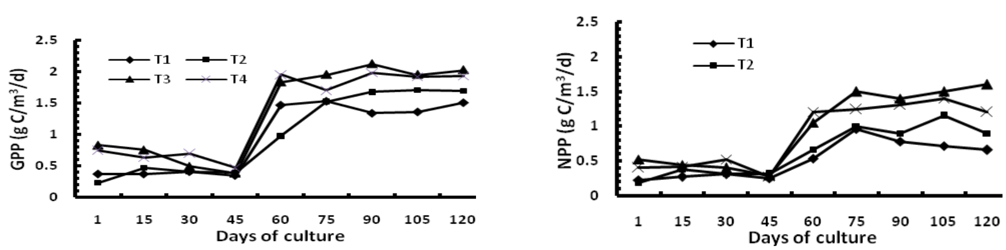

Fig. 2 (GPP, gross primary productivity (NPP) and Net primary productivity (NPP) of *Penaeus monodon* at various days of treatments

prawns add to the organic and inorganic content of pond, thereby stimulating growth of lower food chain. Application of fertilizer further increased GPP in T3 and T4 to a significant level ($F=15.23$: $p<0.01$) in comparison to those of T1 and T2 where no fertilizer was applied. Decrease in GPP at 45 days of culture was due to production of aquatic weeds in almost all ponds which might hamper production of phytoplankton. The trend in variation in net primary production (NPP) in different treatments was same as that of GPP.

Growth of shrimp was almost same in all ponds up to 45 days of culture. After then, growth of shrimp in treatments with fertilization was higher than those of treatments without fertilization and in treatments with higher feeding rate than that of lower feeding rate. After 120 days of culture, mean final mean weight of shrimp was 11.86±0.35g, 12.08 ±0.51g, 13.30±0.99g and 14.50±1.14g) in T1 with 2% and then 1% feed and no fertilization, T2 with 3% and then 2% feed and no fertilization, T3 with 2% and then 1% feed and fertilization and T4 with 3% and then 2% feed and fertilization, respectively. Though mean final weight of shrimp was higher in T2 with higher feeding rate in comparison to that of T1 with less feeding rate, the difference between them was not significant (Table 3). Similar mean weight was observed between T3 and T4. Mean final weight of shrimp was higher in T3 where fertilizer was applied with feed than that of T1 without fertilizer with same feeding rate. But the difference in growth between them was insignificant. But as shown in table 3, mean final weight of shrimp was significantly ($F=5.09$; $p<0.044$) higher in T4 with fertilizer than that T2 without fertilizer but with same feeding rate. As shown in table 3, overall survival of shrimp was 77.37±4.76%, 80.33±2.26%, 81.04±6.98% and 81.41±1.07% in T1, T2, T3 and T4, respectively for 120 days culture period. Though higher survival was recorded in T4, the differences in survival among four treatments were insignificant. Production of shrimp was 458.36±14.86 kg/ha in T1, 484.93±7.26kg/ha in T2, 536.75±4.81 kg/ha in T3 and 592.19±35.05 kg/ha in T4. Production of shrimp was higher in treatment with higher feeding rate. Fertilization increased production of shrimp to a significant level ($F=32.94$; $p<0.001$). The feed conversion ratio (FCR) was lower in treatments T3 and T4 with fertilization than that of T1 and T2 where no fertilizer was applied.

Table 3. Production performance of shrimp ((*Penaeus monodon*) in different treatments

Treatments	Replications	Final Wt (g)	Survival (%)	Production (kg/ha)	Feed conversion ratio
T1	R1	11.50	82.20	472.65	1.92
(Feeding @ 2% of shrimp biomass from 31~80 days of culture and then 1%)	R2	12.19	72.68	442.98	1.85
	R3	11.90	77.22	459.46	1.83
	Mean±SD	11.86±0.35[a]	77.37±4.76[a]	458.36±14.86[a]	1.87±0.05[a]
T2	R1	11.50	82.90	476.67	1.85
(Feeding @ 3% of shrimp biomass from 31~80 days of culture and then 2%)	R2	12.40	78.68	487.82	1.83
	R3	12.35	79.40	490.29	1.88
	Mean±SD	12.08±0.51[a]	80.33±2.26[a]	484.93±7.26[a]	1.85±0.03[a]
T3	R1	14.08	75.64	532.50	1.78
(Feeding @ 2% of	R2	13.64	78.56	535.78	1.81

shrimp biomass from 31~80 days of culture and then 1% + fertilization)	R3	12.19	88.92	541.97	1.83
	Mean±SD	13.30±0.99[ab]	81.04±6.98[a]	536.75±4.81[b]	1.81±0.03[a]
T4	R1	14.60	81.36	594.04	1.77
(Feeding @ 3% of shrimp biomass from 31~80 days of culture and then 2% + fertilization)	R2	13.32	82.50	556.25	1.79
	R3	15.59	80.36	626.28	1.75
	Mean±SD	14.50±1.14[b]	81.41±1.07[a]	592.19±35.05[c]	1.77±0.02[a]

Figures with different superscript differ significantly.

The mean body weight and production of shrimp in the present investigation was lower than that mentioned by Saha *et al.* (2008), where production of shrimp was 667.57-811.76 kg /ha with the average body weight of 20.81-23.95g after 120 days culture at the stocking density of 5 Nos/m^2 and feeding rate of 3-5% of shrimp biomass. In another experiment, Saha *et al.* (2009) reported 699.72-940.19 kg /ha production of shrimp with the average body wt of 17.23-23.95g at the same culture period, stocking density and feeding rate. The production of shrimp in the present investigation is lower than those of Saha *et al.* (2008 and 2009). This might be due to application of feed at reduced rate which might be insufficient for the growth of shrimp. However, increase in primary production by fertilization significantly ($F=32.94$; $p<0.001$) increased production of shrimp. Though differences in FCR between treatments with fertilization and without fertilization were not significant (Table 3), less FCR in treatments with fertilization will reduce cost of production to a certain level. Martinez-Córdova *et al.* (1998) studied impact of fertilization on the production of *Penaeus vannamei* and revealed that growth of shrimp was higher in fertilized ponds, despite a lower feeding rate which suggests that fertilization enhances natural food and contributes to shrimp nutrition. Moorthy and Altaf (2002) revealed that in modified extensive system, natural food contributed considerably to the growth of *P. monodon* and proper assessment of this food in the pond may help to reduce the use of supplementary feed. Bojórquez-Mascareňo ans Soto-Jimėnez (2013) opined that farmers may be able reduce FCR and improve profitability by enhancing the natural productivity during the first weeks of intensive shrimp culture. Gamboa-Delgado (2013) reported that the natural productivity found in semi-intesively managed ponds frequently supplies higher proportions of dietary carbon and nitrogen to shrimp growth than the formulated feed, emphasizing the nutritional relevance of the former. Fertilization also enhances primary productivity increasing growth of shrimp in the present investigation, but reducing feeding rate to 1-3% of shrimp biomass in conjugation with fertilization would not be sufficient enough for the expected growth of shrimp.

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