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ON THE ENVIRONMENT FRIENDLY IMPROVED EXTENSIVE CULTURE OF *PENAEUS MONODON*

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Abstract: A six months long study on the improved extensive culture of tiger shrimp (*Penaeus monodon*) was carried out in six *ghers* (ponds) under three treatments (T_1-without feed and fertilizers; T_2-only fertilizer; T_3-with feed and fertilizers). The stocking density of post-larvae (PL) with a mean initial weight of 0.04±0.01g was 20,000 PLs/ha for T_1 and T_2 and 33,000 PLs/ha for T_3. DO and pH in different ponds ranged from 4 to 13 mg/l and 7.3 to 8.6, respectively with a wide range of fluctuations in salinity levels (5 to 24 ppt) throughout the study period. The survivability rate was highest (54%) in T_2 and lowest (38.5%) in T_1, while the highest production (570 kg/ha/crop) was obtained in T_3 followed by T_2 (372.5 kg/ha/crop) and T_1 (236.8 kg/ha/crop). However, no significant ($p>0.05$) differences were observed between the specific growth rates of shrimp in different treatments, which ranged between 4.15 and 4.45.

Key words: *Penaeus monodon*; Shrimp culture; Aquaculture; Environment friendly; Improved extensive; Fertilizer

Introduction

The 1980s saw a boom in shrimp aquaculture in the Southeast Asia. The rush to develop intensive shrimp farms in response to a strong market demand and speculation for large profits ended by converting many previously rich coastal system into barren wastelands. Shrimp industry in Taiwan has almost been destroyed due to environmental disaster. Other countries also experienced the same consequences. During the last couple of years, semi-intensive shrimp farms of Cox's Bazar, Bangladesh area have suffered heavy losses following destruction of the crops due to severe environmental and disease problems, which has compelled the farms a gradual return to basic method. Khulna region, the fisheries treasure of Bangladesh, has also been experiencing the same problem. A recent trend in intensification in the culture method is noticeable in order to get prodigious return within the shortest possible period. Concurrent with such a general phenomenon of increase in the production, the sector has been facing a great peril from virus incidence

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(Shah, 1998). Therefore, conventional wisdoms suggest that in order to improve the shrimp culture technique under local environmental conditions, an environment friendly modified extensive culture method should be adopted which needs detailed experimental trails emphasizing the environmental parameters and their effect on the growth of the shrimp. As a first step in this process, the objective of the present study was to develop an appropriate management technique to increase the production of shrimp in extensive culture system.

Materials and Methods

***Study Area*:** The experiment was conducted in 6 selected shrimp *ghers* (ponds) of Shymnagar thana under Satkhira district for a total period of 6 months.

Experimental Ponds: The ponds, located on the banks of the Munshiganj and Kadamtoli rivers in the district of Satkhira, had both inlets with feeder canals and outlets on the opposite direction. Water was pumped from the feeder canal to ponds through axial pumps and discharged by gravitational forces through PVC pipes laid at the bottom of the ponds and taken across the embankments. The ponds were designed as P_1 through to P_6. Ponds P_1 and P_2 were used for treatment-1 (T_1) and considered as the controls where no feed and fertilizers were used. Ponds P_3 and P_4 were used for treatment-2 (T_2) where only fertilizer was used, while those designated as P_5 and P_6 were used for treatment-3 (T_3), where both feed and fertilizers were used. The areas of the experimental ponds are shown in Table 1. All the ponds were rectangular in shape. The dikes were firm and high enough to hold 1 m deep water throughout the study period.

Pond Preparation*:* The ponds were sun dried and treated with stone lime ($CaCO_3$) at the rate of 200 kg/ha. After complete sun drying, water was allowed to enter into the ponds during high tide through fine meshed net to prevent the entrance of undesirable organisms. After 2 to 3 days of watering, fertilizers at the rate of urea 40 kg/ha and TSP 20 kg/ha were used and allowed to grow sufficient natural feed for the next 7 days, until the ponds were ready for stocking post larvae (PL) of *Penaeus monodon*.

Stocking of PL: Fingerlings collected from natural sources with the mean initial weight of 0.04g (±0.01) were kept for 5 to 10 days in the pre-stocking tanks (locally called *Goi*) made by the side of the inlets for acclimation before releasing them to the stocking ponds. The stocking density in different ponds varied from 20,000 to 33,000 per hectare (Table 1).

Feeding: Pelleted diet (Grower, Saudi-Bangla Fish Feed Ltd.) containing 36% crude protein level was used in T_3 from the third month. Initially feeding rate was 0.5% of the body weight of the shrimp, which was increased to 1% for the last month of the experimental period. Feed was given twice daily before sunrise and after sunset, and the amount given was recorded for subsequent calculation of growth parameters.

Table 1. Stocking density of the post larvae and total area of the experimental ponds.

Treatments	Pond no.	Area of the ponds (ha)	Stocking density (PL/ha)
T_1: Without feed and fertilizers	P_1	3.5	20,000
	P_2	4.0	20,000
T_2: Only fertilizer	P_3	2.0	20,000
	P_4	6.0	20,000
T_3: Both feed and fertilizers	P_5	1.0	33,000
	P_6	1.0	33,000

Management of Water Quality: Efforts were made to keep the water quality of the pond as good as possible, since in most cases shrimp disease are caused by poor water quality management. No rigid schedule for exchange of water could be maintained, as it was dependent on the tidal condition; however, about 25% to 30% of the total water was exchanged every day. The pH was always maintained at or above 7.3, and seechi disc readings were kept within 30 to 35 cm by applying stone lime whenever necessary at the rate mentioned earlier. Temperature, salinity, DO, CO_2 and pH was monitored fortnightly by using a Centigrade thermometer, hand refractometer, DO meter and a combined digital CO_2/pH meter, respectively.

Measurement of Shrimp Growth: Random sampling was done fortnightly to monitor the growth of the shrimp. Sampling was done in the early morning to avoid the stress from the sunlight. Bulk weight was taken with ordinary balance and the amount of feed to be given was adjusted accordingly. At the end of the culture period, the shrimps were harvested by completely draining out the ponds. Depending on the size of the ponds complete harvesting took 3 to 4 days.

Results and Discussion

Water Quality Parameters: Ranges of various water quality parameters during the study period in the six ponds under three treatments are shown in Table 2. The temperature ranged between 20 to 30°C with almost always more than 25°C, which is reported to be optimum for shrimp growth (Latif and Islam, 1995; Nakara, 1994). The DO range in the present study was 3 to 13 mg/l, which was also within the safe limit for good growth response of shrimp as reported by Chiu (1988) and Apud *et al*., (1985). Law (1988) recommended pH 7.5 to 8.5 as optimum for the culture of *P. monodon*. Attempts were made to keep the pH close to this range in this study (7.3-8.9) by applying lime. The CO_2 content, which ranged from 4 to 8 mg/l could also be considered as good for the growth and survivability of the shrimps. Thus, it appeared that the growth and survivability of shrimps were not affected by these parameters.

It has been reported that a salinity range of 10 to 25 ppt for optimum growth of *P. monodon* (Apud *et al*., 1995;Latif and Islam, 1995), while 15 to 25 ppt salinity was found to be suitable for shrimp growth by Boyd (1989). However, in the present study, except for the last month of the study period, the salinity ranged between 10 and 24 ppt. (Table 2). The effects of salinity on the growth of shrimp under different treatments are

graphically represented in Fig. 1. A direct influence of salinity on the growth of the shrimp under different treatments was observed. From the Fig. 1, it can be seen that the salinity level dropped around 10 ppt from 135th day of the study period in all treatments and growth rates of shrimp also started to slow down from then onwards. This indicated that salinity has great influence on the growth of the shrimp, and that the optimum salinity lies above 14 ppt, as can be assumed from the intercepts of the growth and salinity curves (Fig. 1).

Table 2. Ranges of water quality parameters in different experimental treatments during the study period.

	Ranges of different water quality parameters				
Treatments	Temperature (°C)	DO (mg/l)	pH	CO_2 (mg/l)	Salinity (ppt)
T_1	20-33	6-13	7.3-8.9	4.0-8.0	05-22
T_2	20-33	4-12	7.5-8.9	5.0-7.5	08-24
T_3	20-33	4-12	7.4-8.6	7.3-8.6	06-24

Growth of Shrimp: The growth performance of the shrimp in different experimental ponds under various treatments are summarized in Table 3, from where it was apparent that T_3 attained significantly ($P<0.05$) the highest weight gain while the lowest of that was observed in T_1.

Although there were no significant ($P>0.05$) differences between the initial weights of shrimp in different treatments, the final weight of shrimp in different treatments varied significantly.

Table 3. Summary of growth performance of shrimp (*P. monodon*) under different treatments during the study period.

Features	Treatments			
Growth parameters	T_1	T_2	T_3	±S.E[1]
Initial weight (g)[2]	00.04 [a]	00.05 [a]	00.03 [a]	0.01
Final weight (g)	31.00 [c]	34.50 [b]	37.50 [a]	0.41
Weight gain (g)	30.96 [c]	34.45 [b]	37.47 [a]	0.29
Specific growth (% day)	04.15 [a]	04.26 [a]	04.45 [a]	0.20
Survival rate (%)	38.50 [c]	54.00 [a]	46.50 [b]	0.41
Production (kg/ha/crop)	236.8 [c]	372.5 [b]	570.00 [a]	12.04

[1] Standard error (S.E.) of treatment means calculated from the residual means square in the analysis of varience.
[2] Figures in the same row having the same superscripts are not significantly ($P>0.05$) different.

The specific growth rates (SGR) of different treatments were more or less similar and there were no significant ($P>0.05$) differences between the SGRs of different treatments, which ranged from 4.15 to 4.45. The survival rate of shrimp was calculated on the basis of the total number of shrimp harvested at the end of the experiment that ranged between 38.5% and 54%, with significantly ($P<0.05$) the highest survival rate was observed in T_2 followed by T_3 and T_1 respectively. The higher survivability in T_2 and T_3 than T_1 could be due to the use of fertilizers that produced more plankton in both treatments (T_2 and T_3), while the less stocking density might have produced the highest survivability in T_2.

There was a significant ($P<0.05$) difference between the productions of shrimp under different

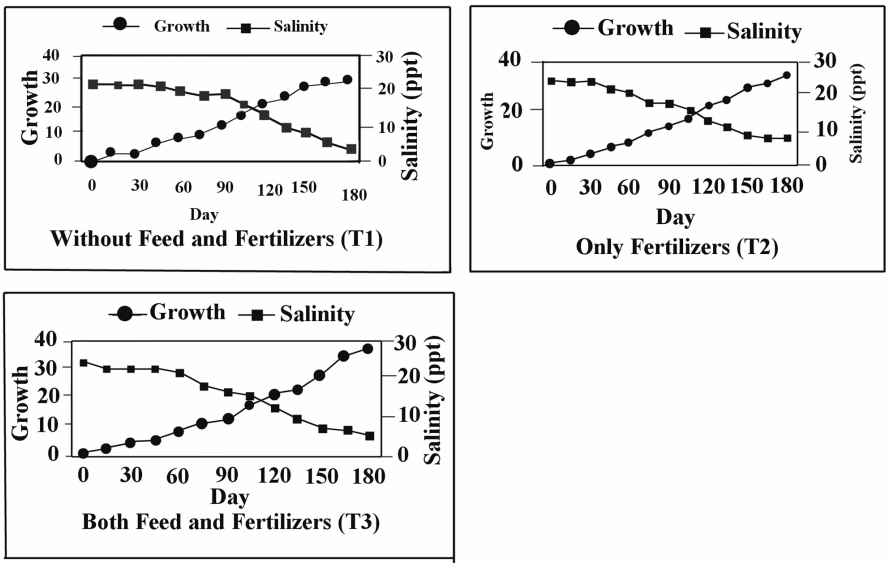

Fig.1: Effect of salinity changes on the growth of *Penaeus monodon* under different treatments.

treatments. The highest production was obtained in T_3 (570 kg/ha/crop) followed by T_2 (372.5 kg/ha/crop) and T_1 (236.85 kg/ha/crop), respectively although T_3 resulted in the second highest survivability. This might be due to the use of both feed and fertilizers in T_3. Latif and Islam (1995) reported that the production of 601 kg/ha/crop of *P. monodon* was obtained in 150 days culture period with fertilizers and some artificial feed. Posads (1988) found a production of 280 and 798 kg/ha/crop of *P. monodon* in extensive and modified extensive culture methods respectively. Hence, the production of shrimp in the present study is in agreement with those reported from shrimp culture under similar condition except that of Posads (1988) who reported a higher production of 798 kg/ha/crop. This was, however, due to the application of not only artificial feed and fertilizers but also other management techniques used in semi-intensive system. Thus, the production of 570 kg/ha/crop of *P. monodon* obtained in the present study in T_3 seems to be quite satisfactory.

Conclusion

Since all the negative consequences of intensive aquaculture experienced in the Southeast Asian countries are already apparent in Bangladesh, it is of the utmost importance to draw lessons from their experiences and avoid yet more of the environmental disasters. Traditional method with some improvements as mentioned in this communication may provide environment friendly alternatives, however, more field trials are necessary to achieve a sustainable production of shrimp through extensive culture.

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