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Optimization of Stocking Rates of Shrimp (*P. monodon*) with Brackishwater Finfish in a Polyculture System

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Abstract : An experiment was conducted in nine earthen ponds each of 0.2 hector. Hatchery produced post larva (PL) of *Penaeus monodon* (1.14 cm, 0.005 g each) were stocked @ 10000, 12500 and 15000/ha in the treatment T_1, T_2 and T_3 respectively. Brackishwater finfish species, such as, *Liza persia, Mugil cephalus* and *Rhinomugil corsula* of initial average length 4.62, 4.22, 3.94 cm respectively and weight 1.41, 1.22, 0.63g respectively, were collected from local rivers and stocked at invariable rates of 8000, 1000 and 2000 individuals/ha in all the treatments. The stocking of finfish was performed during May to mid October. Country produced commercial feed was applied twice a day @ 5-3% of the estimated crop and culture period was continued up to 195 days. The final mean weight of *P. monodon* at harvest was 38.81, 32.79 and 37.69 g for the treatments T_1, T_2 and T_3 respectively. Specific growth rate (SGR%), survival and total production in treatments are found insignificant. The growth of shrimp *P. monodon*, finfish *M. cephalus* and *L. persia* is significant while level; growth for species *R. corsula*, was found insignificant.

Key words: Brackishwater, polyculture, stocking rate, *P. monodon*, *Liza parsia*, *Mugil cephalus*, *Rhinomugil corsula*, growth and survival

Introduction

Brackishwater Aquaculture in Bangladesh at the present time is absolutely directed to farming the brackishwater penaeid shrimp. In the South -West part of Bangladesh, shrimp culture has been traditionally practiced before a long time and the yield per unit area is very low and exceed to rear 150 kg ha^{-1} $year^{-1}$ (Hoq *et al.*, 1994). In the traditional shrimp farming system only post larvae of *P. monodon* are stocked in the ghers (a traditional shrimp farm) but other major brackishwater species of shrimp *viz.*, *Penaeus indicus, P. merguiensis, Metapenaeus monoceros, M. brevicornis* and finfish *viz.*, *Lates calcarifer, Liza parsia, L. tade, L. macrocephalus, Mugil cephalus, Rhinomugil corsula, Oreochromis niloticus, Mystus tengera, Pomadasys hasta, Scatophagus argus* etc.(Natarajan, 1983; Jhingran, 1984; Naskar and Chakraborty, 1984), are found to enter the ghers through accidental intrusion during inlet or exchange of water and reared up there. Among these species, most of them are commercially important and some species are predator and harmful for shrimp production.

Among the finfish species *L. parsia, L. tade, M. cephalus, R. corsula*, are non-carnivorous and bears high demand and market price. Seed of these species are also abundantly available in nature and are cultivable (Chakraborty *et al.*, 1981) in shrimp farming area along with shrimp that might contribute to maximum utilization of water body by keeping environment friendly culture system. Therefore, shrimp-fin fish polyculture technology could be an ideal approach that can possibly ensure optimum utilization of water resources for maximum production per unit area. This system of polyculture may also contribute to reduce the disease risk in the shrimp ghers and could offer a higher rate of production of shrimp and fin fish than the present production from the same area with higher economic benefit.

Considering the above justification with a view to obtain sustainable higher production of shrimp finfish in an environment friendly culture method, the experiment was undertaken to optimize stocking density of the target species, *P. monodon* with three other commercial important brackishwater finfishes.

Materials and Methods

The experiment was conducted during the month of May to November 1999, in nine earthen ponds of Brackishwater Station, Bangladesh Fisheries Research Institute, Paikgacha, Khulna.

The experiment followed Randomized Block Design (RBD) having three treatments, namely T_1, T_2 and T_3.

Selection of ponds: Nine newly re-excavated and repaired earthen ponds each of 0.2 hector, were selected. Water was allowed to enter the ponds by inlet through a long canal connected with the nearby river, the *Kabataski*.

Preparation of the pond: Soil pH was measured and lime ($CaCO_3$) was applied 270-300 Kg ha^{-1} depending on the pH levels of the soil. Mustard oil cake as organic fertilizer was applied @ 100 Kg ha^{-1}. Inorganic fertilizer like triple super phosphate and urea (ratio 3:1) @ 30 kg ha^{-1} was applied. Initially tidal water was allowed to enter up to a depth of about 40-60 cm and wait for natural feed development and water level was finally increased up to 90 cm.

Stocking: Hatchery produced post larvae (PL) of *Penaeus monodon* were stocked @ 10000, 12500 and 15000/ha in the treatment T_1, T_2 and T_3 respectively, in mid May. Brackishwater finfish species like *Liza persia, Mugil cephalus* and *Rhinomugil corsula* collected from local rivers were stocked at invariable rates of 8000, 1000 and 2000 individuals/ha respectively, in all the treatment ponds. Based on the availability of natural seed of finfish the stocking of finfish was performed during May to mid October.

Feed supply: Country produced commercial nursery shrimp feed (*Saudi-bangle*) Starter-1 (content 35% protein) were fed the shrimp twice a day at down and dusk, @ 100% of stocking bio-mass during first week and then the rate were gradually reduced to 60, 40 and 20% accordance with the 2nd, 3rd and 4th week respectively. After 30 days of nursing, shrimp were fed the grower-feed of the same brand (content 30% protein) for twice a day @ 5-3% of the estimated crop. Frequency and amount of feed application was controlled as and when necessary because of cloudy weather or heavy rainfall.

Water management: A portion of water (approximately 20%) was exchanged in all the ponds as per necessity during the new and full moon. To maintain the water pH level,

carbonated lime was used as per requirement. Inorganic fertilizer like urea and TSP in a proportion of 3: 1 were applied @ 30 kg ha^{-1}, depending on the availability of natural feed in pond water. Sampling and data collection: water quality parameters *i.e.*, air and water temperature, pH, salinity, transparency were monitored once in a week. Growth of shrimp and finfishes was monitored fortnightly sampling with a drag or cast net.

Harvesting of shrimp and finfish: After 87 days of culture, harvest was done for *P. monodon* by selective cast net. Remaining finfish species like *L. parsia*, *M. cephalus* and *R. corsula* those were reared in the same ponds for 195 days. The final harvest of finfish and rest of shrimp was done by completely drain out the treatment ponds.

Analysis of data: Statistical analysis were done to find out the impact of stocking on specific growth rate, survival and weight gain of different species following the analytical methods described in Zaman *et al.* (1982).

Results and Discussion

Physico-chemical properties of the experimental ponds are shown as mean (±SD) variation in different months in Table 1. Data reveals that, water temperature during the period was ranging between 32.75 to 29.35°C and higher and lower value was recorded in June and November of the same year. Water salinity range during the study was recorded between 18.25 to 0 ppt, with higher salinity in the month of June which was observed to decrease sharply during the month of August then gradually in the following months towards zero in October. Similarly water pH values were recorded between 9.00 to 7.68 in all the treatments. Though as apparent variation for these parameters was observed among the treatments, but parameter wise range was found within the limit for shrimp and brackishwater finfish culture (Ali *et al.*, 1999 and Roy *et al.*, 1999). On the other hand, a great variation was observed for water transparency and found between 22.00 to 64.00cm, when the higher visibility in the treatments might be due to the growth of aquatic weeds and low for turbidity because of suspended particles after heavy rainfall, erosion of dyke due to strong wind action or silt carried by tidal water. Similarly, the erratic water transparency due to succession of algal blooms was also reported by Nammalwar and Kathirvel (1988). However, Hossain (1987) reported that , variation attributed to the differential formation plankton and qualitative incursion of silt laden in water during tidal exchange.

The initial average length and weight of the four species *P. monodon*, *L. parsia*, *M. cephalus*, *R. corsula* are presented in Table 2. Species wise average length and weight as recorded were 1.10, 4.62, 4.22, 3.94 cm and 0.005, 1.41, 1.22, 0.63g respectively. Only *P. monodon* after 87 days and *L. parsia* after 195 days of culture attained marketable size but not the other two species, such as, *M. cephalus* and *R. corsula*. The final mean weight of *P. monodon* was found 38.81, 32.79 and 37.69 g for the treatments T_1, T_2 and T_3 respectively, while for *L. parsia* it was 27.03, 18.17

Table 1. Variation of water quality parameters (Mean ±SD) in different months during the experimental period.

	Water temperature (°C).						
Treatments	Months						
	May	June	July	Aug.	Sep.	Oct.	Nov.
T_1	31.00±1.436	32.70±2.083	30.17±0.961	31.83±0.353	31.40±1.404	30.83±1.290	29.35±0.812
T_2	30.89±1.431	32.62±1.811	29.92±1.104	31.88±0.600	31.40±1.240	30.75±1.405	29.40±0.936
T_3	30.83±1.369	32.75±1.936	29.96±1.137	31.72±0.565	31.33±1.251	30.91±1.200	29.70±0.566
	Water Salinity (ppt.)						
Treatments	Months						
	May	June	July	Aug.	Sep.	Oct.	Nov.
T_1	17.67±1.323	18.00±2.132	13.08±2.778	5.78±1.202	2.47±1.356	0.42±0.491	0.00±0.000
T_2	17.56±1.589	17.83±2.368	13.00±2.796	5.55±1.667	2.33±1.589	0.33±0.516	0.17±0.408
T_3	18.22±1.093	18.25±2.094	13.25±2.221	5.78±1.481	2.73±1.624	0.42±0.491	0.17±0.408
	Water pH						
Treatments	Months						
	May	June	July	Aug.	Sep.	Oct.	Nov.
T_1	9.00±0.409	8.97±0.605	8.57±0.394	8.40±0.570	8.15±0.573	8.02±0.147	7.90±0.228
T_2	8.64±0.394	8.66±0.604	8.57±0.429	8.29±0.516	8.05±0.514	7.85±1.122	7.70±0.209
T_3	8.35±0.124	8.24±0.370	8.29±0.193	8.27±0.515	8.03±0.552	7.68±0.172	7.68±0.172
	Water transparency (cm)						
Treatments	Months						
	May	June	July	Aug.	Sep.	Oct.	Nov.
T_1	51.33±24.704	64.00±6.055	63.00±15.829	58.25±21.096	31.68±11.323	34.40±16.288	28.25±4.645
T_2	49.85±18.515	57.75±3.774	58.80±16.267	53.78±12.774	35.17±10.373	27.33±5.537	29.78±7.378
T_3	52.33±20.892	57.87±11.752	51.83±10.911	45.67±11.811	29.95±3.387	22.00±3.687	23.87±4.611

Table 2: Cultural feature on shrimp *P. monodon* and brackishwater finfish species *L. parsia*, *M. cephalus* and *R. corsula* in a polyculture system

Treatment	Species	Stocking rates Individuals/ha	Stocking period (Month)	Initial length (cm)	Initial wt.(g)	Culture period (days)	Final length (cm)	Final wt. (g)	SGR* %	Survival %	Production kg ha^{-1}	Total production kg ha^{-1}
T_1	*P. monodon*	10000	Last of May	1.10	0.005	87-195	16.09	38.81	19.21	39.09	151.50	
	L. parsia	8000	Mid of May	4.62	1.41	195	12.97	27.03	13.13	63.72	130.03	
	M. cephalus	1000	August–early September	4.22	1.22	85	9.67	10.91	11.39	64.67	7.06	
T_2	*R. corsula*	2000	Sep- mid Oct.	3.94	0.63	45	7.64	4.39	8.35	72.50	6.39	294.98
	P. monodon	12500	Last of May	1.10	0.005	87-195	15.33	32.79	16.81	33.12	136.00	
	L. parsia	8000	Mid of May	4.62	1.41	195	11.27	18.17	8.59	68.17	110.61	
	M. cephalus	1000	August–early September	4.22	1.22	85	8.38	7.90	7.86	56.67	4.57	
T_3	*R. corsula*	2000	Sep- mid Oct.	3.94	0.63	45	5.84	3.58	6.55	55.42	3.98	255.16
	P. monodon	15000	Last of May	1.10	0.005	87-195	16.15	37.69	19.33	24.92	141.31	
	L. parsia	8000	Mid of May	4.62	1.41	195	11.06	18.03	8.52	62.89	90.62	
	M. cephalus	1000	August–early September	4.22	1.22	85	7.41	7.03	6.84	63.42	4.51	
	R. corsula	2000	Sep- mid Oct.	3.94	0.63	45	6.47	4.12	7.76	73.72	6.24	242.68

* Specific growth rate.

Table 3: Significant test result from specific growth rate, survival and production of *P. monodon* and other fin fishes

Variants	Treatments			F ratio
	T_1	T_2	T_3	
SGR%	13.02±4.573	9.95±4.648	10.61±5.852	0.4087
Survival %	59.77±14.915	53.34±14.654	56.24±21.465	0.09227
Final wt. of *P. monodon*	38.82^a±1.670	32.79^b±2.325	37.69^b±1.276	10.242*
Final wt. of *L. persia*	27.03^a±2.662	18.17^b±2.500	18.03^b±1.822	14.347**
Final wt. of *M. cephlus*	10.91^a±0.391	7.90^b±1.450	7.03^b±1.618	7.643*
Final wt. of *R. corsula*	4.34±0.685	3.58±0.192	4.12±1.080	0.916NS
Total production	294.98±7.347	255.16±37.297	242.67±25.602	3.197

NS = Non significant, SGR = Specific growth rate, * = $P < 0.05$, ** = $P < 0.01$

and 18.03 g for the treatments T_1, T_2 and T_3 respectively. However, growth of *M. cephalus* after 85 days of culture were 10.91, 7.90 and 7.03 g in the testaments T_1, T_2 and T_3 respectively, while, growth of *R. corsula* was obtained after 45 days of culture period were 4.39, 3.58 and 4.12 g in the testaments T_1, T_2 and T_3 respectively (because of late stocking). James *et al*. (1985), reported that, in brackishwater pond, *M. parsia* of 17 mm grown to 90-100 mm at stocking rate of 200,000/ha for 110 days of culture, while 12500/ha, the growth was 151 and 116.2 mm in accordance with and with out supplement feed at 120 days of culture period. The author also stated that, survival for *M. cephalus* ranged 43-63% while an artificial propagated 54 days old hatchling grown to 20.1 cm and 82.3 g in a culture period of 151 days and 28.1 cm, 217.4 g at 200 days. In a monocultue system, growth was 553 g at 197 days and in polyculture it was 2.65-3.68 g/fish/day. Growth of *M. parsia* and *M. cephalus* was found in an average 117.67 mm and 86 mm for 195 and 85 day respectively, in the polyculture system seems to be satisfactory regarding the rearing period. The calculated value showed that, the growth of shrimp *P. monodon* and finfish *M. cephalus* in the treatments were significant ($p > 0.05$), while, for *L. persia* growth is significant at $p > 0.01$ level (Table 3). The growth variations in treatments for *P. monodon*, might due to density of shrimp initially stocked while for *M. cephalus* and *L. parsia* might due to variation of time during stocking at different ponds. It is assume that, erratic growth of submerged aquatic weeds, some undesirable fish (*Tilapia sp.*) and shrimps obtained from the ponds might have relations to growth variations of the targeted species. However, for the species *R. corsula*, growth was found insignificant. Hoq *et al*. (1994), obtained higher survival percent and production in monoculture of *P. monodon* at density 2/m^2 and gradually decreased at, 3/m^2 and 4/m^2 while Ali *et al*. (1999) obtained growth variations due to aquatic weeds in the shrimp ponds. The specific growth rates (SGR%) were calculated for the species in accordance with treatments and shown in the Table 2. The values for *P. monodon* were 19.21, 16.81 and 19.33 in the treatments T_1, T_2 and T_3 respectively. While for *L. parsia* the rate was 13.13, 8.59 and 8.52, for *M. cephalus*, it was 11.39, 7.86 and 6.84 for *R. corsula* the rate was 8.35, 6.55 and 7.76 in the treatments T_1, T_2 and T_3 respectively.

R. corsula showed higher survival rate of 72.50, 55.42 and 73.72% for the treatments T_1, T_2 and T_3 respectively, followed by *L. parsia* 63.72, 68.17 and 62.89% and by *M. cephalus* 64.67 56.67 and 63.42% in the treatments T_1, T_2 and T_3 respectively. The higher survival for *R. corsula* and *M. cephalus* might due to short period of cultural duration. *P. monodon* showed lower survival 39.09, 33.12 and 24.92 in the treatments T_1, T_2 and T_3 respectively compare to finfish. The survival of 40.67% in monoculture of *P. monodon* with a production 231 kg ha^1 crop^{-1} with an individual growth 29.88 g for a culture period 149 days observed by Roy *et al*. (1999). Ali *et al*. (1999) stocked with 4 pl/m^2 and in another study they obtained 35 g mean weight and 28.76% of survival of *P. monodon* for a culture period 105 days. Nammalwar and Kathirvel (1988) obtained 20.6-35.3% of survival and 12.8-17.8 g of growth for *P. monodon* after 6 month of culture while stocked with *Chanos chanos* in a polyculture system.

Therefore, the study shows that, the stocking rate of 10,000 to 15,000 Pls/ha of shrimp *P. monodon* with finfish species *L. persia*, *M. cephalus* and *R. corsula* at 8000, 1000 and 2000 fry/ha be a more suitable combination in a polyculture system if stocking of all the species can ensure in same time.

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