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Determination of suitable density of prawn (*Macrobrachium rosenbergii*) in concurrent culture with shrimp (*Penaeus monodon*) in brackishwater

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ABSTRACT

With the aim of optimizing stocking density of prawn (*Macrobrachium rosenbergii*) in concurrent culture with shrimp (*Penaeus monodon*), an experiment was conducted in brackish water earthen ponds with three different stocking densities of prawn (T1= 3/m^2, T2= 2/m^2 and T3= 1/m^2) with single crop. Whereas, the stocking density of shrimp remained similar (3/m^2) in all the three treatments with a double cropping pattern. Each treatment had three replications. After 115 days of culture, average final weight gain of shrimp for the first crop was similar (25.21g to 27.07g) in all the treatments. Recovery rate (60.02– 62.92%) and food conversion ratio (FCR) (1.69-1.8) of shrimp was also similar in all the treatments. Production of shrimp for the first crop ranged from 465.62 to 481.39 kg/ha in all the treatments and was statistically insignificant ($p>0.05$). However, after 135 days of culture, production of Shrimp in 2nd crop was highest (345.44 kg/ha) in T2. prawn attained an average body weight of 42.0, 46.8 and 48.2 g in T1, T2 and T3 respectively after 225 days of culture and was statistically insignificant ($p>0.05$) among treatments. Production of prawn was recorded 535.94, 534.90 and 309.32 kg/ha in T1, T2 and T3, respectively. Production of prawn was statistically insignificant ($p>0.05$) between T1 (535.94 kg/ha) and T2 (534.90 kg/ha) but it was statistically significant ($p<0.05$) between T1 (535.94 kg/ha) and T3 (309.32 kg/ha) and between T2 (534.90 kg/ha) and T3 (309.32 kg/ha).

Key words: Stocking density, Prawn, Concurrent culture, shrimp, brackishwater environment, Bangladesh.

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INTRODUCTION

Shrimp (*Penaeus monodon*) farming in Bangladesh traditionally started since 1960s, in the low laying tide fed coastal agricultural field with the intention to harvest the naturally introduced shrimp. Despite of enormous potentialities, the average production of shrimp from per unit area was not satisfactory at all, and it is about150 kg/ha/yr (Shofiquzzoha and Ahmed, 2001). The reasons behind this low level of production is the larger sized ghers, irregular and shallower water depth, inadequate water management facilities, lack of proper scientific knowledge among the farmers. All of these leading to culture environment degradation, external stress to shrimp and finally outbreak of white spot disease, hence threatening the shrimp sector.

Recently, the farmers have the tendency to split out their ghers into smaller unit with minimum renovation and they supply minimum inputs (lime, fertilizers and feeds), maintain their gher with relatively better water management practice and the production from this smaller ghers is relatively better than that of the larger ghers (Milstein, et al, 2005). This smaller ghers are also very much

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suitable for the culture of Prawn, *Macrobrachium rosenbergii* (locally called Galda).

Freshwater prawn farming in Bangladesh has a number of socio-economic advantages over shrimp farming. Unlike the shrimp farms which are normally large (average size above 10 ha or 25 ha), and often operated by non-resident elite owners, the Galda farms are mostly small (average size less than an acre) and operated by the landowners themselves. It has been observed frequently that total farm output increases through the inclusion of suitable fish and/or prawn in rice fields (Alam et al., 2006 and Cai et.al., 1995). Besides, Galda is yet not susceptible to the prevailing white spot virus disease (Hameed et al, 2000), that causes huge economic losses to the shrimp. For all these reasons, Galda culture is socially more acceptable and technically and economically more viable and sustainable.

Although a freshwater species, Prawn in early stages needs higher salinity level up to juvenile stage and can survive and grow normally in salinity up to 8 ppt. The year round salinity level of the South-west coastal region provided the opportunity for horizontal and vertical expansion of Galda farming is, therefore, enormous. If prawn could be cultured along with shrimp, it would be an appropriate technique to minimize the disease outbreak for both the species and would be helpful for minimizing the production risk. Polyculture of shrimp and brackishwater fin-fish by Shofiquzzoha et al. (2003), shrimp and some freshwater and hyposaline fin-fish by BFRI (2005) and shrimp, prawn and tilapia by Sherif and Mureau (2000) has been reported. But information regarding the concurrent culture of shrimp and prawn in brackishwater environment is very limited in Bangladesh. Brackishwater aquaculture is an age old practice in India, Philippines, Indonesia etc. (Jhingran, 1982). Both brackishwater and freshwater aquaculture are major growth industries in many parts of Asia, Latin America and represent a very important element in the economy of many developing countries as a source of foreign exchange earnings. Natarajan (1983) and Naskar and Chakraborty (1984) reported that in the Sundarbans the common culturable species are *Penaeus monodon*, *P. indicus*, *Metapenaeus monoceros*, *Mugil cephalus*, *Liza parsia*, *Liza tade*, *Lates calcarifer* etc. Among the culturable fishes mullets and tiger shrimps are the most important members in the brackishwater region. These fishes and prawns are cultured in about 2500 small to large-sized brackishwater fisheries in Sundarbans (Ghosh, 1980). Jana and Chatterjee (1974) mentioned that several important fishes and prawns are now declining from the Sundarbans estuaries due to deterioration of the mangrove vegetation. However, development of concurrent culture of shrimp and prawn in brackishwater environment will be an alternate effort to boost up the existing production levels with minimizing the production risk. As in many other countries in Asia, the brackishwater shrimp (*P. monodon*) and freshwater prawn (*M. rosenbergii*) culture is now receiving much attention in Bangladesh. The present study was undertaken to determine the suitable density of prawn in concurrent culture with shrimp in brackishwater environment.

MATERIALS AND METHODS

An on-station experiment was conducted in earthen ponds with three different stocking densities of prawn (T1= 3/m^2, T2= 2/m^2 and T3= 1/m^2) with single crop. But the stocking density of shrimp remained similar (3/m^2) in all the treatments with a double cropping pattern. Each treatment had three replications.

Pond preparation

All the ponds under the experiment were prepared by dewatering, liming (250 kg/ha), water filling, killing of unwanted animals and fertilization with urea @ 2.5 ppm, TSP @ 3.5 ppm, MP @ 0.8 ppm and molasses @ 3.0 ppm.

Stocking

Stocking of first crop of shrimp was done on 11th March, 2010. Whereas, stocking of prawn was done on 2nd May. At that time, shrimp of first crop attained an average body weight of 4.40 – 6.50g in different treatments. Stocking of 2nd crop of shrimp was done on 18th June.

Post stocking management

In the nursery enclosure, post-larvae were fed with commercial nursery feed. Feed was supplied by

spreading @ 100%, 80% and 60% of the estimated shrimp biomass at 6 h intervals daily in the 1st, 2nd and 3rd week, respectively. After 3rd week of nursery rearing, the juveniles of shrimp were allowed to spread over the whole pond by opening the nursery enclosure. After then, feed was supplied as demand basis in trays at 6 h intervals daily up to 70 days of culture (DOC) and then at 4 h intervals daily up to the end of culture period. For maintaining productivity, the pond water was periodically treated with dolomite (8.0-12.0 ppm) and inorganic fertilizer *viz*. Urea (0.5-1.5 ppm) and TSP (1.5-2.5 ppm) as needed.

Data collection and analysis

Important water quality parameters *viz.*, depth, temperature, salinity, pH, transparency, free carbon dioxide, total alkalinity and dissolved oxygen were determined at weekly intervals following standard methods as mentioned by APHA (1992). Water quality parameters except transparency were recorded in the morning. Transparency of water was measured at noon. Growth performance of both shrimp and prawn were recorded by weekly sampling and analysis was done following one way ANOVA. Duncan Multiple Range Test (DMRT) was also employed for further analysis of the result and the FCR (Food Conversion Ratio) was calculated by using the following formula.

$$FCR = \frac{Amount\ of\ dry\ food\ (g)}{Live\ wight\ gain\ (g)}$$

RESULTS AND DISCUSSION

Variations in water quality variables during the study period have been presented in Table 1. Water temperature was in highest level of 37.5^{0}C during the draught period, at the same time dissolved oxygen dropped to the minimum level of 3.1mg/l. Depth of water in all the experimental ponds seemed to be suitable levels for shrimp culture. Other major water quality variables were found to be congenial for brackish water aquaculture.

Results obtained on weight gain, recovery rate and production of shrimp under different treatments are furnished in table 2. Average final weight gain of shrimp was similar (25.21g to 27.07g) in all the treatments. Hoq et al. (1994) reported a weight gain of 27.99g in 105 days of culture with a stocking density of 4 PL/m^2.They used both handmade and pellet feeds and the culture system was improved extensive. Recovery rate of shrimp was also similar (60.02 – 62.92%) in all the treatments. Production of shrimp for the first crop ranged from 465.62 to 481.39 kg/ha in all the treatments and was statistically insignificant ($p>0.05$). No interspecies interaction between shrimp and prawn was observed up to the harvest of 1st crop of shrimp.

Table1
Range of water quality variables under different treatments during the study period.

Water quality Variables	Treatments		
	T1	T2	T3
Temperature (^{o}C)	30.5-37	30.5-37.5	30.5-37
Transparency (cm)	24-43	24.5-41	22-45
Depth (cm)	80-120	90-132	85-125
pH	8.3-9	8.2-9.2	8.3-9
Salinity (ppt)	0.5-15	0.5-15.5	0.5-15.5
Dissolved oxygen (mg/l)	3.5-7.9	3.1-7.8	4.1-7.5
Free CO_2 (mg/l)	4.2-5.4	6.1-8.2	3.9-5.3
Total alkalinity (mg/l)	115-170	125-165	105-160

Growth performance of shrimp for the 2nd crop has been furnished in figure 1. After 135 days of rearing shrimp attained an average body weight ranged of 20.7-21.4g in all the treatments. Shrimp of 2nd crop showed relatively lower rate in weight gain after 60 days of culture (Figure 1), when the monsoon rain started, sudden fall in salinity and subsequently fall of temperature due to commencement of winter.

Figure-2 depict that growth of prawn up to 75 days of culture was minimum. Afterwards, it showed exponential growth until 180 days of culture then stunted further. Though the culture duration is enough longer to grow marketable size of prawn but actual and congenial growth period seemed shorter considering saline period in early stage and winter in later stage.

Table2
Details of weight gain, recovery rate and production of shrimp under different treatments for the first crop of shrimp.

Parameters	Treatments		
	T1	T2	T3
Initial wt (g)	0.007	0.007	0.007
Final Wt (g)	25.65±1.99	27.07±2.33	25.21±0.75
Recovery rate (%)	62.92±14.21	60.20±13.62	62.32±4.31
Production (kg/ha)	480.63±65.58	481.39±59.40	465.62±22.37
FCR	1.73±0.07	1.69±0.07	1.80±0.07

Table3
Details of weight gain, recovery rate and production of 2nd crop of shrimp and single crop of prawn under different treatments.

Parameters	Treatments		
	T1	T2	T3
Initial wt (g)	0.007	0.007	0.007
Final Wt (g)	20.7±1.82	21.4±1.71	21.4±2.01
Recovery rate (%)	53.32±8.74	53.53±6.74	48.68±3.71
Production (kg/ha)	330.60±77.44	345.44±67.33	313.63±50.68
FCR	1.74±0.07	1.77±0.05	1.74±0.05
Freshwater Prawn			
Initial wt (g)	0.05	0.05	0.05
Final Wt (g)	42.0±3.08	46.8±3.78	48.2±3.67
Recovery rate (%)	42.0 ± 6.91^{bc}	57.4 ± 5.16^{ab}	64.6 ± 8.35^{a}
Production (kg/ha)	535.94 ± 127.14^{a}	534.90 ± 13.34^{ab}	309.32 ± 17.28^{c}
FCR	1.89±0.03	1.84±0.02	1.95±0.03

*Different letters are significantly different with each other when compared with DMRT.

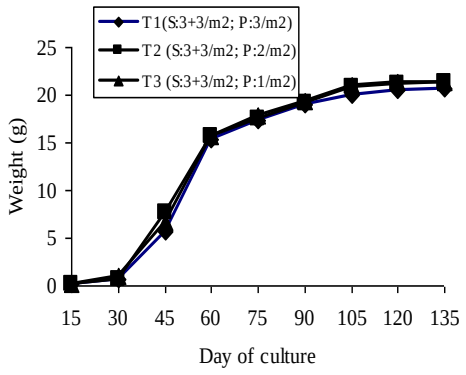

Figure.1
Growth of shrimp (2nd crop) at 135 days

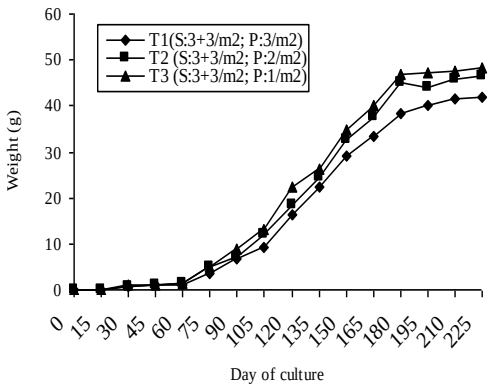

Figure.2
Growth of prawn at 225 days of culture

Details of growth, survival and production of 2nd crop of shrimp have been presented in Table 3. Shrimp of 2nd crop attained an average body weight of 20.7 to 21.4 g in all three treatments after 135 days of culture. Hossain et al. (1992) found the final body weight of 21.65g for 120 days culture of shrimp where hand made feeds were used and stocking density was 30,000/ha and the culture system was improve extensively Survival of shrimp was 48.68 to 53.53% and that of production was 313.63 to 345.44 kg/ha in all treatments. Kumar Roy et al, (2013) reveals that, production of shrimp was 347.20 kg/ha in polyculture system with prawn and catla in crop rotation pond. Quddus et al. (1990) recorded 585 kg/ha shrimp through improved extensive method in 120 days culture period at the stocking density of 28000/ha which was higher than the production of shrimp in the present study. In spite of longer culture duration of 2nd crop of shrimp than the 1st crop of shrimp, body weight gain, survival rate and production was lower than that of 1st crop of shrimp. All these happened might be due to the fall in water salinity and subsequently commencement of winter. It also might be happened due probably to interspecies interaction to that of freshwater prawn when it attained juvenile stages. Growth, survival and production of single crop of freshwater prawn in concurrent culture system have also been furnished in Table 3. After 225 days of culture prawn attained an average body weight of 42.0, 46.8 and 48.2 g in T1, T2 and T3, respectively. Shafi and Quddus (1973) found the final body weight 50.25 g for 180 days culture period of prawn. They used hand made feeds and stocking density was 15000/ha and the culture system was improved extensively. Final weight gain of prawn was statistically insignificant ($p>0.05$) between the treatments. Survival of prawn was 42.0, 57.4 and 64.6% in T1, T2 and T3, respectively. Survival of prawn was statistically insignificant ($p>0.05$) between T3 and T2 and also between T2 and T1. But it was statistically significant ($p<0.05$) between T3 and T1 with the highest (64.6%) in T3. Production of prawn was recorded 535.94, 534.90 and 309.32 kg/ha in T1, T2 and T3, respectively. Chandra et al. (2010) reported that Production of prawn was 428.08 kg/ha in polyculture system with shrimp and white fish where average stocking density of bagda and golda PL and white fishes were 24.16, 12.16 and 0.45 thousand /ha respectively in the study area. Production of prawn was statistically insignificant ($p>0.05$) between T1 and T2, but it was statistically significant ($p<0.05$) between T1 and T3 and between T2 and T3. However, in this experiment prawn showed higher survival with lower stocking density, likewise, production of prawn showed density dependent augmentation.

CONCLUSION

In brackish water environment, growth pattern of freshwater prawn indicated slow growth rate in its initial stage of up to 90 days, then the growth rate enhanced and continued up to 180 days and later then stunted further. Though the culture duration is enough longer to grow marketable size of prawn but actual and congenial growth period seemed shorter considering saline period in early stage and winter in later stage. Advancing the stocking time of prawn congenial grow out period could be increased. Stocking of male prawn with rearing could also be another option to grow optimum marketable size of prawn in concurrent culture system. However, considering body weight gain, survival rate, production and economic return of prawn, it could be recommended that stocking density of prawn should be maintained between 1-2/m^2 for concurrent culture of shrimp and prawn in brackish water environment.

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