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Two crops shrimp farming is a new approach to enhance production in semi intensive farming in coastal region of Bangladesh

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Abstract

Traditionally in Bangladesh, farmer's usually produce single crops shrimp in a year. Most often producer has no information that, two crops in a year are more economically profitable. Therefore current research aimed to evaluate two crops shrimp production performance in semi-intensive culture systems. The study was conducted in a semi-intensive farm, Sabinco Gazi Fish Culture Ltd in Dacope, Khulna from July, 2016 to June, 2017 and two crops were designed as dry crops (February–June, T1) and rainy season crops (July–November, T2). The initial mean body weight of shrimp was 0.31±0.03 and 0.305±0.02g respectively in T1 and T2. The stocking density was 12 and 7 PL/m^2 respectively at two successive crops. After 120 days of cultured period the average individual body weight was 32.33±2.5 and 36±4.5g respectively in T1 and T2, and survival rate was 80.68 and 82.53% successively in two crops. The gross production was 3128.89±103.60 and 2079.76±73.63kg/ha correspondingly at T1 and T2. Although farmers in southern region of Bangladesh usually practice single crop (Feb-June) in a years, however two crops in a year is a new approach to get more profit, and most often it's more profitable than traditional crops.

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Introduction

Tiger shrimp, *Penaeus monodon* known as white gold is highly demanding to customer around the world for its taste and economic value (Hishamunda *et al*., 2009; Paul and Vogl, 2011). Bangladesh is endowed with vast and varied aquatic resources in the form of rivers, canals, flood plain, lakes, tanks, ponds, lagoons, estuaries and along cost line displaying high diversity in their biotic and abiotic characteristics (Azad *et al*., 2009). Also blessed with a favorable conductive climate, the country offers immense scope and potential for a considerable increase in fish production. In Bangladesh, the export of frozen shrimp was 15,023 tonnes in 1988, which tripled to about 49,907 tonnes two decades later, i.e. in 2008 (DoF, 2009). The contribution of frozen seafood towards the GDP amounted to about 4 percent in the financial year 2008-2009 (Chowdhury *et al*., 2006; Azad *et al*., 2009; BBS, 2009; Paul and Vogl, 2011).

Shrimp farming in the South and Southeastern coastal belt of Bangladesh began in the early 1970s. Suitable area available for marine shrimp (*Penaeus monodon*) culture may be in the range of 1, 50,000 ha in the Southwest part and possible 50,000 ha in the Southeast part of the country (Ahmed and Garnett 2010; Islam *et al*., 2005; Ahmed *et al*., 2008). It represents the second largest export industry for Bangladesh after garments with 97% of the shrimp produced being exported (Chandra, 2010). Shrimp culture was contributing about 4% to national GDP and employing approximately 1.2 million people for production, processing and marketing activities. Including their families, this sees approximately 4.8 million Bangladeshi people directly dependent on this sector for their livelihood (Paul, 2012; Haque, 2012))

Traditionally in the southern part of Bangladesh, farmers used to practice single cycle of shrimp production in Bangladesh. But shrimp production is not sufficient because of traditional farming and single crop practice in a year. After harvesting the first crop the farm always remain unused for several months. This time farmers have no additional income from the farm. Therefore the current study will investigate the prospect of two crop production in a year. Present study has been carried out in GAZI Fish Culture Ltd which is the joint venture of Saudi-Bangla. It is one of the fish farm which also contributes in national economy of Bangladesh by culturing tiger shrimp. This study going to observe the growth, survival rate and production of *Penaeus monodon* culture in the semi-intensive method of dry and rainy season.

Materials and methods

Study Site and Experimental setup

The study was conducted in Gazi Fish Culture Ltd. in Dacope, Khulna in two different seasons viz. dry season (Feb-June, T_1) as first crop and rainy season (July-November, T_2) as second crops during 2015-2016. Each group were replicated thrice time. The experiment was conducted with the tiger shrimp with semi-intensive mono culture systems.

Pond preparation

For the semi-intensive culture of tiger prawn pond preparation was started from October and the whole preparation was end up in November. At first weed out the weeds from pond edge, inlet and outlet. The base of each dike was 30'-40', top of each dike was 15'-20' and height: slope was 1:2. Each pond was surrounded by blue net so that any harmful insects, snakes & crabs could not enter the ponds. 20-25kg/ acre $CaCO_3$ was applied with water and spread it all over the pond bottom. It was used to disinfect the pond bottom. 10-15ft long bamboo pole was fixed at the four corner of the dry pond. The bamboo pole was fixed 20-25 ft inside of the pond. Before the entrance of saline water filter net was attached in the inlet pipe so that any foreign particle could not enter in the pond. Water was entered in the pond in the middle of February. The depth of the pond water was 4-5 ft. Crab net was fixed after filling the water. Four aerators were fixed at the four corner of the pond so that it could be used after bleaching. After the entrance of water into the pond it required 2-3 days for settlement then water was treated with bleaching powder at 30-35%. After 3-5 days of chlorine application aerator was started at least 6hrs in day

and night. Before stocking PL in the pond dragging the chain for 7-8 days so that any kind of gas would be out from the ponds.

Productivity enrichment by applying probiotics and fertilizer

Molasses cooking juice (Rice polish 5-7 kg, molasses 5-10kg, fish meal 2-3kg and yeast powder 500-1000gm mixture) was applied for 5-7kg/ acre each day. A. Soil (organic fertilizer) was 6-7kg/ acre then 10-12kg/ acre was applied to develop the plankton development in the pond. pH fixture and Blue mix were used to stable the pH and growth of phytoplankton at 1.5-2kg/ acre and 1-2kg/ acre respectively. Dolomite is a source of Ca, Mg carbonate was used 15-20kg/ acre. Before stocking the PL this kind of probiotics was applied for 5-7 litre/acre or pro-w 100-150gm/ acre.

PL stocking management

The source of PL was hatchery. For the stocking of PL the best size is PL-15, PL-16, PL-17 days. As the culture system was semi intensive PL was stocked through PCR testing. For culturing two crop in the farm, 1st crop was stocked in the last of February to June at 12/m² and the 2nd crop was stocked from July to November at 7/m². During stocking the average PL weight were 0.31±0.03 and 0.305±0.02g respectively in dry and rainy season. For the best time of stocking PL is morning and evening. Before stocking the PL were acclimatized in a hapa in order to reduce mortality rate.

Post stocking management

After the stocking of PL aeration and supply of food was done. The routine of aeration was 6 hours total in day and night for 1st month for the second month 8 hours total in day and night, 10 hours for 3rd month and 12 hours for 4th and 5th month. Regular aeration helps to increase the DO level, it clears the feeding zone and helps in the mixture of water, mineral and probiotics. During the culture period of both season the ponds were fertilized by inorganic fertilizer and probiotics like pro-w, Super ps, Bactogro, soilgro, witogroetc. At the same time inorganic fertilizer such as CaO, dolomite, sodamix was applied at regular interval. For avoiding disease bio-security, regular chain crawling, application of probiotics and minerals and regular health checkup was maintained. There is no treatment for virus disease of shrimp. As I previously mention, it is a semi-intensive farm as a result all the necessary activities were conducted very carefully through good aquaculture practice (GAP) standard.

Measuring of Survival rate, Average daily growth (ADG), Specific growth rate and FCR

The survival rate, average daily growth and FCR were calculated by the following formula:

$$Survival\ rate = \frac{No.of\ total\ live\ shrimp}{total\ no.of\ shrimp\ stocked} X\ 100$$

$$ADG = \frac{Average\ final\ body\ weight\ (g)\ -\ average\ initial\ body\ weight\ (g)}{culture\ period\ (day)}$$

$$FCR = \frac{Dry\ weight\ food\ presented\ (kg)}{Wet\ weight\ of\ animal\ presented\ (kg)}$$

$$Specific\ growth\ rate\ (SGR)\ =\ (ln(Wt) - ln(W0))/tX100$$

Measurement of water Physico-Chemical Parameters

Water physico-chemical parameters (Salinity, pH, alkalinity, Temperature, DO etc) were routinely measured through standard method. Most of the water quality parameters were measured through standard protocol by using HACH kit, produced by HACH, USA (Model FF-2) and also using specific parameters measuring manual. Salinity was measured by Refractometer (ATAGO CO. LTD, Japan, Master- T 2312, Salinity range 0–100ppt), and Digital Thermometer (DIGITAL THERMOME-TER, made in China, model no WT-2, Temperature range –20–80°C) was used to measure temperature. pH was measured by using pH meter (HACH, Sension 3, USA), dissolved oxygen was measured by DO meter (PDO-519, made in Taiwan, Lutron). Alkalinity (titration method with sulphuric acid), ammonia (Nessler Method) were measured by HACH kit, produced by HACH, USA (Model FF-2).

Statistical analysis

Collected data were accumulated, grouped and interpreted according to the objectives as well as parameters. All statistical analyses were considered significant at 5% ($P < 0.05$).

One-way analysis of variance (ANOVA, multiple comparisons, Tukey's test) was used to determine any significant difference of weight of prawn among the treatments using SPSS 25 software and t-test was used to determine any significant differences of survival rate, FCR production among the treatments and using Microsoft excel 2007.

Result

Growth performance of shrimp between two crops

After 120 days of culture period the average body weight were 32.33±2.5 and 36.0±4.5g respectively in T1 and T2 whereas the survival rate ware 80.7 and 82.5% in T1 and T2. On the other hand higher FCR were observed at T1 but average individual weight gain was higher in T2 (Table-1). Again the monthly higher growth trend was observed in rainy season crop (T2) (Fig. 1)

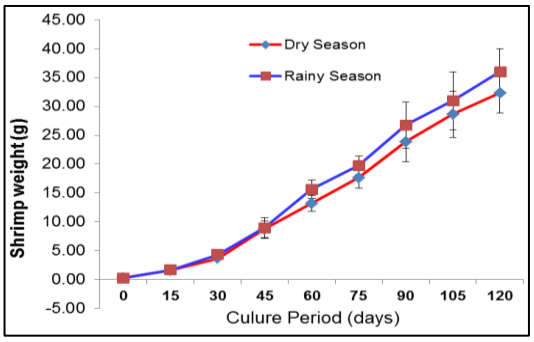

Fig. 1. Average growth pattern of shrimp in two successive crops in a year. Error bar is showing significant deviation from the mean value of shrimp growth.

Water quality parameter

The water salinity was varied between 11-12 ppt in dry season and 6-7 ppt in rainy season all ponds (Table 1).

The salinity gradually increased from February to June. There after it started to decline. The fluctuation of salinity showed different patterns in all the ponds throughout the culture period.

The water temperature values were varied between 27°-29°C in dry season and 24°-25°C in rainy season in all ponds (Table 2). The lowest and highest value of temperature was recorded of February and June respectively. The water alkalinity values were varied between 160-190 mg/L in dry season and 140-150 mg/L in rainy season in all ponds (Table 2).

The lowest and highest value of alkalinity was recorded in the pond T_1P_1 and T_1P_2 respectively. The pH values were varied between 7.8-8.0 in dry season and 7.7-7.9 in rainy season (table 2). The lowest and highest value was recorded from T_1P_1, T_1P_2, T_1P_3. The DO values were varied between 5.5-6 in dry season and 6-6.5 in rainy season (table 2).

The lowest and highest value was recorded from T_1P_1, T_1P_2, T_1P_3. The fluctuation of salinity showed different patterns in all the ponds throughout the culture period.

Table 1. Comparative mean weigh gain in shrimp under two different season.

	Dry Season (T1) (Feb-June)	Rainy Season (T2) (July -November)
Initial Weight (g)	0.31±0.03	0.305±0.02
Final Weight (g)	32.33±2.5 ^{a}	36.0±4.5 ^{ab}
Weight Gain (g)	32.02±1.47 ^{a}	35.70±1.62 ^{ab}
DWG (g/day)	0.267±0.07 ^{a}	0.298±0.05 ^{b}
SGR (%BW/day)	3.87±0.26 ^{a}	3.98±0.32^{b}
Survival rate (%)	80.7±1.53^{a}	82.5±1.32 ^{a}
FCR	1.72±0.07^{a}	1.56±0.1^{ab}
Gross Production (kg/ha)	3128.89 ±103.60^{a}	2079.76±73.63^{ab}

Mean in the same row with different superscripts are significantly different at p> 0.05.

Table 2. Water quality parameters of the studied pond.

Parameter	Dry season (T_1) (Mean±SD)	Rainy season (T_2) (Mean±SD)
pH	7.9 ±0.2	7.8±0.2
Salinity (ppt)	12±0.2	6±0.2
Temperature° C	29±0.3	27.6±0.3
Alkanity (mg/L)	163.3±0.2	146.7±0.2
DO (mg/L)	6.7±0.1	6.2±0.1
Ammonia (mg/L)	0.05±0.2	0.08±0.2

Table 3, total expenditure and profit in two crops shrimp farming system in a semi-intensive shrimp farm in Coastal part of Bangladesh.

Inputs/ Items	Application dose	Unit Price	Dry season Inputs cost (/ha)	Rainy Season Cost
PL	(in T1 12/m2 and T2 7/m2)	1.0	120000	70000
Bleaching powder (kg/ha)	770 kg	30	23100	23100
Feed cost	5447kg/ha in T1 and 3250 kg/ha in T2	115	626405	373750
Probiotic cost (super ps, p^H fixer, super biotic) (kg)			30769	29230
Chemical cost (Lime, Sodamix, A-Soil, others) (kg)			53846	28461
Disel and Electricity cost			96153	76923
Labor			70000	70000
Transportation			50000	30000
Soil excavation			30000	0
Blue & crab net fencing			24000	12000
Other cost related to culture			20000	10000
	Total Cost		1144273	723464

Total Production and Benefit

Treatment/ Crops	Total production (kg/ha)	Unit price /kg (Tk)	Total Benefit/ Sale (Tk)	Expenditure (Tk)	Net profit (Tk)
Dry Season	3135.9	600	1877334	1144273	733061
Rainy Season	2081.56	675	1403838	723464	680374

Economic Analysis of shrimp farm

The production cost includes purchasing of PL, bleaching powder, lime, fertilizer, feed etc., also consider for labor management, basket, harvesting gear, transport. Production cost of semi-intensive culture system in dry and rainy season is shown in table. From the analysis it was shown that production cost is higher in dry season than that of rainy season. Although rainy season doesn't usual practice in southern region, therefore I could be said as additional benefit in a year Table 3.

Discussion

The management technique is the main aspect of the production of shrimp. In order to manage shrimps pond properly under semi-intensive for obtaining maximum yield of tiger prawn some parameters such as, water temperature, salinity, p^H, water transparency, water depth, pond area, pond size, feed, seed and stocking density were detected as influencing factors (Boyd and Fast, 1992).

Water Quality Parameter

Salinity

Fluctuation of salinity below 8 ppt or above 18 ppt has been reported to be retard for growth of penaeid shrimp (Boyd and Fast, 1992). The different trends were found for both the culture systems in the present study. The salinity was 12 ppt in dry season and 6 ppt in rainy season which are favorable for the growth of shrimp (Table 2). Chiu (1988b) mentioned that the optimum range of salinity for *P. monodon* farming would be 10 ppt to 25 ppt. Subrahmanyam (1973), Vergheseet *al.* (1975) have observed a direct influence of salinity on the growth of *P. monodon*.

Water Temperature

Temperature is one of the most important physio-chemical parameters that have direct effect on the growth of marine shrimp (Lester and Pante,1992). Chiu (1988d) reported that the optimum temperature for *P. monodon* culture is 25°C to 32°C. Apud (1989) mentioned a range of water temperature from 25°C to 30°C would be favorable for *P. monodon* culture. In the present study water temperature was found to fluctuate between 27°C and 30°C in both rainy season and dry season.

pH

The best range of water pH for shrimp culture is 7-9 (Boyd and Fast, 1992). Chiu (1988b) noted that optimum range of pH is 6.8-8.7 for shrimp culture. The pH range in all the ponds of rainy and dry season indicated that the water pH ranging from 7.7-8.

Low pH reduces ammonia toxicity but mobilizes metals, including iron and aluminum, which can reduce yields in aquaculture ponds (Simpson *et al.* 1983). Low pH will also reduce natural pond productivity presumably by reducing the availability of nutrients including phosphorus (Boyd, 1982) and carbon sources of photosynthesis, e.g. bicarbonates and hence alkalinity. If the pH reduced, problem may be encountered with soft shrimp exoskeletons and this could affect marketability (Simpson *et al.,* 1983). Due to heavy rain alkalinity and pH would be decreased. To maintain the pH and alkalinity $NaHCO_3$ and $CaCO_3$ would be applied.

Alkalinity

For successful culture of *P. monodon* alkalinity is recommended to be >80mg/L (Hansell, 1993). Alkalinity is the buffering capacity of the pond water. The higher the alkalinity, the better the stabilization of the pond system. The CP aquaculture Pvt. Ltd. recommended the range of alkalinity from 80-120mg/L for shrimp culture. In the present study alkalinity was found 163.3mg/L in dry season and 146 in rainy season.

DO

In the present study the DO level was 6.7 and 6.2 in the dry and rainy season whereas Pakrasi (1978) and Banaerj'ee (1978) considered 4-8 ppm of DO as favorable range for shrimp culture.

Growth performance observation

In the current research comparatively higher individual growth was found in rainy season (36.0±4.5). The final average growth by weight of *P. monodon* in the present study after 120 days was 32.33±2.5g in dry season pond and 36.0±4.5 in rainy season pond (Table 1). Although the stocking density was higher in T1 that might me leading lower individual growth and survival rate in dry season (T_1) comparing to crops of rainy season (T_2). The stocking density of PL was 12 PL/m² in dry season pond and 7 PL/m² in rainy season pond. The almost similar result observed by Hossain *et al.,* (1992), at socking 5/m² and culture period was 120 days.

The result followed by Hoq *et al.,* 1994 in brackish water farm where, individual weight was 27.99 ± 2.07g in 105 days with the stocking density of 4 PL/m². In another experiment by Rahman (2001) in brakish water farm reported a weight gain of 32g in 126 days with the stocking density of 18 PL/m² and 26g in 112 days with the stocking density of 17PL/m².

Survival rate

Survival rate depends on several factors such as water quality, pond ecology, feed ingredients, feeding rate etc. The average survival rate of shrimp from dry season pond was found to be 80.7% and rainy season found to be 82.5% (Table 1). As the natural food is found more in the rainy season due to lower density and thats why the survival rate is varied between dry and rainy season. The poly-culture of *P.monodon* with Liza parsia under proper management, the survival rate of shrimp was 57.08% (Apud, 1981). Shrimp cultured in semi-intensive system with formulated feed survivality was 70% (Chakraborty, 1993). In case of semi- intensive culture, stocking density of 25PL/m² showed survival rate of 76%.

Production evaluation and economic analysis

Production

The production rate of *P. monodon* in dry season pond was 3135.9Kg/ha respectively and in rainy season the production was 2081.56Kg/hac. In the present study stocking density of rainy season was lower than the dry season because more density in the rainy season would be the cause of reduce growth, starvation and disease of shrimp. Pond preparation was mainly done in the dry season so the probablity of occuring disease or mortality increased in the rainy season with the same stocking density. To avoid this disease the stocking density of rainy season was reduced. Growth performance of shrimp in the rainy season was good than the dry season because the shrimp was got more space and feed than the dry season.

FCR

After 120 days FCR was1:1.56 in rainy season and 1:1.73 in the dry season. It is highly satisfactory when compared with the findings of 1:1.69 and 1:1.78 by Liao, (1981) in semi-intensive method for same species.

Economic analysis

The net profit found from dry and rainy season were 733061.00Tk/ha and 680374.00Tk/ha respectively. As the stocking density was higher in the dry season so the gross production was observed higher in dry season comparing to rainy season. But the individual growth of shrimp was observed higher in T2. Because of low density rate the growth of shrimp was good as well as price of shrimp was also good.

Conclusion

Presently most of the semi-intensive shrimp farms in Khulna region are following two crops in a year. Though production cost in dry season was higher than rainy season, which could be compensated by the total profit. The reason for the higher production rate in dry season is due to higher stocking density and better pond preparation. As pond is prepared once in a year for that stocking density in rainy season is low. It is observed that during the rainy season growth rate, survival rate was higher than the dry season but due to higher stocking density as well as the higher net profit in the dry season it is more profitable than rainy season. As most of the farmer in Bangladesh used o practice single crops shrimp farming in a year. Therefore this result will be a milestone to the farmers inspiring to practice two crops shrimp farming for proper utilization of time, shrimp farm and able to attain maximum profits.

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