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Growth and Economic Performances of *Macrobrachium rosenbergii* (De Man, 1879) Culture in South-West Coastal Region of Bangladesh

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Abstract

The growth performance of *Macrobrachium rosenbergii* (Deman,1879) under different stocking densities was conducted under three treatments each with three replications namely T_1: $10m^{-2}$ T_2: $12m^{-2}$; T_3: $14m^{-2}$ for a period of six months from April to September, 2012 in 9 experimental ponds in Terokhada Upazilla under Khulna district. Supplementary feeds (mustard oil cake (20%), wheat bran (20%), rice bran (20%), fish meal (25%) and maize bran(15%) were used for all stocked individual. Water quality parameters and growth performances were monitored monthly. The mean values of water temperature, transparency, dissolve O_2, p^H and salinity were varied from 28.88 ± 0.161°C(T_2) to 31.32 ± 0.97°C(T_1), 29.73 ± 0.34cm(T_1) to 32.70 ± 0.28cm(T_2), 5.33 ± 0.184mg^{-1}(T_3) to 6.17 ± 0.13 mg^{-1} (T_1), 6.52 ± 0.205(T_2)to 6.79 ± 0.18(T_1) and 13.75 ± 0.16(T_2) to 15.22 ± 0.20(T_1). The weight gain of *Macrobrachium rosenbergii were* 59.79± 0.15 g(T_1), 50.*86±0.14g(*T_2*)*,48.78±0.12g*(*T_3*).The* survival rate (%) of *M. rosenbergii* were 75.02±0.577 (T_1), 66.66±0.88 (T_2), 61.01±0.577(T_3) respectively. Yields (Kg ha^{-1} 6 $month^{-1}$) *Macrobrachium rosenbergii* were 2302.04kg (T_1), 1768.52 kg (T_2), 1393.808 kg (T_3) respectively. Total cost 656000 ± 17480 Tk ha^{-1} (T_1), 596120 ± 4520 Tk ha^{-1} (T_2) and 549100 ± 9440 Tk ha^{-1} (T_3) respectively and total return of different treatments T_1, T_2 and T_3 were 1492400 ± 12800 Tk ha^{-1}, 1078200 ± 11930 Tk ha^{-1} and 806480 ± 9190 Tk ha^{-1} respectively. Net benefit were 801900 ± 7340 Tk ha^{-1}, 49400± 5930 Tk/ha and 288600 ± 13240 Tk ha^{-1} in T_1, T_2, T_3 treatments respectively. From these findings, it could be concluded that highest yield was achieved from T_1 and lowest in T_3 which was significantly ($P<0.05$) different among the treatments where stocking density were less than other treatments.

Key words: Growth, Economics *M. rosenbergii*, Production, Stocking density

Introduction

Bangladesh is considered one of the most suitable countries in the world for giant freshwater prawn (*M. rosenbergii*) (De Man 1879) farming, because of its favorable resources and agro climatic conditions. *M. rosenbergii* has significant aquaculture potential and is commercially cultured (Akand and Hasan 1992; Ahmed 2001; Muir, 2003). Freshwater prawn *(M. rosenbergii*) farming is currently one of the most important sectors of the national economy and during the last two decades, its development has attracted considerable attention because of its export potential. The prawn and shrimp sector as a whole is the second largest export industry after readymade garments. Five biggest producers of galda *(M. rosenbergii)* are China (48%), Bangladesh (37%), Taiwan (6%), Thailand (6%) and India (1%) (Khondaker, 2008). According to FAO (2000), cited by Valenti (2002), world production of freshwater prawn between 1990 and 2000 increased from 21,000 to 118,500 tons per year, which corresponds to an increase of about 500%. In the late 1980s, this farming practice began to be adopted widely in the original location in Khulna area, where prawns were grown along with carps and rice (Kamp and Brand, 1994). The expansion of prawn cultivation has been dramatic, and since 1990 adoption has accelerated, spreading to other southwest districts such as Khulna, Satkhira and Jessore. Since the early 1990s prawn farming has become one of the financially most attractive investment opportunities in these areas (Ahmed, 2001). Bangladesh has huge fresh water areas where *galda (M. rosenbergii)* can be cultured in ponds under polyculture system or with fish and rice in gher system. In year 2002-2003, *galda (M. rosenbergii)* contributed 18% in export income but in 2006-2007 it was increased to 24 % (Khondaker, 2008). In 2006-2007, Bangladesh earned 6.25 crore dollar by exporting *galda* (DoF, 2008). A recent estimate has shown that 6,00,000 ha fresh water area can be used for *galda* farming in Bangladesh (Khondaker, 2008). Extensive production typically use slightly modified versions of traditional methods and are called low-density (10,000 to 18,000 post larvae ha.$year^{-1}$) and low-input system. The system relies mainly on natural productivity (e.g., planktons and benthos) of the pond, but organic and inorganic fertilizers and feeds are used to promote the growth of prawn. Extensive feeding practices generally use supplementary diets consisting of a mixture of locally available feed ingredients, such as rice bran, wheat bran, oil cake and fish meal. Semi-intensive operations practice intermediate levels of stocking (18,000-30,000 post larvae ha./year) and other inputs. Farms with semi-intensive feeding practices depend on commercially manufactured pelleted feeds. The main objectives in this study were to evaluate the growth, production, economic returns under different levels of stocking densities for sustainable *M. rosenbergii* culture in south-west coastal region of Bangladesh.

Methodology

Time and location of the study

The experiment was conducted for a period of six months (April'2012 to September'2012) in the farm of *M. rosenbergii* at Tarokhada upazilla is khulna, Bangladesh. The culture practice was mainly started in April and saline water was introduced from the river.

Experimental design

The current research was carried out under three treatments (T_1, T_2 and T_3), each with three replications. In each treatment, the stocking density of *M. rosenbergii* juvenile was varied in different farms.

T_1: The farm size was 50 decimal and stocking density was 10/m^2

T_2: The farm size was 50 decimal and stocking density was 12/m^2

T_3: The farm size was 50 decimal and stocking density was 14/m^2

Pond preparation

The ponds used in the present study are located at Terokhada upazilla of Khulna district which is located in south-west coastal region of Bangladesh. Initially the farms of the present study were allowed to dry and crack to increase the capacity of oxidation of hydrogen supplied and to eliminate the fish eggs, crab larvae, other predators and undesirable organisms. Then farm bottom was scrapped 2 to 4 cm by using a tractor blade to avoid topsoil. Subsequently the farm bottom was ploughed horizontally and vertically a depth of 30 cm to remove the obnoxious gases, to oxygenate the bottom soil and to increase the fertility. The average pH was calculated and required amount of lime was applied to maintain the optimum p^H after three days the water color turned to light green. Healthy *M. rosenbergii* seeds were purchased from a commercial hatchery and stocked in the farm.

Stocking

Fry are normally transported in plastic bags and filled up with oxygenated water and then placed inside the boxes. Five days after fertilization seeds were stocked. Stocking density of prawn in culture was 10, 12 and 14m^{-2} for treatments $T_{1,}$ T_2 and T_3 respectively.

Post stocking management

The pond was fertilized with Urea, T.S.P. and Cow dung at the rate of 100g, 50g and 3kg/dec. respectively as periodical dose and it was done once in month. During the culture period, small amount of supplementary feeds- mustard oil cake (20%), wheat bran (20%), rice bran (20%) and fish meal (25%) and maize bran (15%) were used at a regular basis. For maintaining the suitable water depth for fish in the pond, water was supplied regularly from the deep-tube well.

Table 1. Composition of the formulated diet

Name of ingredient	**% of ingredient**
Fish meal	25.0
Mustard oil cake	20.0
Maize bran	15.0
Rice bran	20.0
Wheat bran	20.0

Feed ingredients were mixed to make ball and then fish were feed with ball twice a day at the rate of 5% of the total body weight.

Table 2. Proximate composition of feed used in the experiment

Components	Diets
Moisture	9.6 %
Crude protein	28.5%
Crude lipid	13.6%
Crude fiber	14.5%
Ash	7.55%
NFE	26.25%

* Nitrogen free extract (NFE) calculated as 100-% (Moisture + Crude protein+ Crude lipid+ Crude Fiber+ Ash)

Study of water quality (physico-chemical) parameters

A series of physico-chemical parameters viz., water temperature, water transparency, hydrogen ion concentration (pH), dissolved Oxygen (DO), were determined twice a week.

Growth performance

The growth performance was calculated through the following equations-

Mean weight gain (g) =Mean final weight- Mean initial weight

Weight gain (g) = Mean final weight (g) - Mean initial weight (g)

$$\text{SGR } (\%\,\text{bwd}^{-1}) = \frac{\text{In final weight - In initial weight}}{\text{Culture period in days}} \times 100$$

(Brown, 1957)

$$\text{Survival rate } (\%) = \frac{\text{Number of fish harvested}}{\text{Number of fish stocked}} \times 100$$

Production= No. of fish harvested x final weight of fish.

Economical analysis

The net benefit was calculated by using the following formula-

Net benefit = total return — total cost

$$\text{Cost benefit ratio was calculated as-} = \frac{\text{Net benefit}}{\text{Total investment}}$$

Statistical analysis

Water quality, fish production, and economic parameters were subjected to one way ANOVA (Analysis of Variance) using computer software SPSS (Statistical Package for Social Science, version-15). The mean values were also compared to see the significant difference from the Duncan Multiple Range Test (Zar, 1984).

Results and Discussion

Water quality parameters

The mean values of different water quality parameters in different months are presented in table- 3. The mean value of water temperature during the study period was found to be ranged from 28.88±0.16 (T_2) to 32.32±0.97 (T_1) °C. Water temperature of 25 to 32°C is considered suitable for culture (Boyd and Zimmermann, 2000). Therefore, the mean water temperature found during the study was similar with the recommended values by

Boyd (1998); Hossain and Bhuiyan (2007) stated that water temperature for prawn culture were 29.72-30.49 °C and 20.4-33.2°C, respectively which are more or less similar to the present findings.

The mean value of water transparency was differed from 29.33±0.345 (T_1) to 32.70±0.28 (T_3) cm. Rai and Rathore (1993) stated that low values of water transparency which could be attributed to rich phytoplankton density and higher budgets of suspended and particulate matter. This finding range of secchi disc reading were found favorable for culture and this was strongly agreed with Wahab *et al.* (1995) who recommended the secchi disc readings between 26 to 50 cm for pond.

The mean value of dissolved oxygen during the study period was varied from 5.33±0.184 (T_3) to 6.17±0.13 (T_1) mgI^{-1}. This value is more or less similar to the findings of Hossain and Bhuiyan (2007), who recorded the DO value of 3.87 to 5.85mgl^{-1} Chakraborty and Mirza (2007) recorded DO value 3.88 to 5.22 mgl^{-1} while Kohinoor (2000) measured dissolved oxygen 2 to 7.4 mgl^{-1} in nursery pond. So, the level of dissolved oxygen (DO) was within the acceptable range in all the experimental ponds for prawn culture.

The mean value of pH during the study period was varied from 6.52±0.205 (T_2) to 6.79±0.023 (T_1). pH values ranging from 6.5 to 9.0 were observed for pond culture (Swingle, 1967). The pH values of the present study are also agreed with the findings of Kohinoor *et al.* (1994); Chakraborty and Mirza (2007); Hossain *et al.* (2013). Salinity is the important physico-chemical factor of the prawn farm. This study showed that the salinity varied from 13.75±0.16 (T_2) to 15.22± 0.20 (T_1). The optimum salinity range (13-15%) for *M. rosenbergii* larvae (Fujimura and Okamoto, 1972; Ling, 1969). Goodwin and Hanson (1975) who indicated that juvenile *M. rosenbergii* grows more rapidly in fresh water or slightly brackish water (<5 ‰) when compared to more brackish water of up to 15 ‰. So, the level of salinity was within the acceptable range in all the experimental ponds.

Growth performance

Mean growth performance of prawn (Juvenile) of three different treatments after 6 months are presented in table-4. Initial weights of three different treatments of *M. rosenbergii* were 0.129 ± .014g, 0.130 ± .005g and 0.129 ± .014g respectively. Daniels *et al.* (1998) stated that freshwater prawn *(M. rosenbergii)* Juvenile stocked in the nursery was about 0.11±0.058g and upper size population are 0.25±0.086g. Smith *et al.* (2009) reported that the stocked prawn initial weight is 0.006 to 2.66 g. So, these findings are more or less similar of the present study.

Final weight of present study of three treatments of *M. rosenberii* were 59.93±.145g, 51.30±.176g and 48.93±.145g respectively. Abramo *et al.* (2007) reported that weight at harvest range from 15.0 to 44.3g and decrease with increasing stocking density. The final weight of the present study of different treatments are more than these findings. Similar type study was conducted by Nabil *et al.* (2013) who observed that increasing the stocking density 50 to 100 animalm^{-2} decreased the final weight of *M. rosenbergii.* Weight gain of three treatments of *Macrobrachium rosenbergii* were 59.79±0.15g, 50.68±0.14 and 48.78±0.12 respectively shown in table-4. Willis *et al.* (2009) stated that Juvenile grew to a weight of 43.25g after 6 months if it stocked 5,10 and 20m^{-2}. Hossain and Akteruzzaman (2007) found that the weight gain of prawn was 88.1g in polyculture. Here, the weight gain of *M. rosenbergii* are more than their findings, though here we stocked 10,12 and 14m^{-2}.

SGR (%, bwd^{-1}) of *M. rosenbergii* were 3.39±0.4, 3.16±0.9 and 3.26±0.16% in T_1, T_2 and T_3 respectively. Hossain and Akteruzzaman (2007) found that the SGR (%, bwd^{-1}) of prawn was 2.0% in polyculture. Here, the SGR (%, bwd^{-1}) of *M. rosenbergii* are more than their findings, though here stocked 10,12 and 14m^2. Similar type study was conducted by Nabil *et al.* (2013) who observed that increasing the stocking density 50 to 100 animal/m^2 decreased the SGR (%, bdw^{-1}) 3.287±0.15 to 2.753±0.12 respectively of *M. brachium* which is closely similar to the present study.

Survival rate of present study of three treatments of *M. rosenbergii* was 75.02±*0.577,* 66.66±0.88 and 61.01±0.577 respectively. Abramo *et al. (*2007) reported that after grow out periods survival rate ranging from 54.3 to 89.9%. Rouse *et al.* (2007) reported that survival rate of prawn in tilapia fry ponds was 65% compared to 75% and 91% respectively. Similar type study was conducted by Nabil *et al.* (2013) who observed that increasing the stocking density 50 to 100 animalm^{-2} decreased survival rate 77 to 57% respectively of *M. brachium*. Survival rate also increased in low density culture ponds in coastal region. Production of *M. rosenbergii* of present study in three treatments were 2302.04 (kg ha^{-1}6$month^{-1}$) 1768.52 (kg ha^{-1}6$months^{-1}$) and 1393.08 (kg ha^{-1}6$month^{-1}$) respectively where stocked Juvenile 10, 12, 14m^{-2} of T_1, T_2 and T_3 treatment. Siddiqui *et al.* (2007) reported that total yield increased low density per m^2 and decreased high densities respectively. These findings simillar to the present study. Willis *et al.* (2009) reported that the production of 2278.61 kg ha^{-1} occured in ponds stocked with 20m^{-2}. But present research result shows that maximum yield comes from T_1 treatment where stocked with 10m^{-2}.

The economics of different treatments are shown in table-5. A simple economics analysis was performed to estimate the net profit derived from a monoculture of *M. rosenbergii* at different stocking densities using a feed for 6 months. The major variable input costs were mainly due to feed, fertilizer, seed, labour and irrigation. The highest net profit was estimated in treatment T_1 (801900±7340) while the moderate was found in treatment T_2 (494000±5930).

Table 3. Variation in the mean values of water quality parameters in different treatment during the study period (T_1, T_2, T_3)

Parameter	Treatments		
	T_1	T_2	T_3
Temperature (°C)	31.32 ± 0.97^{a}	28.88 ± 0.161^{b}	30.10 ± 0.35^{a}
DO(mg/l)	6.17 ± 0.13^{a}	5.66 ± 0.141^{b}	5.33 ± 0.184^{b}
Salinity	15.22 ± 0.20^{a}	13.75 ± 0.16^{b}	13.96 ± 0.21^{b}
pH	6.79 ± 0.18^{a}	6.52 ± 0.205^{a}	6.79 ± 0.23^{a}
Transparency (cm)	29.73 ± 0.34^{b}	32.70 ± 0.28^{a}	32.68 ± 0.35^{a}

$P < 0.05$; figures in a row bearing common letter do not differ significantly.

Table 4. Mean growth performance of prawn (Juvenile) of three different treatments after 6 months.

Growth Parameter	Treatments		
	T_1	T_2	T_3
Initial weight	$0.129\pm.014^{a}$	$0.130\pm.005^{a}$	$0.129\pm.014^{a}$
Final weight	$59.93\pm.145^{a}$	$51.03\pm.173^{b}$	$48.93\pm.145^{c}$
Weight gain (g)	59.79 ± 0.15^{a}	50.86 ± 0.14^{b}	48.78 ± 0.12^{c}
SGR (%, bwd^{-1})	3.39 ± 0.4^{a}	3.16 ± 0.9^{a}	3.26 ± 0.16^{a}
Survival rate (%)	75.02 ± 0.577^{a}	66.66 ± 0.88^{a}	61.01 ± 0.577^{b}
Yield (kg/50dec./6month)	466 ± 3.21^{a}	358 ± 404^{b}	282 ± 1.52^{c}
Yield (kg/hac/6 month)	2302.04	1768.52	1393.808

$P < 0.05$; figures in a row bearing common letter do not differ significantly.

Table 5. Economics of different treatments during the study period (T_1, T_2, T_3)

Parameter	**Treatment**		
	T_1	**T_2**	**T_3**
Total cost (Tk/ha)	656000 ± 17480^{a}	596120 ± 4520^{b}	549100 ± 9440^{b}
Total Returns (Tk/ha)	1492400 ± 12800^{a}	1078200 ± 11930^{b}	806480 ± 9190^{b}
Net benefit (Tk/ha)	801900±7340	494000±5930	288600±13240
Cost benefit ratio	$1 : 1.8^{a}$	$1 : 0.83^{a}$	$1 : 0.49^{b}$

$P < 0.05$; figures in a row bearing common letter do not differ significantly.

Conclusions

This study was conducted on the growth performance of the most valuable export commodity, the freshwater prawn *Macrobrachium rosenbergii*. The maximum production was found in treatment T_1. This study indicates using less stocking density can be the important strategy to improve the *Macrobrachium rosenbergii* yield in fertilizer and feed based culture in ponds.

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