International Journal of Fisheries and Aquaculture Sciences.
ISSN 2248-9975 Volume 6, Number 1 (2016), pp. 77-86
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Effect of Stocking Density on the Growth and Production of Freshwater Prawn (*Macrobrachium rosenbergii*)

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Abstract

To study the effect of different stocking densities on the growth, survival and production of the freshwater prawn the post larvae with mean initial weight of 0.22±0.04g were stocked at 40, 50, and 80PL/decimal and cultured for a period of 150 days under gher conditions. The culture ponds were manured with cow dung and inorganic fertilizers and a supplementary feed of 28.82% crude protein was given to the prawns. Prawns were fed artificial diet with 10% of their body weight at 1st month (up to 30 days) and reduced to 7% at 2nd month (up to 60 days), 5% at 3rd month and were continued till the end of the experiment. Feed was distributed evenly over the ponds surface twice daily. The experimental ponds were harvested after five months of culture. The results indicated that at low stocking density (40post larvae/decimal) the growth, survival and production were higher. Prawns attained a final mean body weight of 38.71±3.79g and 21.59±2.64g in low and higher stocking densities, respectively. The highest survival rate was obtained from low stoking density (90.83%) and the lowest survival rate was obtained from high stoking density (47.92%). The estimated productions were 1.4 and 0.82kg/decimal for low and high stoking densities respectively. Higher specific growth rate (3.45 %per body weight) and low feed conversion ratio (1.12) were found only in the low stocking density. Hence, the growth performance was significantly ($P<0.05$) decreased with increasing stocking density.

Keywords: *Macrobrachium rosenbergii*, stocking density, growth, survival, post larvae.

Introduction

Macrobrachium rosenbergii is a large genus of class Crustacean comprising over 150 species. *Macrobrachium rosenbergii* is the most preferred species for culture, which is commercially called 'Scampi' and popularly known as 'Giant freshwater prawn' or 'Malaysian prawn. Due to its fast growing nature, hardiness, requirement of low protein diets, better domestic and export market and higher returns, this species is recommended for farming in many tropical and sub-tropical countries (Brown, 1991). Several factors are reported to be affecting the production, especially growth and survival in freshwater prawn farming worldwide (New, 1995). Of the many limiting factors that can influence the growth and survival of prawns, stoking density is the factor which has attracted the least attention (Emmerson and Andrews, 1981). Increasing stocking density results in stress which leads to enhanced energy requirements that causing reduced growth and food utilization (Leatherland and Cho, 1985). Stocking density also plays an important role in the balance of an aquaculture system and consequently on the growth and survival of aquatic organisms (Ray and Chien, 1992). Successful aquaculture requires not only careful selection of species, appropriate feeding and water quality management but also a great extent, the density to which the fish are stocked as compared to the food ration and extent of management (Barua, 1990). Higher stocking density reduces the growth and survival rates during fish culture (Sugunan, 1997). Therefore, an investigation was done to find out the effects of different stocking densities on the growth performance, survival and production parameters of *M. rosenbergii.*

Materials and Methods

Study Area:

The experiment was conducted for a period of 150 days during August to December 2014 at Sadar upzilla under Bagerhat district.

Experimental Design:

To know the growth performance, survival and production potential of *Macrobrachium rosenbergii,* three treatments were selected in the present experiment, each with three replications. The treatments were three different stocking densities (with T1, T2 and T3 respectively 40, 50 and 80 PL/decimal).

Pre-stocking management:

All predatory and small fish species were removed from the experimental pond by repeated netting and rotenone (5 ppm/decimal) was used for complete eradication of all the undesirable species. Ponds were prepared properly with lime at the rate of 1 kg per decimal and after 2 days later initial fertilization with urea, TSP and cow dung at the rate of 100 g, 100 g and 200 g per decimal, respectively.

Stocking:

Post larvae (PL) of freshwater prawn were collected from the river Kocha of Pirojpur district. These PL were brought to the experimental sites in oxygenated plastic bags.

Three treatments T1, T2 and T3 were stocked with PL at the density of 40, 50 and 80 PL/decimal. The mean initial weight of PL was 0.22g in all the treatments.

Post stocking management:
After stoking, prawns were feed (Quality special feed) twice daily at the rate 10% of their body weight at 1st month (up to 30 days) and reduced to 7% at 2nd month (up to 60 days), 5% at 3rd month and were continued till the end of the experiment. Throughout the experimental period, water temperature (°C), transparency (cm), pH, dissolved oxygen (mg/L), total alkalinity and total hardness was measured monthly. Monthly sampling of prawn was done by using a seine net to observe the growth of prawn. Growth of prawn in each sampling was measured by using a digital electronic balance. After 150 days of culture, prawn was harvested and counted for total number separately from each treatment to evaluate the survival rate and other analysis. The growth gained by the prawn was calculated by subtracting the previous weight from the corresponding weight at each month. Experimental data collected during the growth trial were

i) Weight gain (g):

$$\text{Weight gain} = \text{Mean final weight} - \text{Mean initial weight}$$

ii) Percent weight gain (%):

$$\%\ \text{Weight gain} = \frac{\text{Mean final prawn weight} - \text{Mean initial prawn weight}}{\text{Mean initial weight}} \times 100$$

iii) Specific growth rate (% per day):

$$\text{SGR (\% per day)} = \frac{\ln W_2 - \ln W_1}{T2 - T1} \times 100$$

Where,

W_1= Initial live body weight (g) at time T_1 (day)
W_2= Final live body weight (g) at time T_2(day)

iv) Survival rate (%):

$$\text{Survival Rate (\%)} = \frac{\text{No. of total live prawn}}{\text{Total no. of prawn stocked}} \times 100$$

v) FCR (Feed Conversion Ratio):

$$\text{FCR} = \frac{\text{Total feed consumed(kg)}}{\text{Total yield(kg)}}$$

vi) Net Production:
The net production of prawn (Kg/decimal) was calculated by the following formula:

$$\text{Net Production (kg/decimal)} = \frac{\text{Survival rate} \times \text{Stocking density} \times \text{Weight gain (gm)}}{100 \times 1000}$$

Statistical analysis:
One-way ANOVA (Analysis of Variance) was used to determine the effect of different stocking densities on the growth performance, survival and production of prawn. Data analysis was done by using the SPSS software (Statistical Package for Social Science) version-20 according to Duncan's New Multiple Range Test (Duncan, 1995) to identify the 5% level of significance of variance among the different treatment means.

Results

The experimental ponds were harvested after five months of culture. In the present study, the stocking density showed a clear effect on the final body weight, specific growth rate, survival rate, FCR and production of prawn. Final body weight and survival rate of prawn in the low density ponds were comparatively higher than those of high density ponds. Prawns cultured under high density ponds exhibited low survivability, combined with high feed conversion rates (FCR). The study revealed a continuous water quality deterioration (Temperature, Transparency, DO, P^H, Alkalinity and Hardness) and frequent mortality in high density ponds.

Water quality parameters:
The water quality parameters *i.e.,* water temperature (^oC), transparency (cm), pH, dissolved oxygen (mg/l), Total Alkalinity (mg/l) and Total Hardness (mg/l) of all the treatments were recorded monthly during the experimental period. The average result of water quality parameters of three treatments have been presented in Table 1.

Table 1: Mean values of water quality parameters recorded from different treatments.

	Parameters					
Treatments	**Temperature (^oC)**	**Transparency (cm)**	**pH**	**DO (mg/l)**	**Total Alkalinity (mg/l)**	**Total Hardness (ppm)**
T1	25.6	33.25	7.8	4.3	115.16	193.29
T2	25.03	32.29	7.75	4.27	116.1	190.1
T3	24.29	30.81	7.71	4.06	113.58	185.86

Growth performance of freshwater prawn:
The growth of freshwater prawn in different treatments under three different stoking densities was different. The different growth performance namely length (cm) and weight (gm) gain, specific growth rate (%), survival rate (%), FCR and Net Production (kg/decimal) were recorded monthly.

Mean length (cm) and weight gain (gm):
The growth increments in length and weight of prawns under high and low density ponds were measured and results are presented in Table 2. It was found that growth rate negatively affected the higher stocking density. Maximum growth was observed in the prawns cultured under low density ponds. Prawns reared at low stocking density

exhibited similar growth patterns throughout the culture period. At the time of harvest, final body weight and length of prawns reared at low density ponds were 38.71g and 14.30cm respectively. The final mean body weight and length of prawns reared at high density ponds were 21.59g and 11.17cm, respectively.

Table 2: Growth performance of *M. rosenbergii* in different stocking densities.

Treatments	Stocking Density (PL/Decimal)	Body weight (gm)		Length (cm)	
		Initial	Final	Initial	Final
T_1	40	0.22	38.71	1.73	14.30
T_2	50	0.22	31.57	1.73	12.23
T_3	80	0.22	21.59	1.73	11.17

Specific growth rate (% body weight):
The specific growth rate (SGR) of prawns cultured in low density ponds was remarkably higher than those of high density ponds. The highest value (3.45%) was obtained from T_1 and the lowest value (3.06%) was obtained from T_3.No significant differences ($P>0.05$) were found among three treatments (Fig.1).

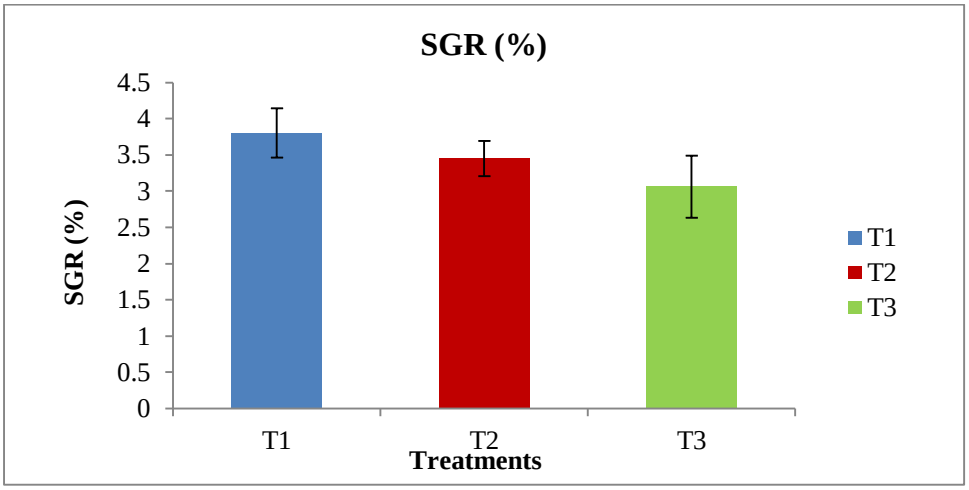

Figure 1: Comparison of SGR of prawns in different treatments during experimental period.

Survival rate (%):
At the end of the experimental period, prawns cultured at low stocking density exhibited an excellent mean survival rate than those at high stocking density. There was very highly significant difference ($P\leq0.001$) in survival rates of prawn among the treatments. The survival rates of prawns reared in low density ponds were over 90.83% (Fig. 2) whereas, a significantly lower (47.92%) rate was observed at high stocking density ponds.

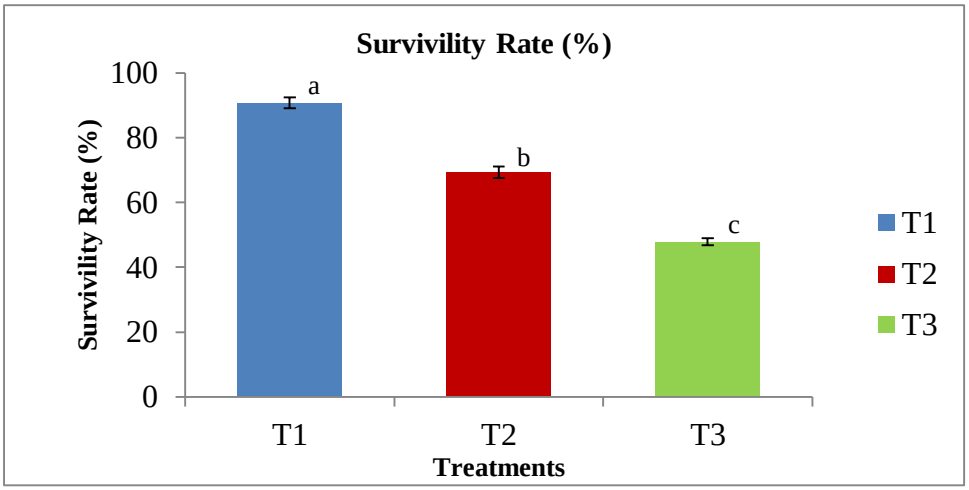

Figure 2: Comparison of survival rates of prawns in different treatments after harvesting.

Feed conversion ratio (FCR):
Similarly, FCR values of prawns in low density ponds were significantly ($P \leq 0.05$) better than those reared in high density ponds. At the end of the culture, the average FCR value of prawns reared at low density ponds was 1.12 whereas prawns of high density ponds displayed a FCR value of 2.10 (Fig. 3).

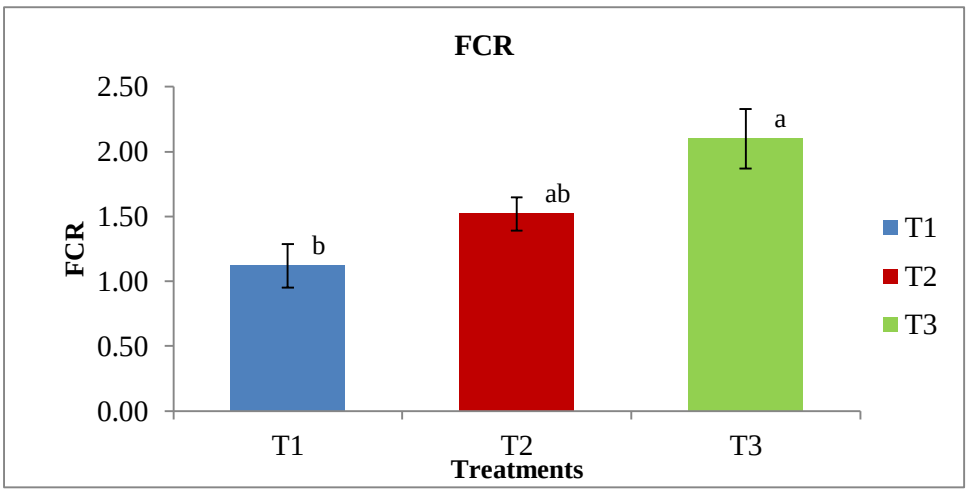

Figure 3: Comparison of FCR of prawns in different treatments during experimental period.

Net production (kg/decimal):
The comparative analysis on prawn production data among the treatments with three different stocking densities were shown in Fig. 4. Net production at harvest was significantly differed ($P \leq 0.01$) between high density and low density ponds. Net

production of high density and low density ponds were 0.82kg/decimal and 1.4 kg/decimal.

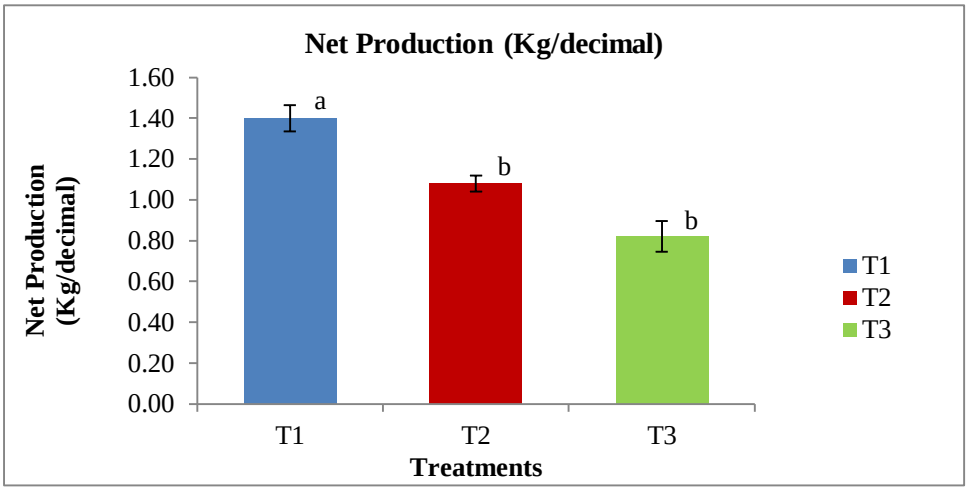

Figure 4: Comparison of net production of prawns in different treatments after harvesting

Discussions

Stocking density has the direct effect on growth and at the same time survival and production has negative relation to stocking density (Siddiqui and Al-Hinty, 1993). Optimal stocking densities of *M. rosenbergii* and exogenous factors such as water temperature, water quality and feed quality, quantity can affect the result of growth and survival (Baskerville-Bridges and Kling, 2000). The present result coincides with the findings of Alikunhi, (1957); Kawamoto *et al.,* (1957) and Haque*et al.,* (1984) who stated that, the growth rate is high in low density. The specific growth rate (SGR) was found to be high in T_1 (3.45%) followed by T_2 (3.31%) and T_3 (3.06%) which indicate that the growth rate is higher in lower densities which agree with LeCren, (1965) and Das *et al.,* (1992), who reported that the growth rate is inversely related to stocking density. The results were in full agreement with the results of El-Sherif and Mervat, (2009) who found that the SGR value of prawn at the end of the trial period decreased (1.48, 1.47, 1.46 and 1.34%) in the order 50, 100, 150 and 200 prawns/m^2respectively.Treatment T_1 (38.49 gm) indicated better growth performance. The lowest growth performance was observed in T_3 (21.37 gm) treatment and also showed comparatively slower growth performance. The growth of *M. rosenbergii* in the present study is quite satisfactory in comparison to the result conducted elsewhere. Hossain *et al.,* (1992) found 21.65±0.81 g in 120 days with stocking density of 5 PL/m^2. In another experiment Hoq *et al.,* (1994) reported a weight gain of 27.99±2.07 g in 105 days with a socking density of 4 PL/m^2. The highest survival rate was found for T_1 (90.83±2.89%) followed by T_2 (69.33±3.06 %) and finally T_3 (47.92±1.91 %) in the current study. Reduced survival at high density is probably due to cannibalism during moulting process which is a very common phenomenon prevailing in crustaceans observed by Rouse *et al*., (1991) and Jones, (1995).). In the present study the better

result was found in treatment T_1 where the stoking density was low. The present result support Powell, (1972) who stated that higher stocking density has harmful effect on the culture of fish its growth, survival and increase of food conversion ratio. Siddiqui *et al.,* (1997) reported higher FCR of 3.7(5 prawns/m^2) to 5.6 (20 prawns /m^2) for *M. rosenbergii*. The feed conversion ratio (FCR) increases with the increase in the density of prawns which was in accordance with the findings of Zaki *et al.,* (2004) who studied the effect of stocking density of marine shrimp on the FCR. Wohlfarth *et al.* (1985) reported that while the prawn weight per individual decreased from 40 to 24 g, the yield increased from 380 to 791 kg per ha and the proportion of marketable animals decreased from 73 to 20%, when prawn density increased from 1 to 4 animals per m^2. Average yield was observed as 91.28 kg/ha for 142 days for culture period in Jia-Mo *et al.,* (1988)'s experiment and 979 kg/ha in 158 days cycle observed by Apud, (1985) in different experiments. D'Abramo *et al.,* (1989) showed that a stocking density between 4 and 6 juveniles per m^2 yielded a production of 1,207 to 1,409 kg/ha within five months and it was further stated that around 4 per m^2 stocking density was economically attractive. The present study showed that, the production of *M. rosenbergii* in the three treatment resemblance with the findings of above stated experiments.

Conclusion

The results of the present study showed that water environment of the treatments were suitable for the growth of prawns. The present study also indicated the growth rate, survivility rate, weight gain, SGR, FCR and production of Prawns were high in treatment T_1 where the stocking density was low. To improve growth rate, survival and production a stocking density of 40 PL/decimal is recommended for prawn culture in South-Western part of Bangladesh.

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