OPTIMIZATION OF STOCKING DENSITY OF *MACROBRACHIUM GANGETICUM (*BATE*)* POST LARVAE FOR GROWTH AND SURVIVAL

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ABSTRACT

Macrobrachium gangeticum is the third largest freshwater prawn in Ganga riverine system. Assessment of stocking density on growth and survival in *Macrobrachium gangeticum* was studied in six earthen tanks of size 0.02ha each at Central Institute of Freshwater Aquaculture, Kausalyaganga Farm. The advanced post larvae with an average weight of 1.02g were stocked at T-I, T-II, and T-III PL / m^{-2}. Rearing was carried out for 180 days. PL were fed twice a day with prepared diet having 30% protein and 11% lipid @ 7- 10% of the body weight. Growth increment was recorded fortnightly. The physiochemical parameters monitored periodically were found within the desired ranges. Data manifested significantly higher ($p< 0.05$) growth rate in prawns in T-I compared to T-II and T-III. Average final growth was 38.3g, 30.4g and 25.5g in treatment T-I, T-II and T-III tanks respectively. Similar trend was also noticed in the survival recording 76%, 62% and 40% in three treatments respectively. Specific growth rate (SGR) was computed to be highest 0.87% in T-I followed by 0.81% in T-II and 0.77% in T-III stocking density. Results further suggest that although the average weight gain and survival were much higher in T-I, the total biomass production recorded to be insignificantly higher 7.38 kg in T-II compared to 6.12 kg in T-I but significantly ($p<0.5$) much less 3.02 in T-III. The Feed Conversion ratio (FCR) was found to be lowest in T1 (1.05) followed by T-II (2.26) and T-III (2.84) suggesting suitable stocking density at 2 post larvae/m^2 for optimum prawn production.

Key words- *Macrobrachium gangeticumi*, post larvae, stocking density, growth and survival.

1. INTRODUCTION

India is bestowed with vast and diverse inland water resources offering immense scope for aquaculture. Freshwater prawn farming contributes to 6% of the global aquaculture production of prawn. Freshwater prawn species are gaining popularity farming industry in the country with the local species available in the river system.(A.K.Singh *et al*., 2011). Due to increased demand for freshwater prawn in export as well as domestic markets; there is an urgent need for the development of viable seed production and culture technologies of Macrobrachium species. Of late, freshwater prawn culture has been recognized as an alternative, eco-friendly and sustainable system for prawn production (Radheyshyam, 2009a). Although freshwater prawns are higher priced product and have a high market demand in both domestic and export markets. Stocking of bigger juvenile prawn allows shorter crop periods (Arud *et al.*, 1983) yielding better growth and survival than direct stocking of PL (Shiigueno, 1970), (Honma, 1971). Growth, survival and yield effects of stocking density on aquaculture are well known for a diversity of species (Garr et al., 2011), (Khatune-Jannat *et al.*, 2012), (Mazlum, 2007), (Samad *et al*., 2005) and (Zhu *et al*., 2011)

Technologies have been developed which allow the intensification of prawn production rates without sacrificing large average sizes or negatively impacting water quality. These technologies include adding substrate materials to the production ponds combined with increased stocking densities (Tidwell and D'Abramo, 2000). Stocking density is an important factor in shrimp culture affecting the growth (Martin *et al*., 1998), survival (Ray and Chien, 1992) and yield (Allan and Maguire, 1992). According to (New *et al.* 2000), high stocking densities of prawns are less profitable due to the agonistic behavior of male prawns. Most of the studies are related to *M. rosenbergii* however, no work on effects of stocking density on growth, survival of *M.gangeticum*. However, (Prasanti Mishra *et al* 2014) stocked *M. malcolmsonii* @20,000-30,000 juveniles ha^{-1} in monoculture. (Radhyshyam *et al* 2009b) stocked *M. malcolmsonii* @30,000-50,000 juveniles ha^{-1} in monoculture and @ 15,000-20,000 juveniles ha^{-1} in carp poly culture with prawns. (Kanaujia *et al.* 1996) have studied comparative effect of stocking density on the growth and survival of *M. malcolmsonii*. Several factors affect the production especially growth and survival in freshwater prawn farming (New, 1995). Stocking rate reported a major factor affecting the individual prawn growth (Karplus *et al*, 1986). In view of this, the present study was undertaken to ascertain whether the stocking density has a direct bearing upon the specific growth rate (SGR), survival and net harvest weight of *M. gangeticum* during six months culture period in earthen ponds. Therefore, an investigation was done to find out the effects of different stocking densities on the growth performance, survival and production parameters of *M.gangeticum* during six months culture period in earthen tanks.

2. MATERIAS METHODS:

2.1 Pond preparation and stocking management

The study was carried out at the fish farm of Central Institute of Freshwater Aquaculture, Kausalyaganga, in six earthen ponds (200 m^2 each) for a period of six months. The ponds were drained out and treated with lime @200kg ha^{-1} and bottom exposed to sun for a week .Thereafter, all the ponds filled with filtered pond water. Raw cow dung (RCD) was applied@ 400kg ha^{-1} as base manure. After fifteen days *M.gangeticum* juveniles with the size range 40.4±10.2 mm and body weight 1.02±0.88 g were stocked in three different densities i e., stocking was done @ 10000 PL ha^{-1}. Treatment-II (T-II) @ 20000 PL ha^{-1} and Treatment-III (T-III) @ 30000 ha^{-1}. Two ponds were used for each treatment. At the time of stocking, prophylactic treatment was done with a dip bath in 0.3% $KMnO_4$.

2.2 Feed formulation and preparation

For formulation of experimental feed, the ingredients such as fish meal, prawn meal, groundnut oil cake, rice bran and wheat bran obtain from local markets. The ingredients were analyzed for proximate composition, and the results are shown in (Table 1). An experimental diet (30% protein) found to be suitable in a previous study (Hossain 2004). The ingredients were weighed according to formulae, mixed and made into 1-mmsize pellets using a pellet machine. The pellets were sun dried and packed in airtight bags. Feed samples were subjected to proximate analysis (Table 2).

Table 1- Proximate composition of the ingredients (% dry matter basis) used in preparation of the diet for *Macrobrachium gangeticum*

Ingredients	Dry matter	Protein	Lipid	Ash	Crude fiber	NFE
Fish meal	88.50	57.90	14.64	23.18	0.80	3.68
Ground-nut oilcake	89.10	42.00	13.12	13.70	11.12	20.06
Prawn meal	88.59	35.91	12.14	9.31	1.21	41.43
Rice bran	90.12	12.10	14.93	15.10	15.21	42.66
Wheat bran	90.00	13.25	4.68	5.60	12.31	63.89

(NFE) calculated as: 100-(% moisture+%protein+%lipid+ %ash +%crude fibre).

Table 2 Formulation (%) proximate composition of the experimental diet used in *M.gangeticum*

Ingredients	**Percentage (%)**	**Proximate composition**	**Percentage(%)**
Fish meal	25.0	Dry matter	90.40
Prawn meal	10.0	Protein	30.31
Groundnut oil cake	15.0	Lipid	11.25
Rice bran	25.0	Ash	14.37

Wheat bran	20.0	Crude fiber	11.12
Binder	5.0	NFE	32.95

2.3 Growth monitoring and harvesting

Feeding 90% was given daily morning and evening using the feeding tray and about 10% feed was given by broadcasting. Growth of prawns was checked fortnightly by operating cast net. Finally, the prawns were harvested while draining out complete pond water after six month of culture. Total body length, weight, sex and number of prawns from each pond were recorded.

2.4 Water quality management

Success of prawn production largely depends on various factors inter related and associated mainly with the management practices and environmental conditions. Physico-chemical parameters of the rearing media play an important role in influencing the larval growth and post larval production in aquaculture medium. Water quality parameters such as ambient temperature (^{0}C), PH, dissolved oxygen (DO) (mg/l), total alkalinity (mg/l) and ammoniacal nitrogen (NH_4-N) were recorded monthly during the experimental period. The parameters were analyzed using the standard methods of (APHA 1985).

2.5 Data Analysis

The increase of length and weight was used as measures of growth. Survival rate, daily growth rate (DGR), specific growth rate (SGR), feed conversion ratio (FCR) and production of the cultured species were determined as per the method outlined by Cuvin-Aralar *et al* (2007).Cost benefit analysis of feed also determined.

Weight gain (g): Weight gain = Mean final weight − Mean initial weight

$$\text{Specific growth rate (SGR) (\% per day)} = \frac{\ln W2 - \ln W1}{T2 - T1} \times 100$$

Where, W1= Initial live body weight (g) at time T1 (day)

W2= Final live body weight (g) at time T2 (day)

$$\text{Feed conversation ratio (FCR) was estimated as} = \frac{\text{Total feed consumed (kg)}}{\text{Total yield (kg)}}$$

The ANOVA followed by Duncan's Multiple Range Test used to determine the differences between the treatment means. The alphabetical notation was used to mark the differences at significant level of an alpha 0.05 (SAS 9.02).

3. RESULTS –

The experimental earthen tanks were harvested after six months of culture period. In the present study, the stocking density showed a clear impact on the final body weight, specific growth rate (SGR), 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).

3.1 Water quality parameter:

In culture tanks the water quality parameters recorded during the experiment are shown in Table-1. No significant variations in the values of each parameter was found among treatments as well as between the replicates. The average water depth during the culture varied between 1.15 and 0.96 meters

Table 3-Mean±SD value of water quality parameters in ponds stocked at different densities

	T-I		T-II		T-IIII	
Parameter	**Range**	**Mean±SD**	**Range**	**Mean±SD**	**Range**	**Mean±SD**
Temp.	28.7-30.1	29.05±0.662	28.4-30.1	29.5±0.729	28.3-30.1	29.4±0.661
pH	7.0-7.4	7.3±0.188	7.1-7.5	7.34±0.126	7.1-7.5	7.3±0.150
DO	5.4-6.8	6.09±0.499	5.5-6.7	6.08±0.463	5.3-6.7	6.05±0.506
Total alkalinity	106-122	115.5±4.945	107-121	114.5±4.881	107-122	115.1±4.863
Ammoniacal nitrogen	0.12-0.16	0.14±0.013	0.13-0.16	0.14±0.010	0.13-0.16	0.14±0.010

3.2 Performance of growth parameters

However, in present investigation the stocking density was kept in the range of 1-3m^{-2}. The results on the growth data indicated that the growth rate of *M. gangeticum* was much higher in lower stocking density as compared to higher stocking density initiated from the first month of rearing onwards. This trend was observed throughout the experimental trials. (Fig 1).

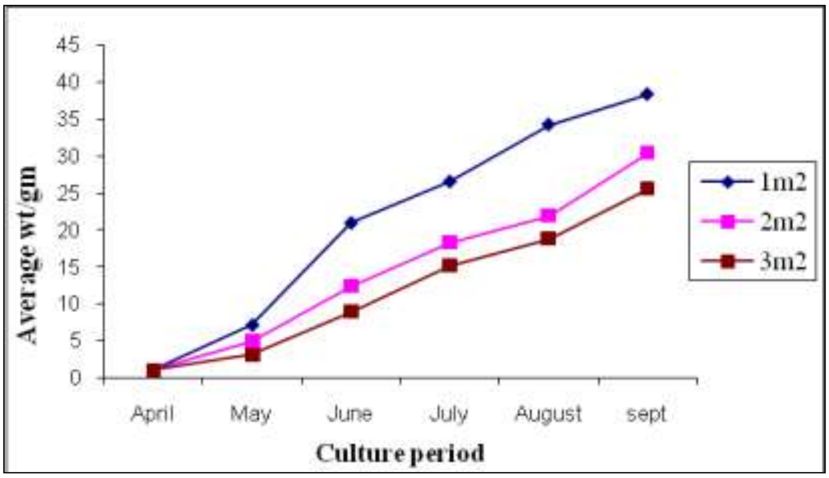

Fig.- 1—Growth of *M. gangeticum* at different stocking density

The average weight of prawns recorded in T-I, T-II and T-III was 38.3g, 30.4g and 25.5g respectively at the end of the experimental period. Similar trend was also observed in survival percentage in all the treatments T-I, T-II and T-III recording 76%, 62% and 40% respectively (Table 4). The lowest survival was observed in higher stocking density.

At the end of the experimental period, prawns reared at lower stocking density exhibited an excellent survival rate than those at high stocking densities. The survival rates differed significantly among treatments showing as high as 76% in lowest stocking density and declined with the increase in stocking density (Table-4).

The yield of prawns in three different stocking densities was computed to be 6.63 kg, 7.43 kg and 3.35 kg pond^{-1} in six months, indicating higher biomass production T-II stocking density compared to other two stocking densities tried. The occurrence of male during harvesting was always lower than that of female with sex ratios computed to be 1.43, 1.69 and 1.22 in T-1, T-II and T-III respectively (Table-4).

The stocking density had a negative effect -0.032 on the total production of prawn. 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 ($P \leq 0.001$) in survival rates of prawn among the treatments.

Table-4 Duncan multiple range test for Growth, production and survival of *M. gangeticum* under different stocking density

Parameters	Stocking density

	T-I	T-II	T-III
No. stocked	200	400	600
Initial wt(gm)	1.02	1.02	1.02
Final wt(gm)	38.3[a]	30.4[b]	25.5[c]
No. recovered	152 [c]	250 [a]	240 [b]
Survival(%)	76 [a]	62 [b]	40 [c]
Female : Male Ratio	1.43	1.69	1.22
Production(kg)	6.63 [b]	7.43 [a]	3.35 [c]

Mean with same alphabet are not significantly different (P≤0.05)

3.3 Specific growth rate (% body weight)

The Specific growth rate (SGR) has been depicted in (Fig. 2). The results showed highest (0.87%day) SGR in T-I followed by T-II (0.81%/day) and T III (0.77%/day). Although the SGR values decreased with the increase in stocking density, the variations found to be very low and insignificant. No significant differences (P>0.05) were found among three treatments (Fig.2).

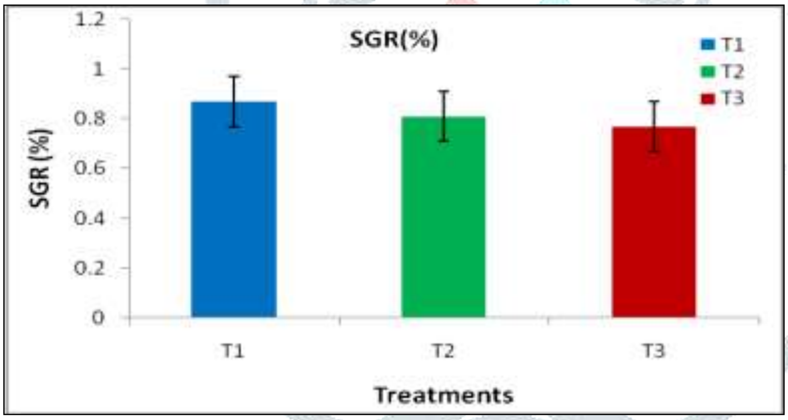

Fig 2:- Comparison of SGR (%) of prawns in different treatments during experimental period

3.4 Feed conversion ratio (FCR):

Similarly, FCR values of prawns in low density ponds were significantly (P≤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 T1(1.82) followed by T-II (2.36) whereas prawns of high density ponds displayed a FCR value of T-III (2.94) (Fig 3).

This suggests that in lower stocking density relatively lesser quantity of feed was required to produce unit /kg of prawn. This might be due to the fact that in T-I density prawns might have used natural food organisms from the system.

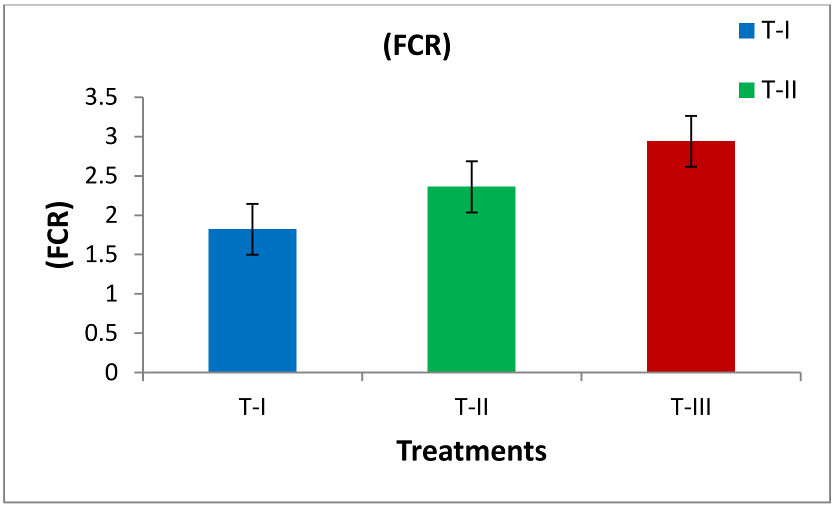

Fig 3: Comparison of FCR of prawns in different treatments during experimental period.

In final harvesting the occurrence of males was always lower than that of female specimens in all the treatments (Table-3).

In the present study, it has been found greater survival at lower stocking densities; this might be due to inadequate space to grow prawns. The space competition might be another reason because of that survival was affected. However, in lower stocking density prawns obtained a higher survival, growth and total production. An important requisite in this case seems to be stocked at optimum stocking density. The results observed here in the growth of prawns were directly affected to the stocking density per square meter.

The stocking density (200 PLm^{-2}) provided better growth as compared to (400) and (600 PLm^{-2}) The final biomass found highest at lower stocking density. In the study greater survival rate was observed at lower densities. These data suggest that higher stocking density, (600 PLm^{-2}) can't be a good strategy to increase production. In high stocking density it is worthwhile to introduce additional appropriate substrate to increase a surface area needed by prawns to grow. The present study demonstrated the advantage of stocking density of growing *M. gangeticum* in earthen ponds. At lower stocking density attain a good growth of freshwater prawn.

4. DISSCUSSION

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).Production in freshwater prawn farming is a function of water temperature, seed availability, food quality, and stress free environment, stocking density, survival and growth rate, Weidenbach (1982).

Using commercial diets containing 30-36% protein, Radheyshayam (2009b) recorded maximum production of *M.malcolmsonii*. Hence the commercial feed used in this present study could be termed as superior quality having 30.31% protein,11.2% lipid with adequate calorie values. (Table 2)

The variations in the parameters as observed within the treatments means found to be negligible and therefore assumed to have no direct impact on the survival and production. Use of quality feed is one of the most important factors for enhancing prawn production like other aquaculture farming. Favorable water quality is the key to all types of aquaculture production and needs to be maintained at optimum levels during the culture period. In this present study all most all parameters were found within the desirable ranges by Banerjea, (1967) Kanaujia *et al*., (1997), New (2002) (Table-3).

Survival rate of freshwater prawn in all the treatments of the current study ranged from 40 to 76% and are in agreement with the findings of Tidwell *et al.* (2004a). New and Singholka (1985a) opined that a survival rate of over 50% could be considered as acceptable for achieving higher biomass yield in prawns,. Malecha, (1983) reported about 50 to 60% of prawn survival in continuous culture systems while Kunda *et al*. (2009) recorded a survival rate of 64% in their all-male freshwater prawn polyculture. In the present study, greater survival at lower stocking density was recorded which might be attributable to due to the availability of adequate space to grow prawns. Hence, the space competition might be another reason which lower the survival rates at higher stocking densities. Adequate space is therefore important for maximizing survival as well as optimizing production in prawns. The results suggest the stocking density at 2 juveniles / m2 is ideal for getting 62 % survival in *gangeticum.*

According to New *et al.* (2000), high stocking densities of prawns are less profitable due to the agonistic behavior of male prawns. In the present study, stocking at 2 juveniles / m2 (T-II) and 1 juveniles / m2 (T-I), achieved higher yields than the stocking at 3 juveniles /m2 (T-III). However, significantly much higher production was recorded at 2 juveniles /m2 stocking density than that of 1 and 3 juveniles/m2 under the conditions of this field trial (Table-4). In freshwater prawn farming, heterogeneous growth (HIG) has been a common phenomenon reported by Daniels and D'Abramo, (1994) and Tidwell *et al*, (1994). When high stocking density monoculture is practiced, the yield obtained usually consisted of prawns of wide size range Smith *et al.*, (1978); Cohen *et al.*, (1983). In this study too heterogeneous growth of both in males and females has been observed in all the treatments. (Roberts and Bauer 1978) reported that reduction in stocking rate resulted in increased weight of prawns and the proportion of marketable yield.

The data further manifested that the average weight of males was significantly higher than that of females in all the treatments. But the contribution of females to total biomass production was found to be record-worthy and related to sex ratio which ranged from 1.22 to 1.69 (female : male) (Table-4) and corroborates the findings of Kanaujia *et al*. (1997) ; Radheyshyam *et al*. (2009b). It was further found that the growth and survival of prawns were directly reflected to the stocking density. According to Sagi *et al*, (1986) increasing the stocking rate lowers the individual weights in prawns.

The present study indicated that growth of prawns at 1 juveniles / m^{-2} (T-I) density resulted in higher average body weight at harvest and achieve greater market value than raising stocking density to 2 and 3 juveniles /m^{-2}.. This could be compared with the results of D'Abramo *et al.* (1989), who opined that the stocking density around 4 PL/m^{-2} would be ideal for *M.rosenbergii.* A positive correlation between stocking rate of prawns and yield and a negative correlation between stocking rate and average weight in prawns was reported by Sandifer and Smith (1975); Willis and Berrigan (1977); Brody *et al.* (1980); Wohlfarth *et al.* (1985). Wohlfarth *et al.* reported that while the average weight of prawn decreased, the yield increased from 380 to 791 kg per ha. But the proportion of marketable size of prawns decreased from 73% to 20%, where stocking increased from 1 to 4 juveniles / m^2 . The feed conversion ratio (FCR) increased with the increase in the stocking density of prawns and Zaki *et al*., (2004) who studied the effect of stocking density of marine shrimp on the FCR. The specific growth rate (SGR) was found to be high in T1 (0.87%) followed by T2 (0.81%) and T3 (0.77%) which indicate that the growth rate is higher in lower densities and Corrobotes the opinion of Le Cren (1965).

The stocking density at 1 juvenile / m^{-2} registered highest growth compared to 2 and 3 juveniles / m^{-2} but the total biomass production at the end of the experiment was found to be highest at the stocking density of 2 juveniles /m2 indicating ideal stocking density for *M.gangeticum* production The results further suggest that either decreasing or increasing stocking density of 2 juveniles / m2 may not be a good strategy to achieve optimum production of *M.gangeticum*. According to Das *et al*., (1992) the growth rate is inversely related to stocking density.

Based on the data generated from this study**,** it can be concluded that under the conditions of this experiment, the stocking density at 2 juveniles / m2 (T-II) could be ideal to achieve maximum production (7.43 kg /0.02 ha earthen tank) of *M. gangeticum.* Lower stocking stocking density plays an important role in culture period of *M.gangeticum.*

ACKNOWLEDGEMENT :

Author is grateful to the SERC, Department of Science & Technology (Govt. of India) for financial support and Director, Central Institute of Freshwater Aquaculture, Bhubaneswar for providing the facilities to carry out the research work.

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