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DEVELOPMENT OF NURSERY TECHNOLOGY OF FRESHWATER PRAWN (*Macrobrachium rosenbergii*)

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Abstract: The present study was conducted during June to December, 2010 with a view to developing a nursery technology with respect to stocking density optimization and survivability of prawn PL in earthen ponds. Hatchery obtained PL were reared with commercial nursery feed and monitoring of water quality for 14 weeks in 12 ponds (1.25dec each) at Khulna University. Four densities viz., 958, 500, 800 and 1000 PL/dec were used with three replicates in each. The range of temperature, DO, pH, alkalinity, hardness, ammonia and phosphate during the study were within the acceptable limit. The mean initial weight of prawn PL was 0.005g. Net gains in weight were 2.069, 4.042, 2.680, and 1.707g from the four treatments, respectively. The mean values of specific growth rate of the PL were 3.192, 3.550, 3.332 and 3.090% per day from the four densities, respectively. Highest values of growth rate and survival rate were found in 500 PL/dec density. Second highest values of the same were found in 800 PL/dec. However, a density of 500-800 PL/dec may be used for better growth and survivability in the prawn nurseries, though there are scopes for further improvement of the process through feeding trial and/or other aspects.

Keywords: *Macrobrachium rosenbergii*, nursery technology, stocking density, survivability

Introduction

Until a few years ago the demand of freshwater prawn seed was used to be met from the natural collection, but of late, the natural sources have been drastically reduced and now hatchery-produced seed is meeting a significant part of the demand. The farmers have claims against the quality of hatchery produced PL. Farmers usually have a strong interest in wild PL rather than hatchery reared PL due to good adaptability in nature, good growth performance and better survival rate. The natural PL is caught at comparatively older stages of development. The hatchery owners try to sell out the PL just after the completion of hatching to start their next cycle of production. Because the farmers do not have the proper knowledge/facilities for carrying out the nursery operation of the hatchery-produced PL, the poor nursed or even without nursed PL are stocked in the ponds. As a result the mortality becomes very high. Moreover, the farming technology is traditional and the production of prawn has remained ever low in Bangladesh. There is no proven technology for nursing the prawn PL; the same could be a determining factor for increasing the supply of healthier and stronger juveniles for stocking in grow out ponds. At the backdrop of the above scenarios the present study was conducted with a view in optimizing the stocking density and higher survival rate in nursery rearing of prawn PL in earthen ponds.

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There are very limited published reports on prawn nursery system in Bangladesh. Some authors such as Angell (1994), Alam *et al*. (1997), Barman *et al*. (2003) and Asaduzzaman *et al*. (2005) reported about prawn nursery system in Bangladesh. Growth of PL of freshwater prawn in the nursery pond is highly dependent on water management and pond depth as well as on the quantity of supplementary feed used (Apud *et al.* 1981). The minimum required ambient temperature for rearing of freshwater prawn to be 22 ^{0}C as stated by Raanan *et al*. (1984).The minimum requirement of dissolved oxygen level of prawn is reported to be 3-4 mg/L., however, at a level below 2 mg/l of oxygen prawn exhibit an initial period of hyperactivity with swimming at the surface and jumping followed by morality (Apud, *et al.* 1985). Nuruzzaman (1992) reported that the shrimp PL (14.0 to17.0 mm) usually should be stocked in the nursery ponds at the rate of 50,000–100,000 PL/ha. After passing 30-40 days the PL retained from 50-55 mm in size. He also stated that after liming, 1000-1200 kg/ha chicken droppings and 500-600 kg/ha cow dung should be applied depending on the fertility of the pond soil.

Alam *et al*. (1997) stated the development of method of nursery rearing of prawn PL to juvenile in hapa-net and cement cistern. According to them in nylon hapa-net nursery for 45 days, juvenile prawn of 47-48 mm could be produced with a survival rate up to 88% at the stocking density of 100-300 PL/m^2. They also added that research attempts were also been made in developing feed for nursery. The effect of multiple stocking for enhancing survival, production and marketable yield structure of *M. rosenbergii* resulted with a range of survival rate from 38.92% (without nursery phase) to 63.31% (with two separate nursery phases) and the mean net production was found to be varied from 169.4 to 744.5 kg/ha/8 months (Kurup and Ranjit, 2005).

This research endeavors to find out a technology for nursing prawn larvae with suitable feeding, fertilization and management of the nursery ponds by determining survival rate of the PL, optimizing stocking density of PL by appropriate feeding and developing technology for nursery management of prawn PL.

Materials and methods

A total of twelve ponds, with adequate aquaculture facilities, located at the Khulna University premise, measuring 1.25 decimal each, were selected. With a view to develop a nursery technology of *M. rosenbergii* with respect to optimization of stocking density and survivability of PL in the nursery ponds the experiment was conducted during July-November of 2010.

The ponds were divided into three groups in accordance with the three treatments on density of stocking of the PL, each with three replications. Three densities were 500 PL/ decimal, 800/ dec. and 1000/dec. There was a control group of ponds with 958/dec density having the same number of replications. For convenience, the treatments were denoted as T_1, T_2, T_3 and T_c. All ponds were enclosed with nylon netting of smaller mesh size with 0.6 meter height from its base for the protection from unwanted lives that might either be predator on the prawn PL directly or take a portion of feed applied for the PL, resulting poor growth and survival. To kill the insects and unwanted lives, the ponds were treated with Rotenone at the dose of 30 g/decimal for every 30 cm water depth. After one week, lime was applied into the ponds at a dose of 2 kg/dec. due to presence of excess black soil at the bottom of the ponds. After one week of liming, the ponds were fertilized with both organic (cowdung 10kg/dec) and inorganic (Urea and Triple Super Phosphate at 150g and 75g per dec., respectively) fertilizers. The PL were not stocked directly rather they were acclimatized for 4-5 hours keeping the poly bags submerged in the nursery ponds before stocking. Then they were stocked at the densities of 500, 800, and 1000 PL/dec. in the ponds marked as T_1, T_2 and T_3 respectively and at 958 PL/dec. in the control group ponds. The PL was fed twice daily with a commercial larval feed for up to 4 weeks of stocking named “Yeon Feed”, and in the subsequent days, with a grower feed named “Quality Feed” at 10% of the body

weight by using tray. Cow dung was applied at 1 kg/dec in every 15 days and Urea and TSP were applied once in every week at the rate of 50g/dec and 25g/dec respectively.

The stocking weight of the PL was recorded before releasing into the ponds. Data on growth of the PL in weight was recorded once in a week and the physico-chemical parameters of the pond water were also recorded fortnightly. A total of 20 PL from each pond was collected by using a push net (*thela jal*). For ease of weighing, the PL were anesthetized by a bath of 1 ppt Ethyl-4-amino benzoate (Benzocain) prepared at 10% alcohol (Shah, 1984). After measuring the individual weight of the PL in gram up to 3 digits after the decimal point by using an electric balance the sampled PL were returned to the respective ponds. Water temperature, dissolved oxygen (DO), pH, total ammonia, hardness, total alkalinity and phosphate were recorded fortnightly between 9.00 am to 11.30 am.

Results

Water quality parameters: The temperature of the ponds water was found to be more or less similar in different ponds. The mean values of water temperature ranged from 25.10 to 31.70 ^{0}C in different treatments.

The values of DO were found to be ranged from 4.21 to 6.90 mg/l. The average value of DO in the Tc ponds was found to be 5.587±0.058 mg/l and similarly the values for T_1, T_2 and T_3 were found to be 6.092±0.156, 5.639±0.187 and 5.513±0.217 mg/l, respectively (Table 1).

Table 1: Water quality parameters of the treatment ponds throughout the study period

Parameters	Treatments	Mean	Std. Error	Std. Deviation	Maximum	Minimum
1.Temperature (^{0} C)	T_c	28.23	1.090	2.437	31.433	25.26
	T_1	26.69	1.642	4.023	31.567	25.10
	T_2	27.95	0.850	2.082	31.467	25.26
	T_3	28.05	0.872	2.136	31.467	25.26
2. Dissolved O_2 (mg/l)	T_c	5.587	0.058	0.143	5.813	5.423
	T_1	6.092	0.156	0.381	6.583	5.597
	T_2	5.639	0.187	0.457	6.220	4.893
	T_3	5.513	5.513	0.435	6.260	4.940
3. pH	T_c	7.080	0.112	0.250	7.333	6.767
	T_1	7.087	0.083	0.186	7.333	6.900
	T_2	7.367	0.053	0.118	7.533	7.233
	T_3	7.380	0.039	0.087	7.467	7.267
4. Total alkalinity (mg/l)	T_c	163.022	10.546	23.582	183.333	127.777
	T_1	150.000	8.640	19.320	179.167	129.167
	T_2	154.722	8.489	18.983	175.000	127.777
	T_3	133.055	8.055	18.013	154.167	116.667
5. Hardness (mg/l)	T_c	183.000	1.700	3.801	186.667	178.333
	T_1	186.667	1.054	2.357	190.000	183.333
	T_2	202.667	2.449	5.477	210.000	196.667
	T_3	196.667	2.789	6.236	203.333	190.000
6. Total Ammonia (NH_3) (mg/l)	T_c	0.084	0.006	0.012	0.099	0.073
	T_1	0.090	0.006	0.011	0.099	0.073
	T_2	0.073	0.009	0.018	0.087	0.050
	T_3	0.089	0.004	0.009	0.096	0.077
7.Phosphate (PO_4) (mg/l)	T_c	0.560	0.023	0.045	0.620	0.520
	T_1	0.665	0.031	0.061	0.720	0.580

T_2	0.588	0.018	0.037	0.640	0.560
T_3	0.663	0.034	0.068	0.733	0.570

pH values were found to fluctuate from 6.6 to 7.70 in different treatments. The average values of pH were found to be 7.080±0.112, 7.087±0.083, 7.367±0.053 and 7.380±.039 mg/l in T_c, T_1, T_2 and T_3, respectively (Table 1).

The values of total alkalinity as recorded from the twelve ponds were found to range from 100.00 to 212.00 mg/l in differemt treatments. The average values of alkalinity were found to be 163.022±10.546, 150.00±8.640, 154.722±8.489 and 133.055±8.055 mg/l in T_c, T_1, T_2 and T_3, respectively (Table 1).

The values of total hardness were found to range from 161 to 222.00 mg/l in the treatments. The average values of hardness were found to be 182.6±1.52, 185.867±1.323, 196.733±1.827 and 196.667±1.597mg/l for T_c, T_1, T_2 and T_3, respectively (Table 1).

The average values of ammonia were found to be 0.084±0.006, 0.090±0.006, 0.073±0.009 and 0.089±0.004 mg/l in T_c, T_1, T_2 and T_3, respectively.

The values of total phosphate level as recorded from the twelve ponds were found to range from 0.38 to 0.82 mg/l in the treatments. The highest value was found in the pond T_{3c} and the lowest was found in T_{1c}. The average values of phosphate were found to be 0.560±0.023, 0.665±0.031, 0.588±0.018 and 0.663±0.034 mg/l in T_c, T_1, T_2 and T_3, respectively (Table 1)

Growth performance: After a rearing period of 14 weeks, the final average weights gained by the PL stocked were found to be 2.074, 2.685 and 1.712g from T_c, T_1, T_2 and T_3, respectively whereas the net gain in weights of the PL were found to be 2.069, 4.042, 2.680 and 1.707g from T_c, T_1, T_2 and T_3, respectively (Table 2). The average values of daily weight gain found in the experiment over a period of 14 weeks were 0.025, 0.049, 0.033 and 0.021g/day from T_c, T_1, T_2 and T_3, respectively and the highest value (0.049 g/day) was found in T_1(Table 2).

The percentages of net increase in weight in the PL were 2955, 5774, 3828 and 2439% per week from T_c, T_1, T_2 and T_3, respectively and the highest percentage of net increase in weight (5774% per week) was found in T_1(Table 2). Weekly obtained percentages of increase in weight were found to decrease rapidly from the beginning and more or less slowly towards the end of the experiment (Fig 1).

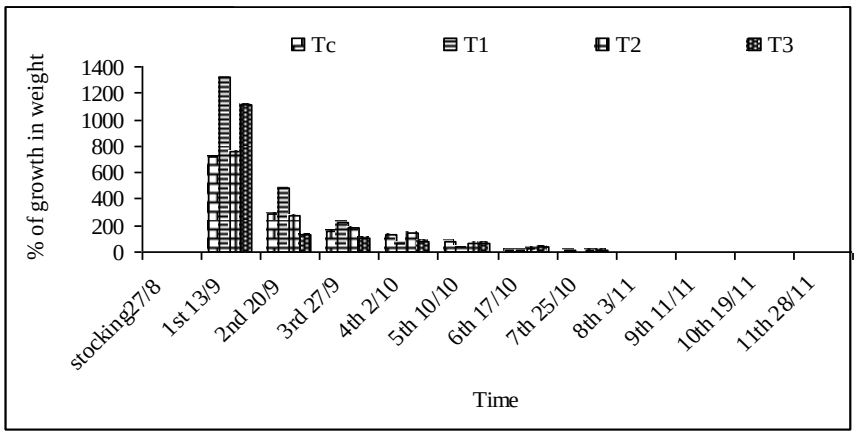

Fig 1: Percentage of weight gain in the experiment

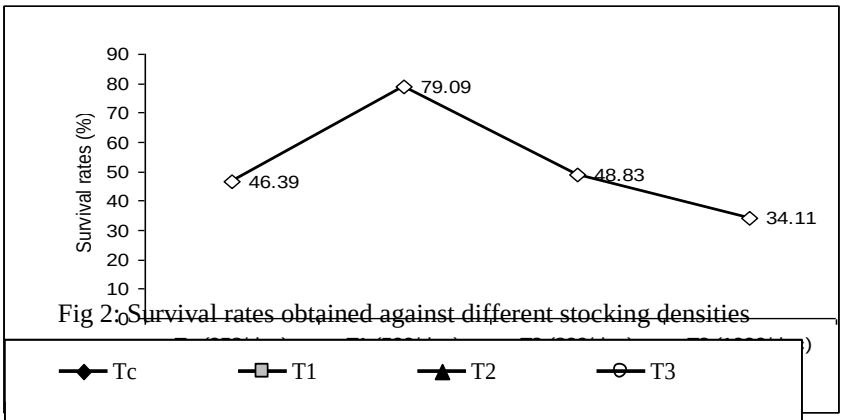

Fig 2: Survival rates obtained against different stocking densities

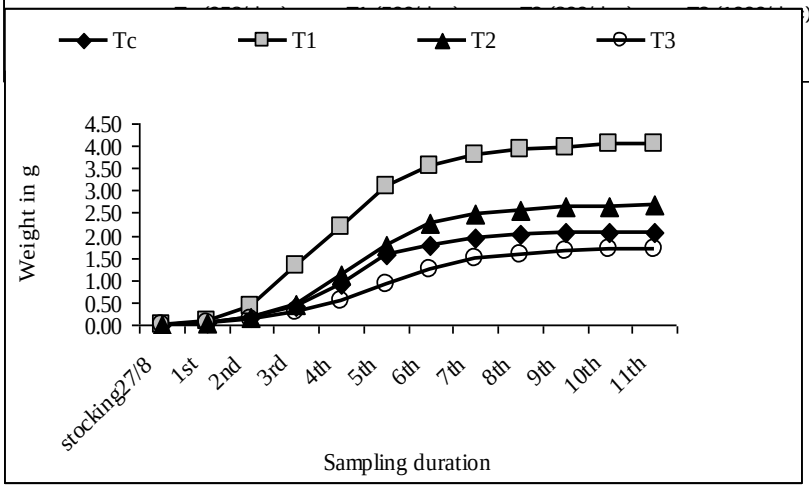

Fig 3: Weight gain obtained against different stocking densities

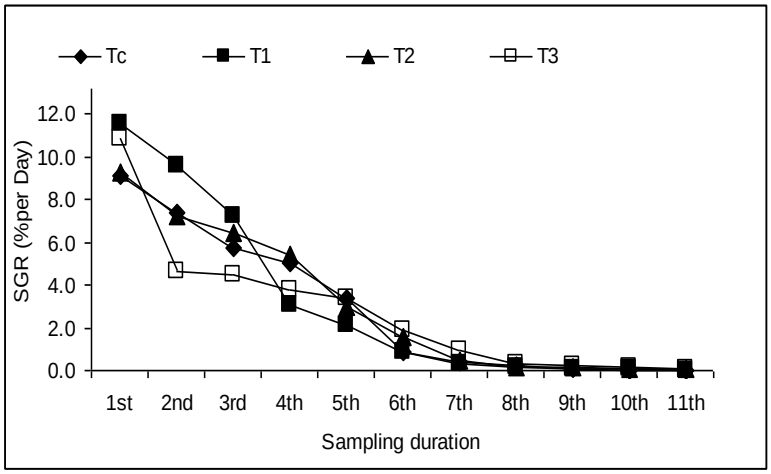

Fig 4: Specific growth rate (% per day) against different stocking densities

The mean values of specific growth rate observed in the experiment were 3.192, 3.550, 3.332 and 3.090% per day in T_c, T_1, T_2 and T_3, respectively and the highest value (3.550 % per day) was found in T_1 whereas the lowest (3.090 % per day) was in T_3 (Table 2).

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Table 2: Weekly growth performance of *M. rosenbergii* PL by mean weight gain, percentage of weight gain and specific growth rate

Parameters	Treatment	Weekly average value												During the study period	
		Initial	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	Net gain	Mean net gain	Average daily gain
Weight gain (g)	T_c	0.005	0.041	0.160	0.404	0.908	1.564	1.794	1.936	2.019	2.061	2.070	2.074	2.069	2.625	0.025
	T_1	0.005	0.071	0.416	1.332	2.194	3.082	3.562	3.782	3.914	3.981	4.027	4.047	4.042		0.049
	T_2	0.005	0.043	0.163	0.458	1.104	1.782	2.285	2.482	2.561	2.631	2.659	2.685	2.680		0.033
	T_3	0.005	0.061	0.142	0.291	0.536	0.921	1.243	1.470	1.557	1.635	1.689	1.712	1.707		0.021
Percentage weight gain	T_c		720	289.43	153.03	124.67	72.35	14.70	7.88	4.32	2.08	0.42	0.18	2955/week	5069.25 (per week)	
	T_1		1322	485.09	220.19	64.69	40.50	15.59	6.17	3.49	1.72	1.16	0.50	5774/week		
	T_2		753	281.25	181.35	141.22	61.41	28.23	8.62	3.18	2.72	1.09	0.97	3828/week		
	T_3		1113	134.07	104.69	84.52	71.66	35.01	18.24	5.94	4.99	3.32	1.38	2439/week		
SGR (% per day)	T_c		9.138	7.380	5.760	5.022	3.377	0.851	0.412	0.230	0.111	0.024	0.010	3.192		
	T_1		11.53	9.590	7.220	3.095	2.109	0.899	0.325	0.186	0.093	0.062	0.027	3.550		
	T_2		9.311	7.265	6.418	5.463	2.971	1.543	0.449	0.170	0.146	0.059	0.052	3.332		
	T_3		10.84	4.617	4.444	3.801	3.352	1.862	0.909	0.313	0.264	0.178	0.074	3.090		

Survival rate

After a rearing period of 14weeks, the mean survival rates of the stocked PL were found to be ranged from 34.11% to 79.39% in the treatments. The mean values of survival rates were obtained to be 46.39, 79.09, 48.50 and 34.11% from T_c, T_1, T_2 and T_3, respectively. The highest rate was found in treatment T_1 and the second highest was found in T_2.

Discussion

Lack of availability of seed appears to be an obstacle in the development of culture of *M. rosenbergii* in Bangladesh. Farmers usually have a strong interest in wild PL rather than hatchery produced PL; the hatchery produced PL have low survival rates and poor growth performance compared to wild PL. Usually the absence of a nursery rearing phase of the PL after the hatchery cycles of rearing results in low survival rates in the grow-out ponds (Bindu *et al*.1999). Regardless of grow-out approach, the incorporation of prawn nursery system seems to offer potential for increasing the yields, value and predictability of the crop (Smith *et al*. 1978; Willis and Berrigan, 1977). However, rearing the post larvae in nurseries under high stocking densities, in turn, has resulted in higher mortality rates and also in increased size disparity among the individuals (Malecha *et al*., 1989). Moreover, with the adoption of a nursery phase, faster morphotypic transformation might have taken place, since the post-larvae reared in the nurseries had a better opportunity to survive, which resulted in the presence of larger prawns at the time of harvest (Kurup and Ranjit, 2005).

Efforts have been made in the present study to optimize the stocking density and to determine the survival rate for developing an appropriate nursery technology of *M. rosenbergii* in earthen ponds. The findings of the study are discussed in the light of the available references as below.

Water quality parameters: Growth, feed efficiency and feed consumption of fish and prawn are normally governed by a few environmental factors. Environmental parameters exert an immense influence on the maintenance of a healthy aquatic environment and production of food organism. The water quality parameters measured in different treatments in the present study throughout the experimental period were found to be within the acceptable range

Temperature: Hoq *et al*. (1996) report that water temperature ranging from 27.5 to 30.5 ^{0}C is suitable for the growth of *M rosenbergii*. Maclean *et al*. (1994) suggest the favorable temperature

range to be 28.9 to 29.1^{0}C for the species. The water temperature recorded from the experimental ponds ranged from 25.10- 31.70 ^{0}C and was within the range of suitable temperature as recommended by Fair and Foftner (1981) however, the lower limit was somewhat less than that of described by Hoq *et al*. (1996) and Maclean *et al*. (1994).

Dissolved Oxygen: Dissolved oxygen levels in the pond water varied from 4.21 to 6.90 mg/l. Hoq *et al*. (1996) record DO ranging from 4.0 to 5.9 mg/l in five prawn farms which were suitable for fish culture. Jia-Mo *et al*. (1988b) report the presence of dissolved oxygen at 4.5 mg/l in *M. rosenbergii* culture ponds. Jaruvat and Somnuk (1987) report that shrimp would normally die if dissolved oxygen is less than 0.7 mg/l. Hossain *et al*. (2000) report the presence of dissolved oxygen content at 3.0 to 6.1 mg/l in earthen ponds used for *M. rosenbergii* monoculture. From the statistical point of view, difference in DO level between T_c and T_1 was significant and the same among the other treatments was not significant when compared using ANOVA ($p<0.05$). The significantly higher level of DO in T_1 indicated the better quality of water i.e. little or no organic deposit might exist in the bottom level of the ponds of T_1.

pH: Rapid fluctuation of pH level of a culture pond causes the hinder of growth of *galda* PL. The pH values ranging from 6.1 to 7.7 are considered suitable for culture of *M rosenbergii* in earthen ponds (Jia-Mo *et al*. 1988a). Hoq *et al*. (1996) report pH values ranging from 7.5 to 8.0 in five prawn farmers ponds. Hossain *et al*. (2000) reported 6.8 to 8.4 pH value range as suitable for *M. rosenbergii.* In the present study statistically the difference in the pH levels between T_c and T_2, T_1 and T_2, and T_1 and T_3 was significant but the same among the other treatments was insignificant when compared using ANOVA ($P<0.05$).

Total alkalinity: Total alkalinity values in the present study ranged from 100.00 to 212.00 mg/l. These values were more or less similar to the results of Dewan *et al*. (1991), Wahab *et al*. (1995), Nirod (1997) and Kohinoor *et al*. (2001). Therefore, it might be said that the values obtained was within the suitable range for fish and *galda* PL culture. There were no significant difference among the treatments when compared with ANOVA ($P<0.05$).

Hardness (mg/l): From the statistical point of view difference among the treatments was insignificant. On average 40-200 ppm hardness in the pond water is good for prawn PL (Ali and Mazid, 2005) and the findings of the present study were found to fall within the range.

Total Ammonia (mg/l): The average values of total ammonia as recorded from the twelve ponds were found to range from 0.04 to 0.10 mg/L. The highest value was found in the ponds T_2c T_3b. Both Das (1998) and Ali and Mazid (2005) recommended the favorable ammonia level for *galda* PL to be less than 1 ppm. Average ammonia level in all the treatments in the present experiment was less than 1ppm.

Phosphate (PO4) (mg/l): Phosphate is an important nutrient in the aquacultural water. The values of total phosphate level as recorded from the twelve ponds were found to range from 0.38 to 0.82 mg/L. The phosphate level of a prawn culture pond should be with in 0.5-1.00 mg/l (Das, 1998). The phosphate level in the present experiment was found within this range.

Growth performances of the stocked *M. rosenbergii* PL

Weight Gain (g): From the present study it is apparent that highest weight was gained by the prawn PL stocked at the density of 500 PL/dec in the treatment T_1 and the second highest was obtained from T_2. T_1 showed higher growth in terms of net increase in weight than that of T_c, T_2 and T_3. Treatment T_3 showed the lowest growth performance. This might be explicated to competition for food. Growth in terms of weight depends upon environmental parameters, density of stocking, food supply, shelter, insect, predation etc (Fujimura and Okamoto, 1970). The higher growth rate obtained in T_1 could be attributed to the low stocking density compared to the other treatments that might facilitated the prawn PL better opportunity to consume both natural and supplementary feed. Water temperature is one of the major factors that govern the growth of fish

and other aquatic organism (Fujimura and Okamoto, 1970). If prawn PL is kept at temperature far below the suitable lower limit (25^0C) normal growth is stunted and the PL become very weak (Ali and Mazid, 2005). The water temperature of the experimental ponds was found to be below the recommended temperature range during the last two weeks due to onset of winter and consequently the growth rate was found to be low during the end of the experiment (Fig 3). There were highly significant differences among all the treatments in terms of weight (g) gain when compared using ANOVA ($P<0.0\ 5$).The growth rates and average weight gain obtained in the present experiment were found to increase more or less rapidly at the beginning of the experiment and then started decreasing towards the end of the experiment

Average Daily Weight Gain (g): Treatment T_1 showed better performance in terms of average daily weight gain (g) than that of the other treatments. These findings were agreeable with the findings of Siddiqui and Al-Hinty, (1993) who found the daily weight gain in *M. rosenbergii* to be 0.318 and 0.319g. The lower average daily gain in T_3 might be due to competition for feed.

Percentage of Increase in Weight: The average percentage of increase in weight 5774% per week in the treatment T_1 was significantly higher than that of in T_c, T_2 and T_3 which might be explicated to the less competition for food in low stocking density applied in the treatment.

Specific Growth Rate (% per day): The SGR of *M. rosenbergii* was significantly highest 3.550 % per day in treatment T_1. The findings were agreeable with the findings of Sharma and Reddy (1996). SGR was found to be decreased gradually towards the end of the rearing period.

Survival rate: The ultimate aim of the research was to help obtaining a higher survivability rate compared to the prevailing rates in the culture farms in the areas by stocking nursery reared PL. The available information suggest that the rate of survival is very poor with the *galda* farmers and the same was mainly attributed to the lack of nursery technology of the hatchery produced PL. The PL without nursed are stocked in the culture farms with the consequent high mortality and less production from the farms. In the present study the highest survival rate of *galda* PL was obtained at 79.09% in treatments T_1, which could be explicated to the low stocking density. No significant difference between T_c and T_2 was found using ANOVA ($P<0.05$) but differences were there among the other treatments. The results were agreeable to the findings of D'Abramo *et al*. (1989) who found that the survival rate of prawn PL in earthen ponds varied from 54.3% to 89%. Generally, by using an arbitrarily stocking density of more than 1000 PL/dec the galda farmers face a higher mortality rate (up to 50-70%) (Asaduzzaman *et al*. 2005). The survival rate obtained from T_1 (500 PL/dec) was much higher than that of the rates obtained by the traditional farmers.

Conclusion

The present experiment was carried out with a view to optimizing stocking density and survival rates in earthen nursery ponds in order to develop a nursery technology. Out of the four densities tried in T_c, T_1, T_2 and T_3, the density 500PL/dec provided with the highest survival and net gain in weight; the second highest survival and growth rate were achieved in the density 800PL/dec. Thus a density range of 500-800/dec may be recommended for use in the prawn nurseries for better growth and survivability.

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