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Determination of Optimum Stocking Density of *Macrobrachium rosenbergii* in Carp Polyculture in Earthen Pond

M.M. Haque, N.T. Narejo, M.A. Salam, S.M. Rahmatullah and M.A. Islam
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, Bangladesh

Abstract: A four month long experiment was conducted in earthen ponds (each of 81 m^2 in size) during the month from August to November, 2001 to observe suitable stocking density of *Macrobrachium rosenbergii* in polyculture of Indian major carps viz. catla (*Catla catla*), ruhu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*). Six densities of *M. rosenbergii* with carps were considered as treatments. Each treatment had three replications. All the fish were same age group and mean initial weight of prawn, catla, ruhu and mrigal were 1.1± 0.12, 14.2 ± 0.52, 8.5 ± 0.16 and 11.8 ± 0.20g respectively. Water quality parameters including temperature, dissolved oxygen and pH were found in the suitable range. The best combination of prawn-carp polyculture (prawn: catla: ruhu: mrigal = 25: 15: 15: 15) was found in the treatment T_3 with significantly ($p<0.05$) highest growth of *M. rosenbergii* and carps.

Key words: Stocking density, *M. rosenbergii*, carp polyculture

Introduction

The giant freshwater prawn *Macrobrachium rosenbergii* dominates in the shell fish production of Bangladesh, because of its fast growth and adaptation to the environment and artificial feed. During the last few years demand of prawn in the world market is consistently increasing due to its export potential. Polyculture with combinations of common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypohthalmichthys molotrix* Val.) and tilapia (*Oreochromis*) hybrids has been investigated (Cohen and Ra'anan, 1983; Cohen *et al.*, 1983 and Wohlfarth *et al.*, 1985). Polyculture of the freshwater prawn with channel catfish, *Ictalurus punctatus* (Pavel, 1985) or with a mixture of channel catfish, grass carp and silver carp (Miltner *et al.*, 1983) has also been studied. The polyculture approach generally involves comparatively low stocking densities of prawns and is economically attractive since the pond can be managed exclusively for the fish. Thus, no special management considerations need to be afforded prawns. Polyculture also improves the ecological balance of the pond water, preventing the formation of massive algal blooms (Cohen *et al.*, 1983) and allows the use of manures as substitute for supplemental feeds (Moav *et al.*, 1977).

No published information affordable for the rural farmers is available on optimum stocking density of prawn *M. rosenbergii* with carp polyculture in Bangladesh. There is a great potential for successful freshwater prawn culture in numerous ponds of Bangladesh. Now a days, the production of prawn from natural sources is decreasing day by day due to overexploitation and environmental pollution reported by many scientists. The present study was undertaken to observe optimum stocking density of prawn in carp polyculture with supplemental feed, under condition of Bangladesh Aquaculture.

Materials and Methods

Site and duration: The experiment was conducted in the Field Laboratory of the Faculty of Fisheries, Bangladesh agricultural University, Mymensingh and carried out for a period of 4 months (August to November 2001).

Experimental ponds and fish: Eighteen experimental ponds each comprised an area of 81-sq. m (2 decimal) were used for the study. For each treatment, triplicate ponds were used. The aquatic weeds and undesirable fishes were removed. No fertilizer was applied to the pond as they apparently rich in nutrients. Juveniles prawn (*M. rosenbergii*) and indigenous carp fry catla (*C. catla*), ruhu (*L. rohita*) and mrigal (*C. mrigala*) were purchased from private fish seed multiplication farm. Water depth of the pond was maintained to 1 m in every pond throughout the experimental period.

Stocking of fish: Prawn and fishes were stocked in 6 densities; each density was treated as treatment. Layout of the experimental design is shown in Table 1.

Feed preparation and feeding: Locally available ingredients such as fishmeal, mustard oil cake, sesame meal, rice bran and wheat bran were used for the feed

Table 1: Layout of the experimental design

Fish	Density/decimal (40.5 sq. m) T_1	T_2	T_3	T_4	T_5	T_6
Prawn	15	20	25	30	35	40
Catla	15	15	15	15	15	15
Ruhu	15	15	15	15	15	15
Mrigal	15	15	15	15	15	15

The mean initial weight of prawn, catla, ruhu, and mrigal were 1.1± 0.12g, 14.2 ± 0.52g, 8.5 ± 0.16g and 11.8 ± 0.20g respectively. Coconut leaves were drawn in the pond bottom for better shelter.

Table 2: Composition of the formulated diet

Ingredients	% of ingredients
Fish meal	30.0
Mustard oil cake	12.5
Sesame meal	12.5
Rice bran	25.0
Wheat bran	20.0

formulation. The prepared diet was composed of 30% protein. The composition of the experimental diet is shown in the Table 2. Fishes were fed pelleted feed (0.4-cm dia.) once a day at the rate of 5% of the total body weight. The feed was supplied directly to the fishponds between 9:00 to 10:00 am.

Monitoring of water quality parameters: The water quality parameters such as temperature, dissolved oxygen and pH of all the treatments were monitored fortnightly during the experimental period.

Analysis of the experimental data: Sampling of fish was done fortnightly to measure weight by an electronic balance. Weight gain, specific growth rate (SGR), survival rate and production was calculated. Comparison of treatment mean was carried out using one-way analysis of variance (ANOVA), followed by testing of pair-wise differences using Duncan's Multiple Range Test (Vann, 1972). Arcsin transformation was used for percentage survivility (Zar, 1974) before subjecting the data to the analysis of variance. All statistical analysis were done using MSTAT-C statistical package.

Results and Discussion

Growth and production of fish are normally governed by few environmental factors (Fry, 1971 and Brett, 1979) Environmental parameters exert an immense influence on the maintenance of the healthy aquatic environment and

Table 3: Fortnightly fluctuation of water quality parameters over the experimental period

Treatments	T_1	T_2	T_3	T_4	T_5	T_6
Temperature	27.8-31.2	27.6-31.0	27.8-31.3	28.7-31.2	28.8-29.9	28.5-30.1
Dissolve oxygen	5.5-6.0	5.3-5.6	5.5-6.2	5.5-6.0	4.8-5.7	5.5-5.6
pH	8.4-8.5	8.3-8.4	8.4-8.5	8.2-8.6	8.1-8.5	8.4-8.6

Table 4: Growth and survivability of prawn and Indian major carp at different densities

Prawn and fish species	Treatments T_1	T_2	T_3	T_4	T_5	T_6	±S.E[2]
M. rosenbergii							
Initial weight (g)	1.10	1.10	1.10	1.10	1.10	1.10	-
Final weight (g)	39.5[a1]	39.00[a]	38.9[a]	36.7[b]	35.40[bc]	33.5[c]	±0.49
Weight gain (g)	38.4[a]	37.9[a]	37.8[a]	35.6[b]	34.3[bc]	32.4[c]	±0.93
SGR (%day)	2.98[a]	2.97[a]	2.97[a]	2.92[bc]	2.89[b]	2.84[c]	±0.14
Survival (%)	85.00[a]	84.50[a]	84.00[a]	77.33[bc]	71.42[b]	67.50[c]	±0.41
Catla catla							
Initial weight (g)	14.20	14.20	14.20	14.20	14.20	14.20	-
Final weight (g)	275.30[ab]	274.50[ab]	276.50[a]	272.50[ab]	271.20[b]	273.50[ab]	±0.75
Weight gain (g)	261.10[ab]	260.30[ab]	262.30[a]	258.30[ab]	257.00[b]	259.30[ab]	±0.89
SGR (%day)	2.47[a]	2.46[a]	2.47[a]	2.46[a]	2.46[a]	2.47[a]	±0.16
Survival (%)	94.00[a]	93.90[a]	93.50[a]	91.00[ab]	90.50[ab]	89.50[b]	±0.92
Labeo rohita							
Initial weight (g)	8.50	8.50	8.50	8.50	8.50	8.50	-
Final weight (g)	276.00[ab]	277.00[ab]	280.50[ab]	277.00[b]	276.20[b]	275.01[b]	±1.50
Weight gain (g)	267.50[ab]	268.50[ab]	272.00[ab]	268.50[b]	267.70[b]	267.00[b]	±1.20
SGR (%day)	2.90[a]	2.90[a]	2.91[a]	2.90[a]	2.90[a]	2.89[ab]	±1.13
Survival (%)	94.40[a]	93.90[a]	93.30[a]	92.50[a]	92.00[ab]	91.50[b]	±0.53
Cirrhinus mrigala							
Initial weight (g)	11.80	11.80	11.80	11.80	11.80	11.80	-
Final weight (g)	160.00[a]	155.50[ab]	161.20[a]	156.20[ab]	159.50[ab]	158.00[b]	±0.49
Weight gain (%)	148.20[a]	143.70[ab]	149.40[a]	144.40[ab]	147.70[ab]	146.20[b]	±0.52
SGR (%day)	2.17[a]	2.15[a]	2.18[a]	2.15[a]	2.17[a]	2.16[a]	±0.49
Survival (%)	92.90[a]	92.20[a]	92.20[a]	91.20[a]	90.50[ab]	89.33[b]	±0.59

SGR = Specific growth rate (% day)

[1]Figure in the same row having the same subscripts is not significantly different ($p>0.05$)

[2]Standard error of treatment means calculated from the residual mean square in the analysis of variance.

Table 5: Individual and total production of prawn and carps

Fish production (kg ha^{-1}/120 days)	T_1	T_2	T_3	T_4	T_5	T_6
Prawn	120.93	158.21	196.07	203.99	211.78	216.08
Carps	2355.01	2330.57	2359.24	2278.97	2269.45	2248.85
Total	2475.94	2488.78	2555.31	2482.96	2481.23	2464.93

production of food organisms. The water quality parameters and their fortnightly fluctuation during the study period as shown in the Table 3 were found within the suitable range.

Temperature recorded (27.6 to 31.3°C) during the study period is more or less similar to that reported by Mumtazuddin *et al.* (1982) and Rahman *et al.* (1982). The dissolved oxygen values during the experimental period were found between 4.8 and 6.1 mg l^{-1}, which is similar to the findings as reported by Rahman *et al.* (1982). In the study pH was measured from 8.2 to 8.6, which is in the productive range of 6.5 to 9.0 as observed by Swingle (1967). Growth performance of prawn in different treatments in terms of mean weight gain (g), specific growth rate (SGR) and survival were calculated and shown in Table 4. The prawn stocked in the treatment T_1, T_2, and T_3 showed significantly ($p<0.05$) highest final weight gain among all other treatments. The growth was started to decline significantly ($p>0.05$) from the treatment T_4(30 prawn/decimal) to treatment T_6 (40 prawn/decimal). In the present investigation it was observed that increasing the stocking density reduced the growth rate which is in accordance with the findings of Chowdhury *et. al.* (1991). There was a significant variation in the values of average percent daily gain (SGR) in different treatments it might be due to the variation in the stocking densities. The higher specific growth rate (SGR) of *M. rosenbergii* was started to increase from the treatment T_1 to T_3 while decreases from T_4 to T_6. Similar observations has been reported by Chowdhury *et. al.* (1991) and Trino *et al.* (1992).

Similarly, no significant ($p>0.05$) difference of survival rate was found between the treatment T_1, T_2 and T_3 and highest survival rate (85%) of *M. rosenbergii* recorded in treatment T_1. The survival rate was declined from the treatment T_4 to T_6 and lowest survival rate (67%) in the treatment T_6, it might be due to the increase of stocking density. Hoq *et al.* (1996) reported that survival rate of prawn was ranging from 32.22% to 75.5%, which supports the present findings. The total production of prawn in the present study (Table 5) ranged between 120.93 to 216.08 kg ha^{-1}/120 days, which is more or less similar to findings of Jose *et al.* (1991). Total production also followed the survival rate in all the treatments. Best individual growth, survival and production was observed in the treatment T_3 (25 prawn/decimal) in case of prawn as well as carps which indicated suitable optimal stocking density for the prawn with carps in polyculture system.

The growth rate of carps catla, ruhu and mrigal was also found highest in the treatment T_3, which indicated that the combination of *M. rosenbergii* with carp polyculture (prawn: catla: ruhu: mrigal = 25: 15: 15: 15) is well matched. John *et al.* (1995) observed that freshwater prawn performed better in composite culture than monoculture or bispecies culture system. The result of the present findings agreed with the observation of John *et al.* (1995). On the basis of better growth and production, the resulted combination (prawn: catla: ruhu: mrigal = 25: 15: 15: 15) might be affordable for the rural farmers of Bangladesh.

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