

Culture System Development of Shol; *Channa striata* in Captive Condition with Indian Major Carps

¹M.E. Ahsan, ²M.L. Rahman, ²M.A. Salam and ³T. Akter

¹Department of Fisheries Management,
Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh

²Department of Genetics and Fish Breeding,
Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh

³Department of Aquaculture,
Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh

Abstract: The study was carried out to develop culture system of Shol; *Channa striata* under monoculture and polyculture system in earthen pond condition. Nine earthen ponds were selected for this experiment. The average area of the ponds was 3 decimal with 1m depth. In the experiment, three treatments T₁, T₂, T₃ corresponding to the stocking densities of fish 50 (only shol), 50 (shol 33, mrigal 9 and rui 8), 50 (shol 33, catla 9 and rui 8) per decimal respectively. Artificial feed were supplied throughout the experiment. The water quality parameter such as temperature (°C), pH, dissolved oxygen (mg/l) and transparency (cm) were observed monthly. The highest weight gain of shol was 42.9±0.65 in T₁ and lowest weight gain was 34.9±0.76 in T₃. The specific growth rate (%/day) was 1.05±0.51, 0.99±0.49 and 0.96±0.45 in T₁, T₂ and T₃ respectively. The treatment-wise average highest production was obtained 14.16±0.29 kg in T₂ and lowest production was obtained 5.83±0.29 kg in T₁. The total production were obtained 496.50±0.50, 1165.58±0.50 and 912.25±0.43 kg/ha in T₁, T₂ and T₃ respectively. There were significant difference (p<0.01) in weight gain (g), survival rate (%) and production in three treatments. It was found that the weight gain (g), specific growth rate (%/day), survival rate (%) of shol was higher in monoculture than polyculture system, but total fish production was higher in polyculture than monoculture system.

Key words: Culture System • *Channa striata* • Growth Performance • Captive Condition

INTRODUCTION

Channa striata is a freshwater common striped snake-headed belonging to the family Channidae of the order Channiformes and has accessory respiratory organs that help the fish to survive in inhospitable situations [1]. It has a natural distribution in India and the other neighboring countries like Bangladesh, Thailand, Myanmar etc. In Bangladesh it is locally known as shol. It is one of the most important fish species includes into SIS (small indigenous species) of Bangladesh. It is a common freshwater fish which is abundantly found in river, beels and canals of Bangladesh [2]. It has a great demand in market because as food fish and its high

nutritional value. The production of shol depends upon only the natural sources and its production is decreasing day by day due to destroy the feeding, breeding and nursery ground. The culture of shol is still not common practices neither under monoculture nor polyculture in the pond condition. Polyculture or composite culture is the system in which fast growing compatible species of different feeding habits are stocked in different proportions in the same ponds [3]. The polyculture system is a new ways to raise fish production. Several indigenous species were selected, each with different feeding habits. They were compatible when raised together in culture ponds and could use the resources more efficiently than a single species.

Corresponding Author: M.E. Ahsan, Department of Fisheries Management,
Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh.
Tel: +8801715093536.

From this idea, it seems to be one of the systems to have a greater expectation in present context of Bangladesh. The basic principle of the polyculture species of different feeding habits are in the same pond to avoid food competition and best utilization of natural foods of different habits without any harm to each other. It is a fact that, polyculture may produce an expected result if the fish with different feeding habits are stocked in proper ratios and combinations [4]. The principle based on the assumption that fish growth is an expression of their reaction to among their things, the sources of natural food in the environment. The possibilities of increasing fish production per unit area, through polyculture, are considerable, when compared with monoculture system of fish. Different species combinations in polyculture system effectively contribute also to improve the pond environment. Fish species selection plays an important role for any culture practices. Stocking density of different fish species in a polyculture system also plays an important role on overall production of fish. Higher density of a species may affect the growth of another species similarly lower density of a species may reduce the overall production. So, in order to ensure the better utilization of natural fish feed in different strata and zones of a pond. Species selection for polyculture primary importance was given to Indian major carps was rui (*Labeo rohita*), catla (*Gibelion catla*) and mrigal (*Cirrhinus cirrhosus*) [5]. Sometimes kalibaus (*Labeo calbasu*) has been included in polyculture. Among these species, the growth performance and production of mrigal is higher than other local carps. Polyculture is an established and recognized method for more production of fish with friendly environment. Experiment of polyculture of Indian major carps is available but polyculture of shol with major carps is very scant. The key technique of the polyculture is based on the relationship between participatory organisms at different level of food chain of the environment that is why natural food utilization is efficient and thus increase fish yield per unit area synergism and antagonism between ecologically different species depends on stocking densities of each species on food availability. In order to maintain the appropriate stocking densities for each species, the various relationships between different fish groups must be understood. Considering above factors the proposed research results is very important in aquaculture system which to be explore the polyculture system with shol in pond condition.

MATERIALS AND METHODS

Experimental Area: The experiment was carried out at the Fisheries Field Laboratory Complex of the Faculty of Fisheries, BSMRAU, Gazipur for a period of 6 (six) months during 2, April 2015 to 30, September 2015. Nine earthen ponds were selected for the experiment. The area of each pond was 3 decimal and average depths of the ponds were 1m. The ponds were rectangular in shape, well exposed to sunlight and completely free from aquatic vegetation.

Pond Preparation: Ponds were drained out completely to eradicate all undesirable fish, insect and other aquatic organisms. Aquatic weeds were removed manually and the grasses on the pond dykes were also pruned manually into very small size. The pond was serially numbered as 1-9 for convenience of the study. Lime was applied at the rate of 1kg/decimal. Lime was soaked in an earthen pot and then applied by spreading homogenously in the pond. The ponds were filled with underground water from a deep tube-well supply after one week of lime application and then organic (cow dung 5-6kg/decimal) and inorganic (Urea 100g+TSP 100g/decimal) fertilizers were applied to grow the phytoplankton and zooplankton.

Experimental Design and Stocking of Fish: The experiment was carried out with three treatments each having three replicates. For the convenience of the study, all ponds are arbitrarily numbered as 1, 2, 3, 4, 5, 6, 7, 8 and 9. Ponds were alienated in three treatments, viz., treatment-I (T_1), treatment-II (T_2) and treatment-III (T_3) each having three replicates. T_1 was designed with monoculture (only shol), T_2 and T_3 were designed with polyculture. The fishes were stocked at the rate of 50/decimal (only shol) in T_1 . In T_2 shol were stocked at 33/decimal and mrigal and rui were stocked at 17 individuals/decimal and in T_3 shol were stocked at 33 individuals/decimal and catla and rui were stocked at the rate of 17/decimal. The average length and weight of the experimental fry of carp and shol were rui (9.7cm and 9.82g), mrigal (8.0cm and 12.0g), catla (8.0cm and 10g) and shol (7.0cm and 7.5g). All the fry were acclimatized with experimental pond water in polythene bag and then stocked at 3.00pm. The species composition is given in the Table 1.

Table 1: Stocking density and the different species combinations in three treatments

| Treatments | Species | No. of Fish/decimal | No. of Fish/pond | No. of fish/ha |
|----------------|----------------------------|---------------------|------------------|----------------|
| T ₁ | <i>Channa striata</i> | 50 | 150 | 12,500 |
| | Total | 50 | 150 | 12,500 |
| T ₂ | <i>Channa striata</i> | 33 | 99 | 8250 |
| | <i>Cirrhinus cirrhosus</i> | 9 | 27 | 2250 |
| | <i>Labeo rohita</i> | 8 | 24 | 2000 |
| | Total | 50 | 150 | 12,500 |
| T ₃ | <i>Channa striata</i> | 33 | 99 | 8250 |
| | <i>Gibelion catla</i> | 9 | 27 | 2250 |
| | <i>Labeo rohita</i> | 8 | 24 | 2000 |
| | Total | 50 | 150 | 12,500 |

Feeding and Management: Different feed ingredients such as wheat bran, mustard oil cake and a protein mixture named Jasoprot (protein concentration 60%) were collected from local market for the formulation of experimental diets. Artificial feed was given for the proper growth of fishes throughout the experimental period. For this purpose, experimental supplementary feeds were prepared using wheat bran (35%), mustard oilcake (40%) and protein mixture (Jasoprot) (25%). Special attention was given in regular feeding of fishes in ponds. Fishes were fed at a rate of 6% of their body weight at the beginning, which was gradually reduced to 5% and 4% and lastly 3% of their body weight for the last two months respectively. Feeds were applied once a day at 9.00 AM. Throughout the experimental period feeds were applied to the fish by broadcasting method. The experimental ponds were monitored everyday especially in the morning and evening to observe the behavior of the fishes.

Sampling: The water quality parameters viz., transparency (cm), water temperature (°C), dissolved oxygen (mg/l) and pH were measured during every sampling day between 8.00 AM and 9.00 AM. Throughout the experiment period the water level was always maintained more or less at 1 meter. Sampling of fish was also done monthly in the morning at 9.00 AM to 10.00 AM. Five fish of each species from each pond were caught by cast net in each sampling. The weight was taken by precision weighing balance (measuring range from minimum 1g to maximum 1kg) and length was taken by measuring scale.

Growth Parameters: The following parameters were used to evaluate the growth of fish such as length gain (cm), weight gain (g), percent weight gain, FCR, survival rate (%), production kg/ha/180 days.

Weight Gain (g): Weight gain was calculated as:

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

Percent Weight Gain: This is a fairly straightforward measure of the overall increase in the mean body weight over a time period.

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

Specific Growth Rate: The specific growth rate (SGR) was determined by using following formula.

$$\text{SGR (\% / day)} = \frac{\ln W_2 - \ln W_1}{t_2 - t_1} \times 100$$

where,

W₂ = Final weight (g); W₁ = Initial weight (g) and t₂-t₁ = Time interval

Physicochemical Parameters: Temperature (°C), dissolved oxygen (DO), transparency (cm) and pH were measured by following methods. During the study period, temperature or the water of the ponds was recorded using a Celsius thermometer. Transparency was measured with a secchi disk of 20cm diameter. Dissolved oxygen (mg/l) was measured by a digital electronic oxygen meter (YSI, Model 58 USA). pH of water samples was determined with the help of a digital pH meter (Jenway, Model 3020, USA).

Harvesting of Fish: Ponds were dewatering completely to harvest all the fish at the end of the experiment and counted species wise. Then the final growth gained by each species was recorded by measuring length (cm) and weight (g) of individual fish.

Table 2: Monthly growth increment of shol under three treatments

| Treatment | Initial weight (g) | Average weight (g) | | | | | | Net weight.(g) increase |
|------------------------------|--------------------|--------------------|------|------|------|--------|-----------|-------------------------|
| | | Aril | May | June | July | August | September | |
| T ₁ (Monoculture) | 7.5 | 13.5 | 20.0 | 28.0 | 35.5 | 42.5 | 50.40 | 42.89 |
| T ₂ (Polyculture) | 7.5 | 130 | 19.1 | 26.5 | 33.5 | 39.5 | 46.50 | 39.0 |
| T ₃ (Polyculture) | 7.5 | 12.5 | 18.0 | 25.0 | 31.6 | 37.1 | 42.43 | 34.93 |

Table 3: Comparison of mean values (\pm SD) of growth parameters of shol; *C. striata* among the three treatments

| Parameters | T ₁ | T ₂ | T ₃ | F-Value | Level of significance |
|---------------------------|--------------------------------|---------------------------------|--------------------------------|---------|-----------------------|
| Mean initial weight (g) | 7.50 \pm 0.01 ^a | 7.50 \pm 0.01 ^a | 7.50 \pm 0.01 ^a | 0.308 | NS |
| Mean final weight(g) | 50.40 \pm 0.53 ^a | 46.50 \pm 0.50 ^b | 42.43 \pm 0.45 ^c | 195.425 | ** |
| Mean weight gain (g) | 42.89 \pm 0.65 ^a | 39.0 \pm 0.80 ^b | 34.93 \pm 0.76 ^c | 9.285 | ** |
| % Weight gain | 38.56 \pm 22.17 ^a | 35.88 \pm 20.81 ^a | 34.54 \pm 18.64 ^a | 0.178 | NS |
| SGR %/day) | 1.05 \pm 0.51 ^a | 0.99 \pm 0.49 ^a | 0.96 \pm 0.45 ^a | 0.167 | NS |
| Survival (%) | 80 \pm 1.00 ^a | 72 \pm 1.00 ^b | 70.33 \pm 0.58 ^b | 103.00 | ** |
| Production (kg/treatment) | 5.83 \pm 0.29 ^c | 14.16 \pm 0.29 ^a | 11.08 \pm 0.07 ^b | 929.495 | ** |
| Production (kg/ha) | 496.50 \pm 0.50 ^c | 1165.58 \pm 0.50 ^a | 912.25 \pm 0.43 ^b | 1815518 | ** |

Values of the parameter in each treatment with different superscripts (a,b,c) differ significantly ($p < 0.05$), NS indicates non-significant at 5% level and ** indicates significant difference at 1% level.

Table 4: Mean (\pm SD) values of physicochemical parameters under three treatments

| Parameters | Treatments | | |
|-------------------------|---------------------------------|--------------------------------------|---------------------------------|
| | T ₁ | T ₂ | T ₃ |
| Water depth (cm) | 98.67 \pm 1.15 | 98.33 \pm 1.53 | 98.0 \pm 2.0 |
| Transparency (cm) | 27.0 \pm 0.77 (26.0-28.0) | 27.0 \pm 0.67 (26.9 \pm 0.38) | (26.0-28.0) (26.5-27.5) |
| Temperature (°C) | 30.33 \pm 0.98 (29.0-32.0) | 30.42 \pm 1.02 (29.0-32.0) | 30.22 \pm 1.05 (28.5-31.5) |
| Water pH | 7.44 \pm 0.34 (7.0-7.9) | 7.41 \pm 0.42 (6.9-8.0) | 7.65 \pm 0.57 (7.0-8.5) |
| Dissolved oxygen (mg/l) | 6.83 \pm 0.61 (6.0-7.5) | 7.00 \pm 0.71 (6.0-8.0) | 6.75 \pm 0.52 (6.0-7.5) |

Estimation of Survival Rate and Production: Survival rate: After completion of the experiment, total number of fishes of each species from each replication was harvested and counted. The survival rate was estimated by the following formula:

$$\text{Survival rate (\%)} = \frac{\text{No. of harvested fishes}}{\text{initial no. of fishes}} \times 100$$

Production: After 6 (six) months of the experiment most of the fishes were caught by dewatering the ponds. The gross and net production was calculated by the following formula: Production = No. of fish harvested \times Mean final weight.

Statistical Analysis: One-way analysis of variance (ANOVA) was used to determine the performance of fishes in different species combinations. This was followed by Duncan's New Multiple Range Test (DMRT) at 5% level of significance to observe any difference among treatments means in SPSS-11.5 Program.

RESULTS

The growth parameters such as weight gain, percent weight gain, specific growth rate (%/day) of shol were calculated monthly and survival rate (%), total production, percent contribution of different species of total yield were calculated at the end of the experiment. In this experiment, significantly higher net weight gain (42.9g) was recorded in T₁ and the lower net weight gain (34.9g) in T₃ (Table 2). The mean final weight gain of other fishes in polyculture system was 400g (mrigal), 250g (catla) and 125g (rui). There was significant difference ($P < 0.01$) in weight gain of shol under three treatments. The average percent weight gain was slightly higher in T₁ (38.56 \pm 22.17) than T₂ (35.88 \pm 20.81) and T₃ (34.54 \pm 18.64) respectively. There was no significant difference in average percent weight gain of shol ($P > 0.05$) under three treatments (Table 4). The average SGR of shol 1.05 \pm 0.51, 0.99 \pm 0.49 and 0.96 \pm 0.45 were recorded in T₁, T₂ and T₃ respectively. There was no significant difference ($P > 0.05$) in the average SGR (%/day)

of shol among three treatments. The higher survival rate (80) was recorded in T_1 and the lower survival rate (70.33) was recorded in T_3 . The survival rate (%) of fish was estimated after harvesting of fish by dewatering of ponds. The values of survival rate were 80 ± 1.00 , 72 ± 1.00 and 70.33 ± 0.58 in T_1 , T_2 and T_3 respectively. There was significant difference ($P < 0.01$) of shol in survival rate in three treatments. The fish production (kg/treatment) were recorded 5.83 ± 0.29 kg (only shol), 14.16 ± 0.29 kg (shol 3.31kg, silver carp 8kg and rui 2.5kg) and 11.08 ± 0.07 kg (shol 3.10 kg, catla 5 kg and rui 3 kg) in T_1 , T_2 and T_3 respectively and the total fish production (kg/ha) were recorded 496.50 ± 0.50 , 1165.58 ± 0.50 and 912.25 ± 0.43 in T_1 , T_2 and T_3 respectively. There was significant difference ($P < 0.01$) of total fish production in the three studied treatments (Table 3).

A number of physicochemical parameters of pond water were determined which produced a large number of data. The mean values and standard deviation with ranges of each water quality parameters of the three treatments have been presented in Table 4. Monthly recorded physicochemical parameter has been presented in Table 4. During study period, the mean water depth varied from 98.0 cm to 98.7cm among the three treatments. The water temperature varied from 29.0 to 32.0 °C in T_1 , 29.0 to 32.0 °C in T_2 and 28.5 to 31.5 °C in T_3 . The mean values of water temperature were 30.33 ± 0.98 , 30.42 ± 1.02 and 30.22 ± 1.05 °C under T_1 , T_2 and T_3 respectively (Table 4). There was little variation of water transparency during study period. The mean values of water transparency were recorded 27 ± 0.77 , 26.95 ± 0.67 and 26.91 ± 0.38 cm in T_1 , T_2 and T_3 respectively (Table 4). The ranges of water transparency recorded were 26 to 28 cm in T_1 , 26 to 28 cm in T_2 and 26.5 to 27.5 cm in T_3 respectively. The range of pH of water in the experimental ponds was found to vary between 6.9 and 8.5 (Table 4). The highest pH value 8.5 was observed in T_3 and lowest pH value 6.9 was recorded in T_2 . The mean values of pH were 7.44 ± 0.34 , 7.41 ± 0.42 and 7.65 ± 0.57 in T_1 , T_2 and T_3 respectively. The highest dissolved oxygen (DO) concentration 8 mg/l recorded in T_2 while the lowest 6 mg/l was found in T_3 . The ranges of dissolved oxygen in different treatments during study period were found more or less similar and were between 6-8 mg/l. The mean values of dissolved oxygen concentration were 6.83 ± 0.61 mg/l in T_1 , 7.00 ± 0.71 mg/l in T_2 and 6.75 ± 0.52 mg/l in T_3 respectively.

DISCUSSION

The obtained results of the present study on weight gain, % weight gain, specific growth rate, total fish production and various water quality parameters are discussed below and compared with the findings of other researches in the relevant field. During study period significantly higher ($p < 0.05$) weight gain (42.9g) of shol were observed in T_1 than T_2 (39.0g) and T_3 (34.9g). More or less similar findings have been reported by Islam [6], Ahmed [7] in polyculture of rui and Ahmed [8] in monoculture of rui. In the present study, the average percent weight gain of shol was 38.56 ± 22.17 g, 35.88 ± 20.81 g and 34.54 ± 18.64 g in T_1 , T_2 and T_3 respectively. Slightly higher percent weight gain of shol was recorded in T_1 which might be due to feeding or other biological activities. More or less similar findings have been reported by Sufian [9] in polyculture of rui. In the present study, the higher mean values of SGR of shol was recorded 1.05 ± 0.51 in T_1 and lower mean value were recorded 0.99 ± 0.49 and 0.96 ± 0.45 in T_2 and T_3 respectively (Table 3). Similar findings were recorded by Milstein *et al.* [10] who recorded SGR of rui ranged from 1.16 to 0.99. Ridha [11] reported SGR value of fish was 1.10 and 0.87 per day. Modac [12] found the SGR value of rui at 1.65 ± 0.74 in the Indian carp polyculture. The results of the present study were more or less similar to the results quoted above. The higher survival rate of shol was recorded 80 ± 1.00 in T_1 (monoculture), 72 ± 1.00 and 70.33 ± 0.58 were recorded in T_2 and T_3 respectively in polyculture. The survival (%) rate obtained in the present study is more or less similar with the finding of Hossain [13]. In the present study, the experiment-wise fish production were recorded 5.83 ± 0.29 kg, 14.16 ± 0.29 kg (shol 3.31kg, mrigal 8 kg and rui 2.5 kg) and 11.08 ± 0.07 kg (shol 3.10 kg, catla 5 kg and rui 3 kg) in T_1 , T_2 and T_3 respectively. On the other hand, total fish production (kg/ha) were estimated 496.50 ± 0.50 kg, 1165.58 ± 0.50 kg and 912.25 ± 0.43 kg in T_1 , T_2 and T_3 respectively. Total yield of fish were recorded in polyculture system at 685 ± 128 , 735 ± 135 and 653 ± 50 kg/ha/6month in three treatments by Tina F.W. [14]. Ahsan *et al.* [15] obtained the average production of carps 1696-1835 kg/ha in 172 days. So, the production of present study was more or less similar with the above findings. Although higher production was obtained from polyculture but individual growth performance of shol was higher in monoculture.

Water quality parameters exert an important role on the growth and production of fish and other aquatic organisms. The suitable water quality parameters are

prerequisite for a healthy aquatic environment and for the production of sufficient fish food organisms. Temperature is one of the most important water quality parameter that influence the growth, food intake, reproduction and other biological activities of aquatic organisms. With the increase of temperature food intake, metabolism and growth rate of fish are increased. This experiment was held in summer and the temperature was found to vary from 28.5 °C to 32 °C in ponds (Table 4), which was suitable for fish growth. The findings of the present study were similar to the findings of Alim *et al.* [16] and Milstein *et al.* [10]. Water transparency is a gross measure of pond productivity. In the present study, the transparency values ranges from 26 cm to 28 cm in different treatments indicated the pond water seemed to be within the productive range of fish culture. The findings of the present study were similar to the findings of Raihan [17] who recorded transparency values ranges from 11.5 cm to 50 cm and 11 cm to 63.5 cm. So, the result of the present study was more or less similar to that of the above authors. The most important water quality parameter in fish culture is the dissolved oxygen content. Successful fish culture depends on the careful management of dissolved oxygen at optimum level. Dissolved oxygen concentration of the experimental pond of the present study ranged from 6mg/l to 8mg/l. The present findings are higher than Milstein *et al.* [10] and Kadir *et al.* [18] who recorded dissolved oxygen concentration in pond water ranges from 4.7 mg/l to 6.7 mg/l and 5.7 mg/l to 6.7 mg/l respectively. So, the results of the present study were more or less similar to that of the above authors. The pH is considered as an important factor in fish culture and treated as the productivity index of a water bodies. Water with pH values of about 6.5 to 9 are considered best for fish production. Most water bodies have pH within the range of 6.2 to 8.5. The present findings agree with the findings of Ahmed [8] who found that the range of pH varies from 6.6 to 8.8 and 6.3 to 8.9 respectively. The present findings were also more or less similar with the findings of Dewan *et al.* [19] and Kohinoor *et al.* [20]. The pH ranges from 6.9 to 8.5 recorded in this study were more or less similar to that of the above authors. The all physicochemical parameters of this study were within the suitable ranges.

CONCLUSION

From the obtained results, the better growth performance of shol was found in monoculture system compared to the polyculture system but total production

was obtained higher from polyculture than monoculture systems. It can be concluded that shol culture with carp was better than monoculture. Further studies are needed to find out optimum growth performance of shol at optimum density under monoculture and different species combination under polyculture system.

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