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Mustafizur Rahman
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Zannatul Ferdous
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Subrata Mondal
Department of Fisheries and Marine Bioscience, Jessore University of Science and Technology, Bangladesh

Md. Ruhul Amin
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Correspondence:
Zannatul Ferdous
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Stocking density effects on growth indices, survival and production of Thai Sharpunti, *Barbonymus gonionotus* (Cyprinidae: Cypriniformes) reared in earthen Ponds

Mustafizur Rahman, Zannatul Ferdous, Subrata Mondal, Md. Ruhul Amin

Abstract
To test the effects of stocking density on growth, survival and production of Thai Sharpunti (*Barbonymus gonionotus*) an experiment was carried out for a period of 2 months in 9 earthen ponds (each of 2.0 decimal). Three stocking densities were tested: ponds with 100, 200 and 300 fish per decimal designated as treatment T_1, T_2, T_3 each having three replications that were randomly selected. At stocking, all the fishes were same age group having body weight of 2.05g. Fishes in all the experimental ponds were supplemented with Saudi Bangla nursery feed for the first 29 days and starter-1 feed for days of 30 to 64. Water quality parameters were within suitable range for fish culture. At the expiration of trial period, results showed significant differences ($P<0.01$) including weight gain, percent weight gain, average daily weight gain and specific growth rate among the three treatments (T_1, T_2 and T_3 respectively), indicating the decrease of growth performance with the increasing stocking density, whereas total fish yield were higher with higher stocking density. The survival rate was estimated highest in T_1 compared to other two treatments (T_2 and T_3). Considering the highest net production the stocking density applied in T_3 found best, but more research still needed to further optimize stocking density of Thai Sharpunti in aquaculture ponds. Till then, stocking 300 *B. gonionotus* fish per decimal will yield a better production to fish farmers.

Keywords: Stocking density, Growth, Production, *Barbonymus gonionotus*

1. Introduction

Stocking density is one of the most important variables in aquaculture because it directly influences survival, growth, behavior, health, water quality, feeding and production [1, 2]. For the development of rearing techniques appropriate stocking densities must be determined for each species passing through successive production stages to enable efficient management and maximize production benefits. Culture of fish in ponds applying the right stocking density can effectively improve the yield per unit area. Furthermore, the use of the appropriate density is a commercially beneficial operation, focusing on maximizing the utilization of the rearing system, water and financial resources. On the other hand, growth and survival of fry and fingerlings depend on stocking density, type and quantity of fertilizers and supplementary feeds. To obtain maximum economic returns, it would be necessary to stock the ponds at appropriate stocking densities for optimum growth, survival and production of fingerlings.

Barbonymus gonionotus [3] commonly known as silver barb, is an exotic fish of Bangladesh belonging to Cyprinidae family. Among all the exotic fish species of Bangladesh, it is considered to be one of the best suitable species for aquaculture due to its better palatability, high yield potential and market demand. It grows fast at high stocking densities [4] although stocking density can have either positive or negative effects on fish growth and this interaction seems to be species-specific [5]. Moreover, higher stocking densities may cause crowding effects and reduction of growth rates. Overcrowding may easily induce "size hierarchies'' within the fish population as a result of smaller fish is inhibited from feeding satisfactory because of the presence of lager ones. Fish held at high density are generally regarded as being exposed to a complex set of inherent factors interacting with each other *e.g.* altered water quality, decreased food availability and changes in social interactions. Therefore, 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 [6].

Further, to obtain maximum economic returns it would be necessary to stock the ponds at right stocking densities for optimum growth. By taking all of the facts into consideration, the present study was therefore, designed to investigate the influence of stocking density on the growth, survival and production of fingerlings reared in ponds with a view of complimenting existing information to assist fish farmers on better culture methods.

2. Materials and Methods

2.1 Location and Experimental procedure

The present trial was conducted for a period of 64 days from March to May, 2013 in nine experimental pond situated at the Field Laboratory complex, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh. The ponds were rectangular in shape possessed similar size, depth, basin configuration and bottom type. The surface area of each pond was 81square meter (2 decimal) with an average depth of 1.2 meter. Quick lime (Cao) was applied at the rate of 1kg/decimal. After 7 days of liming, underground water was entered into the pond by pumping. After that, ponds were divided into three treatments (T_1, T_2, and T_3) on the basis of stocking density. In case of T_1, Thai sharpunti (*B. gonionotus*) was stocked at the rate of 100 fish/decimal, in T_2 200 fish/decimal and in T_3 300 fish/decimal. At stocking, all the fishes were same age group having body weight of 2.05 g.

Table 1: Experimental Layout of Thai Sharpunti culture

Treatment	Pond size (dec.)	Stocking density/dec.	Stocking size (g)
T_1	2	100	2.05
T_2	2	200	2.05
T_3	2	300	2.05

Fishes were fed with commercially available pelleted feed twice times a day once in the early morning and next at afternoon (8:30 a.m. BDT and 5:30 p.m. BDT). The name of feed was Saudi Bangla fish feed from a well-developed fish feed company. Proximate composition of feed was analyzed through the nutrition laboratory, Department of aquaculture in Bangladesh Agricultural University, Mymensingh. At the beginning of experiment, feed was supplied at the rate of 15% of the body weight and gradually it was readjusted from 14%, 12%, 13%, 11%, 10%, 9% and 8% respectively. Each time the feed was broadcasted homogenously to the whole pond. The feeding strategy is shown in Table 3. During the study, water temperature, pH and dissolved oxygen (DO) were recorded as 26.5 ± 1.5 ºC, 7.3 ± 0.1 and 6.5 ± 0.5 ppm respectively.

Table 2: Proximate composition of experimental diet

Name of major composition	Amount (%)	
	Nursery	Starter-1
Moisture	13.68	13.16
Protein	25.73	26.08
Lipid	8.40	8.85
Ash	22.39	19.97
Carbohydrate	23.60	26.06
Fiber	6.20	5.88

Table 3: Feeding strategy for different types of feed

Culture period	Types of supplied feed	Feed rate (% of body weight)
1-7 days	Nursery	15%
8-14 days	Nursery	14%
15-22 days	Nursery	13%
23-29 days	Nursery	12%
30-36 days	Starter-1	11%
37-43 days	Starter-1	10%
44-50 days	Starter-1	9%
51-64 days	Starter-1	8%

2.2 Evaluation of Growth performances

Periodic sampling of *B. gonionotus* was carried out to check the general health, growth and survival and to adjust the feeding rate. 30 fishes were randomly collected from each pond using a Berjal and weight of fishes was taken by using a portable balance (Model HI 400EX). Measurement experiences were completed on each sampling day before feeding with appropriate ration. After that, fishes were released back immediately into their respective ponds.

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

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

$$\text{SGR (\%/day)} = \frac{\ln \text{final weight} - \ln \text{initial weight}}{\text{Number of experimental days}} \times 100$$ [7]

Survival (%) = No. of fish harvested/No. of fish stocked × 100

Production= No. of fish harvested×Average final weight of fish

2.3 Statistical analysis

One way analysis of variance (ANOVA) was used to compare growth rates, survival and production. All data were analyzed using the SPSS (SPSS, Chicago, IL, USA). The Duncan's test was used to determine differences among treatment means. Differences were considered statistically significant at $P<0.01$.

3. Results

The growth indices and survival rate of Thai Sharpunti in different treatments recorded during this study was summarized in Table 4. Stocking density (Treatments) had significant effects ($P<0.01$) on all growth parameters (Weight gain, Percent weight gain, Specific growth rate) which were higher in ponds with lower stocking density (100 fish/decimal) compare to the pond with higher stocking density (300 fish/decimal). Additionally, survival rate of Thai Sharpunti decreased with increasing stocking density. However, the effects of stocking density were contrary to the average total yield of Thai Sharpunti. The average total yield of Thai Sharpunti in T_3 was 1518.06 kg/ha/2months which was significantly higher than T_2 (1114 kg/ha/2months) and T_1 (603.85 kg/ha/2months) respectively.

Table 4: Growth parameters (±SE) of Thai Sharpunti (*B. gonionotus)* under three treatments during the experimental period

Parameters	T_1	T_2	T_3
Initial weight	2.05±0.20	2.05±0.18	2.05±0.16
Final weight	54.53±0.51^a	52.04±26.76^b	49.90±0.56^c
Weight gain	52.48±0.51^a	49.99±0.55^b	47.85±0.56^c
% Weight gain	2560.16±25.29^a	2438.37±26.76^b	2333.98±27.33^c
Average daily weight gain	0.820±0.008^a	0.78±0.009^b	0.75±0.009^c
SGR (%/day)	5.13±0.02^a	5.05±0.016^b	4.99±0.018^c
Survival %	89.67±1.45^a	86.67±0.88^a	82.11±1.16^b

Mean values in the column with different superscripts are significantly different ($P<0.01$)

4. Discussion

Stocking density is one of the most important parameter in fish culture operations, since it affects growth, yield and survival of cultured fish. In intensive aquaculture, stocking density is a key indicator that determines the economic viability of the production system.

In this current study, growth was indirectly density dependent *i.e.* fish grown at lower density (100 fish/decimal) achieved the highest weight gain. This observation agrees well with the findings of [8] who reported that increasing the number of fish would adversely affect fish growth. The observed decreased growth rate with increasing stocking density in this study corresponds to observation also reported by [9, 10]. Additionally, [11] pointed out that weight gain and specific growth rate have negative correlation with stocking density in the fingerlings of Nile Tilapia and their values decline with increasing stocking densities. Similar results have also been reported in Rainbow trout (*Oncorhynchus myksis*) [12] and Halibut (*Paralichthys olivaceus*) [13]. Lower growth in higher stocking densities is generally related to poor water quality, competition for food, social interaction, aggressive behavior and metabolism associated with high stocking density. However, in our observation stocking density showed a clear influence on final body weight, specific growth rate as indicated by the statistical significance (Table 4). The highest specific growth rate (5.13±0.02) was recorded at the lowest stocking density, whereas the lowest value (4.99±0.018) was recorded at the highest stocking density. This finding is in line with the agreements of [8] who also observed poor outcome at high stocking densities for the same species.

The highest survival rate (89.67 %) for *B. gonionotus* was realized at the lowest stocking density (100 fish/ decimal). Our data also concurrent with the findings of previous researchers [14, 8] who reported higher survival rate at the lowest stocking density. They also opined that fish survival decreased as stocking density increased, due to cannibalism, poor handling, and severe competition for food and space. Similar results were also obtained by [15, 10] for fry/ fingerlings of various carp and barb species.

In the present study, higher yield was observed at higher fish density, while higher growth was observed at lower fish density. However, the relation between fish growth and fish yield was not linear. The more or less similar non-linear relationship between fish growth and fish yield was also observed by [8] in Thai Sharpunti cultured in earthen ponds. In another study [16] evaluated production and growth performance of local Sharpunti (*B. sarana*) and Thai Sharpunti under semi- intensive culture systems at stocking density of 16000 fish/ha and they obtained a yield of 1304 kg/ha/6 months and 2075 kg/ha/6 months, respectively [17] obtained a production of 1196 kg/ha/6 months of *puntius sarana* from pond culture. [10] conducted an experiment on the growth and production of *B. gonionotus* (Bleeker) in fertilized ponds with supplementary feeding and obtained a yield of 2384.26 kg/ha/6 months. In comparison with the findings of the above researchers the production of Thai Sharpunti in this study was satisfactory. All water quality parameters tested throughout the experimental pond is within the acceptable level for nursing of Thai Sharpunti fingerlings that agree well with the findings of [18].

5. Conclusion

Finally, it can be concluded that, stocking density had a significant effects on growth, survival and production parameters of Thai sharpunti. However, the relation between fish growth and fish yield was not linear. But the pond with 300 fish/ decimal showed the highest production. Further studies for a longer period with more treatments are also required to find out more appropriate stocking densities and mass seed production techniques of Thai Sharpunti under captive nursery-rearing system.

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