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Effect of stocking density on growth performance and the survival of golden mahseer, *Tor putitora* (Hamilton) in primary nursing system

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Abstract
Growth performance and survival of *Tor putitora* spawn under different stocking densities were evaluated in primary nursery management system during the period from 16 November to 6 December 2018. The experiment was carried out in six earthen ponds of 0.02 ha each under three treatments with two replications. Five day old hatchlings were stocked at the rate of 0.50 million/ha was designated as treatment- 1 (T_1), 0.75 million/ha` as treatment- 2 (T_2) and 1.00 million/ha as treatment- 3 (T_3), respectively. Spawns were fed with commercially available nursery feed containing 39.80% crude protein. It was observed that, lower stocking density showed highest daily weight gain in T_1 (growth 0.05 g/day) followed by higher stocking density in T_2 (growth 0/031 g/day) and T_3 (growth 0.024 g/day), respectively. It is also noticed that, the lower stocking showed the highest survival rate (74%) than the other two treatments. The values of different water quality parameters were within the optimum ranges for the nursery rearing of carp fry. Water quality parameters did not show significant variations in the experimental ponds under different stocking densities. Among the three stocking densities lower stocking density (T_1) showed the best result compare with the other two higher stocking densities.

Keywords: spawn, primary nursing, stocking density, growth, survival

Introduction

Golden Mahseer (*Tor putitora*) is one of the most important endangered fish species of Bangladesh. Once the fish was widely distributed throughout Bangladesh, India, Nepal and Pakistan, considered as a popular sports fish for this region [16]. This fish is highly popular for its qualities and test. Once these fish contribute a significant amount in total fish production of The Indian subcontinent [24].

Tor genus consists of more than 20 other species which are not yet scientifically identified [20]. Two species of these, *Tor tor* and *Tor putitora* are available in the hilly streams of Sylhet, Mymensingh, Dinajpur and Chittagong districts in Bangladesh [21]. The fish is habituated with a wide range of temperature, from semi-cold waters of foot hills to warm waters. The body is stout and bearing medium to large size barbs and attains nearly 3 m in length and 45 kg in weight [1]. In the early larval stage, it is carnivorous in nature and later it is omnivorous. *Tor* also feeds on larvae, small mollusks and algal coating on rocks [5]. Spawning ground of this species is sandy ground with pebbles, where the oxygen and temperature is higher compared with other parts of its habitat [19]. The spawning season of Mahseer in Bangladesh lies between November to late January [10]. The fecundity of *T. putitora* is comparatively low compared with other carp species, which ranges from 8000 to 12,000 eggs/kg [9].

The natural stocks of Mahseer fishes have declined due to prolonged drought, frequent devastating floods, siltation and soil erosion in the hilly rivers, reservoirs and man-made changes i.e. construction of flood control measures and drainage structures, dumping of agrochemicals and industrial pollutants, indiscriminate and destructive fishing practices in the aquatic ecosystem. These not only damage the breeding grounds but also destroy the availability of brood fish including hatchlings, fry and spawn [9]. Currently, this fish enlisted as a critically endangered species [12]. Therefore it is urgent to protect the fish from declining. The causes of declining not only degradation the natural habitat but also the non-availability of fry and spawn due to improper nursery management. For the better management practice of this species it is important to develop a well-managed nursery protocol. This fish has also great potential for polyculture with other carps. Single stage nursery system of *T. putitora* is well developed [22]. But multi-stage nursery system gives the better result on growth and survival of spawn. Growth, survival and production of spawn and fry in ponds depend on stocking density, type and quantity of fertilizers and supplementary feeds. Therefore, the present study was designed to assess the effects of stocking density in a primary nursing system of *Tor. putitora* under controlled condition.

Materials and Methods

Site selection and experimental design

The experiment was conducted in the pond complex of the Freshwater Station, Bangladesh Fisheries Research Institute, Mymensingh during the period from 16 November to 6 December 2018 (21 days) in three earthen ponds of 0.04 ha (40 X 10 m) with 1 m depth. Each pond split into two parts of 0.02 ha by using fine mashed filter net. Three treatments differing in stocking densities (0.50 million/ha, 0.75 million/ha, 1.00 million/ha) of hatchlings were employed with two replications each.

Pond preparation, stocking and management

The ponds were prepared following standard management practices [13, 18]. Ponds having proper inlet and outlet facilities, were cleaned and dry under sunlight to remove aquatic vegetation and all unwanted species. After drying 250 kg/ha lime was applied over the pond bottom. And after seven days of liming, ponds were filled with groundwater at 1m depth. Then 25 kg/ha urea and 50 kg/ha TSP were applied to produce the live feed for the spawn. Seven days after fertilization a fine mesh net used to remove harmful insect and predatory zooplankton. Five days old spawn of *T. putitora* obtained from BFRI hatchery were stocked in experimental ponds (Average length 1.21± 0.06 cm and average weight 0.015± 0.003 g) according to the experimental design. Spawn was fed with nursery feed three times daily. For 1st week 20 kg/ million/ day feed was applied while it was 24kg/ million/ day in the 2nd week and 28kg/ million/day in the 3rd week. Moreover, ponds were fertilized every seven days with 12.5kg/ha urea and 25kg/ha TSP respectively.

Proximate composition of feed

Commercially available Mega nursery fish feed was purchased from the Mega Feed company, Bangladesh. Proximate composition of the feeds (Moisture, protein, lipid, ash and fiber) were analyzed [3]. Proximate composition of feed given in Table 1.

Table 1: Proximate composition (% of dry matter) of the supplementary feed

Brand name of feed	Crude protein	Crude lipid	Crude fiber	Ash	NFE*
Mega nursery feed	39.80	6.80	5.68	18.20	29.52

*NFE (Nitrogen free content) = 100-% (crude protein+ crude lipid+ crude fiber+ ash)

Water quality parameters

The important physico-chemical parameters of water *viz.*, water temperature, pH, dissolved oxygen (DO), total alkalinity and ammonia were analyzed at every seven days interval to ensure that water quality was within permissible limits. The samples for the study were collected between 08:00 and 09:00 h.

Fish sampling

Spawn was collected weekly with fine-meshed net for growth analysis. At the 22nd day, all fry were collected to calculate the final length, weight and survival.

Estimation of length and weight

The length gain, weight gain and daily weight gain were calculated as:

Length gain (cm) = (Mean final length – Mean initial length)

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

Daily weight gain (g/day) = (Mean final weight – Mean initial weight) / Duration of the experiment (Number of the day).

Survival (%) = (Total no. of fry harvested/ Total no of fry released) X 100

Statistical analysis

The mean values for the growth of different treatments were tested using one way ANOVA. Each value and parameters of different treatments expressed as mean± Standard deviation (SD). The level of significance was 95%.

Results

There were no significant differences were observed in water quality parameters of different experimental ponds. Water quality parameters were within the best ranges during the sampling period (Table 2).

Table 2: Water quality parameters of experimental ponds (16 November 2019- 6 December 2019)

Sl no.	Parameters	T_1	T_2	T^3
1	Temperature (° C)	22.0- 27.6	22.5- 27.9	22.0- 27.6
2	Dissolve oxygen, DO (mg/l)	6.90- 7.38	6.80- 7.40	6.65- 7.20
3	pH	7.90- 8.64	7.90- 8.60	7.80- 8.60
4	Ammonia (mg/l)	0- 0.03	0- 0.03	0- 0.03
5	Alkalinity (mg/l)	160- 180	160- 180	160- 180

The growth and survival details of three treatments along with the initial and final particulars are presented in Table 3. In the experiment, *T. putitora* attained maximum length and weight in the lowest stocking density of 0.5 million/ha in T_1 followed by T_2 and T_3 with the stocking densities of 0.75 and 1.0 million/ha, respectively (Figure 1 and Figure 2). It was also observed higher daily weight gain in the lowest stocking density in T_1 followed by T_2 and T_3, respectively (Figure 3).

There were significant ($P<0.05$) differences in final length of T_1, T_2 and T_3. In the case of final weight gain and daily weight gain, T_1 was significantly compare with T_2 and T_3 but T_2 and T_3 had no significant differences. The highest survival rate (74%) also observed in the lowest stocking density (T_1). All treatments were implemented under the same environmental conditions and feeding was same. Ponds size and depth were also same for all treatments. Nursery management procedure was also the same for all the treatments. Only the stocking densities were different among the treatments and shows significant difference in final length, weight and daily weight gain (DWG).

Table 3: Stocking, harvesting and growth performances of *T. putitora* in experimental ponds under different stocking densities

Treatment	Stocking density (million/ha)	Released (million)	Harvested (million)	Length (cm)		Weight (g)		Daily weight gain (g/day)	Survival (%)
				Initial	Final	Initial	Final		
T_1	0.5	0.02	0.015	1.21± 0.065	2.81± 0.12^a	0.015± 0.003	1.06± 0.10^a	0.050± 0.006^a	74
T_2	0.75	0.03	0.019	1.21± 0.065	2.42± 0.15^b	0.015± 0.003	0.67±0.08^b	0.031± 0.004^b	62
T_3	1	0.04	0.023	1.21± 0.065	2.08±0.09^c	0.015± 0.003	0.52± 0.07^b	0.024± 0.003^b	58

All values were reported as mean and standard deviation (M ± SD). Figures in the same row having the same superscripts are not significantly different and having different superscripts are significantly different (P<0.05).

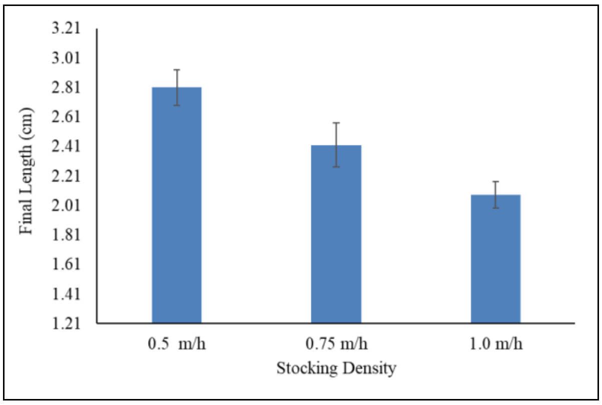

Fig 1: Individual final length (cm) of *Tor putitora* under different stocking density treatments in the primary nursery system

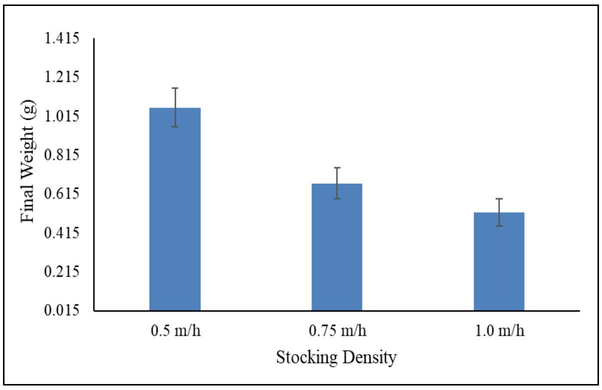

Fig 2: The final weight of *T. putitora* under different stocking density treatments in the primary nursery system

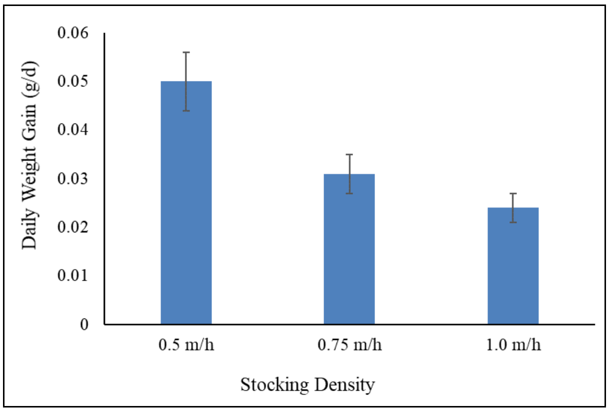

Fig 3: Daily weight gain (g/day) of *Tor putitora* under different stocking density treatments in the primary nursery system

Discussion

Growth in terms of length and weight was maximum at the lower stocking density and showed a significant decreasing trend with an increase in stocking density (P<0.05). It is empirical that stocking density has a direct effect on food supply, space for living and water quality. Different studies indicate that there was a significant inverse linear relationship between stocking rate and growth linked such depression in growth to unavailability of proper space [17, 8, 7]. Physiological stress may also cause poor growth performance under high stocking densities as observed in *Salmo gairdneri* and *Oncorhynchus kisutch* [26, 7], in some cases attributed low growth due to poor water quality [25]. In this experiment, the values of different water quality parameters were generally within the optimum requirements for the nursery rearing of Mahseer spawn. In the present experiment, no distinct variations in the water quality parameters were observed at different stocking densities indicated that increasing stocking densities did not impose any environmental stress to the fish. There were the same findings also observed in *Carassius carassius* on growth and survival of primary nursing system [2]. However, the level of Dissolve oxygen (DO) was optimum in experimental ponds. Alkalinity level indicates the natural production of these ponds were moderately high. Which is closed to [14, 23]. Higher alkalinity values might be due to the higher amount of lime doses at the experimental period. The pH level of this experiment was optimum for the fish culture supported by [14].

In this experiment, crude protein level having 39.80% dry weights were used in supplementary feeding for *Tor putitora* spawn. For the growth of *Labeo rohita* spawn optimum protein requirement is 31% [6]. 32.06% crude protein use in the one stage nursery management system [22]. Supplementary feeds containing 20.3- 29.5% crude protein for a semi-intensive culture of *T. putitora* record the lower growth performance [11].

High growth performance was observed in terms of weight; length and weight gain of *Tor putitora* spawn in T_1 where the stocking density was lower as compared to T_2 and T_3, although same food was supplied at an equal ratio in all the treatments due to the reason of competition for food at higher density treatments. T_1 having low density considering the suitable stocking density for the fish growth in nursery pond, as the number of spawn increases for the same stocking area, its effects the growth performance of Mahseer [22]. The treatments having great number of spawn with a high food concentration cause a stressful situation [22]. The highest weight gain of Mahseer (*Tor putitora*) spawn and Crucian Carp (*Carassius carassius*) in nursery ponds in lowest the stocking density [22, 2]. The highest survival in showed in lowest stocking density under single stage nursery system of Mahseer (*Tor putitora*) [22] the same result observe in Crucian Carp (*Carassius carassius*) in primary nursery system [2].

The low density of *Tor putitora* spawn spawn that shows higher growth compare with higher density. Because higher density treatments spawn have higher competition for food and space [23]. Further research should be done on stocking densities of this critically endangered species to understand the growth and survival in secondary and tertiary nursing system.

Conclusions

From the above findings of this experiment, it can be concluded that the length and weight gain of *T. putitora* spawn were inversely related to the stocking densities. Decreasing with the stocking densities result increasing with length and weight. Finally, present findings of this experiment might be helpful for the seed production of *T. putitora* in primary nursery system.

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