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Md. Hafiz All Hosen
Faculty of Fisheries,
Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh

Rubaiya Pervin
Faculty of Fisheries,
Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh

Sheik Istiak Md. Shahriar
Faculty of Fisheries,
Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh

Correspondence
Sheik Istiak Md. Shahriar
Faculty of Fisheries,
Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh

Changes in growth performances, survival rate and water quality parameter of pond on different stocking density of Gulsha Tengra (*Mystus cavasius*) in a monoculture system

Md. Hafiz All Hosen, Rubaiya Pervin and Sheik Istiak Md. Shahriar

Abstract
This study highlighted the effect of different stocking density of Gulsha Tengra (*Mystus cavasius*) on its growth performance, survival as well as water quality parameters of the pond in a 4 months trial in a monoculture system. Changes in water quality and growth performance were analyzed considering three different stocking density such as 400 ind./decimal (T1); 500 ind./decimal (T2) and 600 ind./decimal (T3) with two replication of each using Complete Randomization Design (CRD). Water quality parameters were *viz.* temperature, dissolve oxygen (DO), pH and transparency were measured fortnightly during the study period. Results showed significant differences (P>0.05) between treatments. Temperature was relatively high with an apparent opposite trends of DO in T3 treatment. Moreover, it was observed that the highest length and weight was found in T1 treatment. In addition, better growth rate with maximum survivability was recorded in low stocking density. It might be concluded that comparatively lower stocking density of Gulsha Tengra could provide more production and also be suitable in order to maintain better water quality parameters in enclosed culture condition.

Keywords: Gulsha Tengra, growth performances, survival rate and water quality parameters

1. Introduction
Bangladesh is one of the advanced countries in aquaculture production as it secures 4th position in the world [7]. The annual production of fish from aquaculture was around 20.6 lakh MT in the year 2014-15 and it contributes about 55.93% of total fish production [9]. More than 50% of aquaculture production solely comes from farming of Indian major carp species, especially Rui (*Labeo rohita*), Catla (*Gibelion catla*) and Mrigal (*Cirrhinus cirrhosus*) while some Chinese carps like Silver carp (*Hypophthalmichthys molitrix*), Bighead carp (*Hypophthalmichthys nobilis*) and Grass carp (*Ctenotherongadon idella*) [25]. Besides that culture of catfishes in commercial ponds are being popular now a days among farmers since it has high nutritional quality and market demand associated with high market price [13].
Gulsha Tengra (*Mystus cavasius*) which is also known as *Gangetic Mystus*; is a freshwater catfish species belongs to the family Bagridae, widely distributed in ponds, canals, beels, floodplains, streams and rivers of many South-Asian countries likely Bangladesh, India, Myanmar, Pakistan, Sri Lanka, Nepal and Thailand etc. [27, 5, 26, 21, 32]. This fish is famous for its eury-omnivorous nature of food habit as it consumes a large variety of food items such as algae, zooplankton, insect larvae, small fish, eggs, worms and soft shelled organisms [12, 6]. In addition, Gulsha Tengra contains considerably high percentage of protein (13.81%) with low quantity of fat content (2.26%) and rich in calcium and phosphorus as well [13].
Gulsha Tengra has been addressed as threatened species by IUCN and some researchers in Bangladesh [24, 14, 1] because the catch of this indigenous fish from open water bodies is being dwindled gradually; might be due to increased fishing pressure to meet up the high market demand. Over exploitation, habitat destruction and ecological changes are also the causes of their low catch from inland water bodies as well. Therefore, aquaculture of Gulsha Tengra in pond should be practiced scientifically in order to protect and conserve this species.
Though several researches have already been conducted in Bangladesh and abroad regarding stocking density of catfishes such as the effect of stocking density on growth and survivability of juvenile catfish [22, 28], stocking density optimization [29], different catfishes stocking ratios in

a polyculture system [8], growth performances of catfishes with carp [16, 23]; however, there is a lack of enough information regarding growth performance of Gulsha Tengra in different stocking density under pond condition. Thus, this study was aimed to investigate the effects of different stocking density on water quality parameters and growth performance of Gulsha Tengra in a monoculture system.

2. Materials and Methods

2.1 Experimental design

The study was carried out for a period of five months from 1st March to 30th July, 2016 in nine different ponds located at Kachubari, Thakurgaon district, Bangladesh. The selected ponds were about 50 decimal in size and around six feet water depth was maintained throughout the study period. One month old Gulsha Tengra about 3 cm long and 2 g in weight was stocked in these experimental ponds. Three different treatments viz., 500 ind./decimal (T1), 600 ind./decimal (T2) and 700 ind./decimal (T3) were stocked with three replicates of each treatment.

2.2 Experiment procedure

The ponds were repeatedly netted and finally treated with rotenone at 4.5 kg/ha to eradicate unwanted fish species. Then, the ponds were treated with dolomite at 200 kg/ha and after ten days inorganic (TSP 25 kg/ha and urea 20 kg/ha) and organic fertilizers (cattle dung 1 ton/ha) were applied to create a suitable environment prior to stocking. The stocked fish were fed at morning and afternoon daily at the rate of 5% body weight with commercial pellet feed containing 30% crude protein supplied by Nourish Poultry and Hatchery Co. Ltd., Bangladesh.

2.3 Water quality parameters

Four physico-chemical parameters of pond water were recorded *viz*., temperature, dissolved oxygen, pH and transparency were measured with an interval of 7 days during the whole period of study. In present study, temperature and dissolved oxygen were measured by using mercury-in-glass thermometer and a dissolved oxygen meter (YSI model 58, USA), respectively. The water pH was measured by using portable pH meter (CORNING model 445) and the transparency of pond water was determined using Secchi disc.

2.4 Growth parameters

20 fishes from each pond were randomly harvested with the help of seine net from 1st April to 30th July 2015 in order to measure the length and weight gain of fishes using the following formulas -

2.4.1 Total length: The length of fish (tip of the snout to the edge of caudal fin) was measured with the help of measuring scale and board.

2.4.2 Weight gain: Weight gain (W) was calculated as, $W = W_2 - W_1$, where, W_1 is initial weight and W_2 is final weight.

2.4.3 Specific growth rate: Specific growth rate of Gulsha Tengra fish under different treatments was calculated using the following formula –

$$SGR\ (\%) = \frac{\ln W_2 - \ln W_1}{T} \times 100$$

Where, $\ln W_2 - \ln W_1$ is the difference of logarithm of initial and final weight and T is the duration of the experiment (days).

2.4.4 Survival rate: The survival rate (SR) of Gulsha Tengra fish was calculated as follows:

$$SR\ (\%) = \frac{\text{Final total number of fish}}{\text{Initial total number of fish}} \times 100$$

2.5 Statistical analysis

The obtained data were analyzed statistically by one way Analysis of Variance (ANOVA) using SPSS statistical program (version-20). Significant difference between mean values was analyzed by Duncan's Multiple Range Test (DMRT) at significance level of 0.05.

3. Results and Discussions

3.1 Water quality parameters

Monthly variation of temperature, pH, dissolve oxygen and transparency recorded from different treatments are shown in Table 1.

Table 1: Variations in water quality parameters of pond water under different treatments

Parameters	Month	Treatment		
		T_1 (500/decimal)	T_2 (600/decimal)	T_3 (700/decimal)
Temperature	April	28.00±0.25^a	28.00±0.20^a	28.05±0.15^a
	May	28.60±0.10^a	28.65±0.15^a	28.75±0.10^a
	June	22.40±0.15^c	22.50±0.20^{bc}	22.65±0.15^a
	July	18.60±0.12^c	18.75±0.14^{bc}	18.85±0.10^a
pH	April	8.20±0.05^a	8.20±0.10^a	8.15±0.20^a
	May	8.20±0.15^a	8.15±0.10^a	8.10±0.15^a
	June	7.90±0.10^a	7.75±0.10^b	7.70±0.15^b
	July	7.20±0.10^a	7.05±0.15^b	6.92±0.10^b
Dissolved oxygen	April	6.90±0.05^a	6.65±0.10^b	6.15±0.20^c
	May	6.50±0.15^a	6.15±0.10^b	5.65±0.15^c
	June	7.00±0.10^a	6.55±0.10^{bc}	6.00±0.15^c
	July	7.80±0.10^a	7.15±0.15^b	6.50±0.05^c
Transparency	April	29.40±0.05^b	29.45±0.10^b	29.60±0.20^a
	May	28.00±0.15^b	28.15±0.10^a	28.25±0.15^a
	June	30.40±0.10^c	30.65±0.10^b	30.85±0.15^a
	July	34.10±0.10^c	34.55±0.15^b	34.95±0.05^a

*Mean values in column with different letters are significantly different (P<0.05).

Different stocking density of Gulsha Tengra has exerted significant effect on temperature, pH, dissolved oxygen and transparency of pond water. The highest mean temperature (28.75 ºC) was recorded in T_3 at the end of the May; followed by 28.65 ºC in T_2 while the lowest temperature (28.60ºC) was recorded in T_1 (Table 1). Results exhibited that the effect of stocking density was significant (P<0.05) in respect of temperature. However, no significant difference of temperature was observed in the month of April and May. Significant variation (P<0.05) was observed among other water quality parameter as well. The highest DO content (7.80 ppm) in T_1 and the lowest (6.50 ppm) in T_3 were recorded in July. In the same month, the highest and the lowest recorded pH were 7.20 (T_1) and 6.92 (T_3) respectively (Table 1). The highest transparency was 34.95 cm in T_3 treatment, whereas the lowest transparency was 34.10 cm in T_1 treatment in the month of July (Table 1).

This study highlighted the effect of different stocking density of Gulsha Tengra (*Mystus cavasius*) on its growth performance, survival as well as water quality parameters of pond in a 4 months trial in a monoculture system. In the month of May, relatively high water temperature was observed in higher stocking density ponds (Table 1). Greater biomass of fishes which results overcrowding in association with enhanced metabolism and activity might be the reasons of higher temperature of these ponds in this summer month. Begum *et al.* 2008 [3] was also drawn similar conclusion on temperature regarding higher stocking density of another catfish named *Mystus gulio.* In general, higher temperature limits the solubility of dissolved oxygen in culture system i.e. dissolved oxygen decreases as the temperature increases. Significantly, a reverse trend of dissolved oxygen in relation to temperature was observed throughout this study (Table 1). However, DO was found lower with the increase of stocking density. This result was comparable with Oguguah *et al.* 2011 [23] and Kohinoor *et al.* 2012 [17]. According to Tucker (1994) [33]; dissolve oxygen in a higher stocking density pond might be responsible for poor heath, lower growth and higher mortality rate. Again, Brazil and Wolters (2002) [4] reported the decreased growth of channel catfish (*Ictalurus punctatus*) larvae due to the presence of low level of dissolved oxygen. Lowest value of pH was recorded in T3 (Table 1). Overcrowding is also responsible for producing higher amount of CO_2 which ultimately reduces the water DO as well as pH. Expect that comparatively higher pH of water indicated that the water was productive. Several researchers found higher pH under different stocking density of catfishes like; Nwipie *et al.* 2015 [22]; Kohinoor *et al.* 2012 [17]; Oguguah *et al.* 2011 [23]; Kohinoor *et al.* 2004 [18]. Transparency of those ponds varied with the change of seasons such as highest transparency was recorded in monsoon period during heavy rain. Moreover, better water qualities were observed in lower stocking density (500 ind./ decimal) compared to others.

3.2 Growth parameters

3.2.1 Total length

The total length of gulsa tengra was varied as the stocking density changes. The effect of stocking densities on the total length of Gulsha Tengra is presented in Fig 1. The results revealed that stocking density had significant (p<0.05) effect on the total length of this fish. The maximum length (16.51 cm) and minimum length (14.10 cm) were also recorded in T_1 and T_3 respectively. It was observed that the highest total length for each sampling was found in T_1 followed by T_2 and T_3.

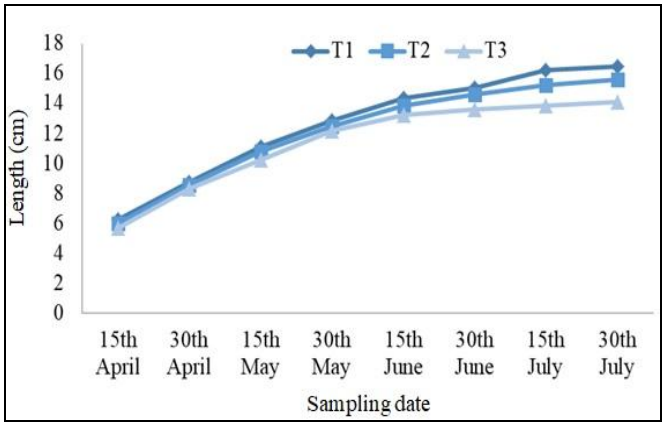

Fig 1: The changes of total length of Gulsha Tengra in three different treatments.

3.2.2 Total weight

The effect of stocking density was remained significant in response of final weight of Gulsha Tengra which is shown in Fig 2. At the end of the experiment, the highest final weight (33.50 g) was observed in T_1, followed by T_2 (26.92 g) and the lowest final weight (21.11 g) was obtained in T_3 (Fig 2).

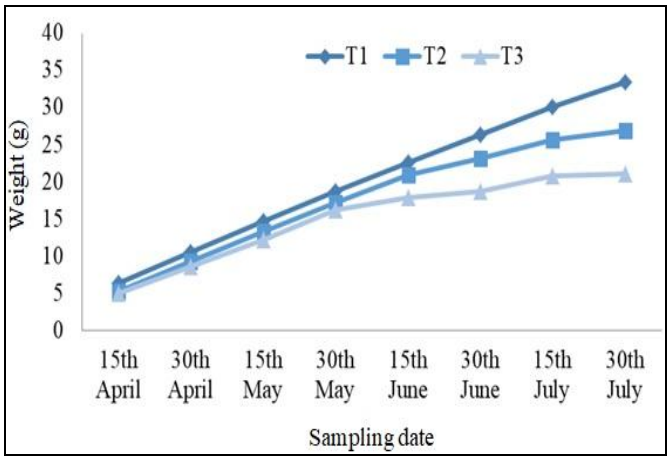

Fig 2: Effect of stocking density on weight of Gulsha Tengra in three different treatments.

3.2.3 Specific growth rate

Specific growth rate (SGR) of Gulsha Tengra fish is presented in Fig 3. The specific growth rate varied from 5.50% to 0.76%, 5.10% to 0.47% and 4.80% to 0.22% in T_1, T_2 and T_3, respectively. The specific growth rate was also varied significantly according to different stocking density and it was always higher in lowest stocking density (T_1) and followed by T_2 and T_3.

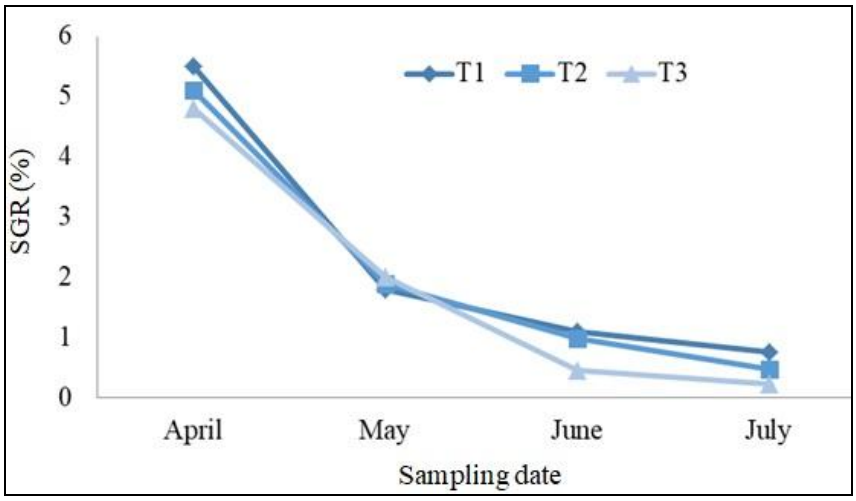

Fig 3: The changes of specific growth rate of Gulsha Tengra in three different treatments.

3.2.4 Survival rate

It was found that the effect of stocking density on survival rate was significant. Survival rate of Gulsha Tengra in different stocking density is shown in Table 2. However, the highest survival rate (95.00%) was observed in T_1 followed by T_2 (94.00%) and the lowest survival rate (93.33%) was recorded in T_3 at the end of experiment (Table 2).

Table 2: Survival rate of Gulsha Tengra in three different treatments.

	Treatment		
Survival rate	T_1 (500/decimal)	T_2 (600/decimal)	T_3 (700/decimal)
	95.00%	94.00%	93.33%

Proper growth and survivability of aquatic organisms is dependent on different stocking density [15]. M'balaka *et al.* 2012 [20] also reported that growth parameters and survival rate is adversely affected by the higher stocking density. However, increased stocking density deteriorates water quality which ultimately reduces the growth, disease resistance and survivability of culture organisms [19], [11]. According to Tucker 1994 [33], the growth and survivability of fish is negatively affected by the increased stocking density. In this study, the total length and individual weight gain of Gulsha Tengra decreased as the stocking density increased (Fig 1 and Fig 2). Engle (2001) [10] mentioned that highest total length was observed at lower stocking density. Aminur *et al.* (2015) [2] also found noteworthy effect of stocking density on the length of Catfish (*Sperata aor*). Gross production of culture species increased with the increase of stocking density while the mean weight of individual fish decreases [33]. Although some fish species can tolerate extreme crowding for a long time where food completion could limit their growth and results poor weight gains [30]. Possible reasons of higher body weight in lower stocking density might be due to less competition for food and space compared to that of in higher stocking density. Similar findings were reported on catfish by Nwipie *et al.* 2015 [22] and Kohinoor *et al.* 2012 [17]. Furthermore, the total length, weight, specific growth rate and maximum survival rate (95%) was greatest in lower stocking density. Rahman *et al.* 2013 [24] stated that better water quality, higher growth and much production was found at the stocking density of about 800 fry/ decimal. The maximum length of Gulsha Tengra was reported to be of 40 cm [31].

4. Conclusion

In this experiment, maximum length (16.51 cm) and minimum length (14.10 cm) were also recorded in T_1 and T_3 treatment respectively. Culture period could be extended to get greater size of this catfish species. Moreover, under higher stocking density, this fish species suffered stress because of aggressive feeding competition which ultimately resulting in growth retardation. Finally, it can suggest that relatively lower stocking density may be helpful for maintaining better quality of pond water and highest individual weigh gain as well as more profit could be earned from culturing this Gulsha Tengra in a mono culture system.

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