E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2018; 6(3): 49-52

www.fisheriesjournal.com
Received: 08-03-2018
Accepted: 09-04-2018

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Effect of stocking density on growth performance of Indus mahseer (*Tor macrotepis*)

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Abstract
Effects of stocking densities on the growth and survival of mahseer (*Tor macrolepis*) fingerlings were examined in a six glass aquaria. The experiment was conducted for two months in aquarium having a size of 1x1.5x2 feet (height x width and length) each. Fingerlings were stocked at 10, 20 and 30 with duplicated, designated as treatment-1 (T1), treatment-2 (T2) and treatment-3 (T3) respectively. At stocking, all fingerlings were of the same group with a mean Total body length of 7.8±2.15, 9.96±2.31, 5.68±1.25cm and weight of 5.38±3.57, 9.39±4.76, 2.96±0.72gm respectively. Fingerlings in all the treatments were fed with Orayza commercial fish feed at 40% crude protein value. Water levels were maintained in the entire aquarium. Highest weight gain was observed in T1 and lowest in T3. Final length, final weight and survival of fingerlings also followed the same trends as weight gain. Overall, highest growth and survival of fingerlings were obtained at a density of 10 fingerlings. Hence, of the three stocking densities, 10 appear to be the most suitable stocking density for rearing of mahseer fingerlings in aquarium under laboratory study.

Keywords: *Tor macrolepis*, stocking density, fingerlings, survival, growth

Introduction
Mahseer fish belonging to genus "*Tor*" are widely distributed in Southern Asia from Afghanistan in the west to Thailand and Malaysia in the east and also present in China Pakistan, Indonesia, South and Southeast Asia including the Indian peninsula. *Tor* genus consists of *Tor macrolipes* and more than 20 other species which are not yet scientifically identified (Pervaiz *et al*. 2012) [11]. This fish group inhabits semi-cold waters of foot hills. They also possess medium to large size barbs. According to its feeding habit in the early stages of its development it is carnivorous and later on when it became adult diverts it to omnivore. Sometimes it becomes opportunistic feeder and also feeds on larvae, small mollusks and algal coating on rocks (Chatta and Ayub, 2010) [2]. Two species of Mahseer are found in Indus River system in Pakistan which is Zobi mahseer (*Nazirito rezhobensis)* and Golden Mahseer (*Tor macrolepis)*. Golden Mahseer is known as a high valued game and food fish. This popular game fish belonging to one of the largest species of family *Cyprinidae* and attains weight over 50 kg and is called as the "pride of Anglers" (Chatta *et al*. 2015) [1].

The natural stocks of mahseer fishes have decline due to prolonged drought, frequent devastating floods, siltation and soil erosion in the hilly rivers and reservoir and man-made changes i.e. construction of flood control measures and drainage structures, dumping of agro-chemicals and industrial pollutants, indiscriminate and destructive fishing practices in the aquatic ecosystem (Rahman *et al*. 2007) [13]. These not only damage the breeding grounds but also destroy the availability of brood fish including hatchlings, fry and fingerlings. The Indus golden mahseer (*Tor macrolepis*) is now identified as a critically endangered species (Rahman *et al*. 2005) [14]. To protect it from elimination and to conserve its natural stocks, the development of breeding, rearing and culture techniques are very important (Rahman *et al*. 2007) [13]. The main issue to aquaculture is the non-availability of fry/fingerlings. Growth, survival and production of fry and fingerlings in ponds depend on stocking density, type and quantity of fertilizers and supplementary feeds. The present study was undertaken to develop an economically reasonable and viable technology for the seed growth and survival of *Tor macrolepis* under a controlled aquarium system.

Materials and Methods

Feeding trial experiment was conducted at fisheries research laboratory, Department of Zoology and Biology, PMAS Arid Agriculture University, Rawalpindi. Fish fingerlings were collected from the Office of Assistant Director Fisheries District Attock. Before the experiment the fingerlings of Indus golden mahseer (*Tor macrolepis*) were acclimatize for up to 10 days. Thus the fish retrieve their normal condition from the stress caused by transportation. The research experiment was carried in six glass aquaria of equal size respectively 1 x 1.5 x 2 (width x height x length) for the duration of two months. All the aquaria were filled with equal level of fresh tap water. Every two aquaria were stocked with a ratio of 10, 20 and 30 fingerlings and referred as treatment-1 (T1), treatment-2 (T2) and treatment-3 (T3). A total of 120 fingerlings were stocked to evaluate the effect of stocking density on the growth performance of fish. Aquarium aerators were used for water aeration fixed at the bottom of each aquarium, which produces a sufficient amount of oxygen for the fish. The fish were fed at the rate of 5% body weight with standard supplementary fish feed having 40% crude protein. The fish feces and uneaten food accumulated at the bottom of the aquaria were siphoned out regularly to maintain proper water quality for fish growth and health. Water replacement was done twice a week. The aquarium covered by the nylon net which is fixed by the clothing cleft to prevent the fish escape by jumping. The initial body weight and body length of fingerlings were measured before stocking. Sampling was done on every ten days interval. A sample size of five fish from each aquarium was collected randomly to observe the growth parameters i.e. body weight, standard length, fork length and total length. After taking the data the fish were released back to their respective aquaria. The growth parameters i.e. body weight; standard length, fork length and total length of the fish were measured after 10 days of duration. Total body weight was measured to fix the ratio of supplementary feeding.

One way Analysis of Variance (ANOVA) was used to evaluate the difference of frequency of stocking density of fish in different treatments and furthermore the Post Hoc (Duncan) test was applied to check the significance difference in growth among different treatments.

Results and Discussion

Survival rate and Growth performance

Significant difference was recorded in the survival rate of Indus Golden Mahsser (*Tor macrolepis*) in aquarium rearing. 100% survival was recorded in T1 followed by the T2 (85%) and T3 (70%). Higher mortality was occurring in T3 due to higher number of fingerlings. 10 days of recorded growth (body length and weight) of fingerlings are shown in Figs. 1 and 2. Significant difference was found in the growth performance of Indus Golden Mahseer fingerlings with three different stocking densities (10, 20 & 30) were stocked in three treatments (T1, T2 and T3) respectively. The increase in length and weight was highest in T1 followed by T2 and T3. Growth and length parameters of fingerlings are shown in Table 1.The greatest increase in length and weight occurred in T1 and the lowest in T3. However, the mean final length and weight of fingerlings in different treatments were significantly different (P<0.05). The highest weight gain was in T1 and lowest in T3. T1 was 100 % Survival rate followed in T2 and T3.

Table 1: Shows the Growth parameters survival and production of mahseer (*Tor macrolepis*) fingerlings after 60 days of rearing

Growth Parameters	Treatment		
	T1	T2	T3
Initial weight (g)	11.02±5.42	8.17±1.22	3.30±0.34
Final weight (g)	11.02±0.52	7.92±1.50	3.63±0.45
Initial stlenght (cm)	8.52±1.84	8.72±0.06	5.62±0.58
Final stlength (cm)	8.22±0.32	7.64±0.38	5.72±0.3
Initial fork length (cm)	9.3±2.04	9.45±0.09	6.1±0.76
Final fork length (cm)	9.14±0.26	8.46±0.48	6.38±0.3
Initial Total length (cm)	10.22±2.42	10.18±0.22	6.46±0.78
Final Total length (cm)	10.42±0.2	9.62±0.62	7.18±0.4
Survival (%)	10(100%)	20(85%)	30(70%)
Production*	10(10)	17(20)	21(30)

All the data in the same row have significantly different (P<0.05).

*Total number of fingerlings that survived and then harvested after 60 days of rearing in aquarium.

The graph shows the increase in weight and total length of fish.

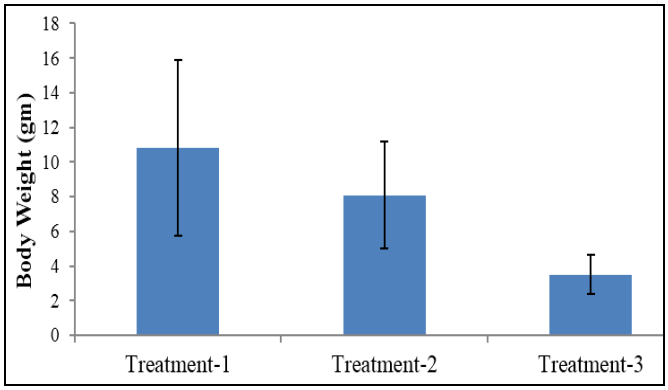

Fig 1: shows increase in average weight of fingerlings each 10 days of duration

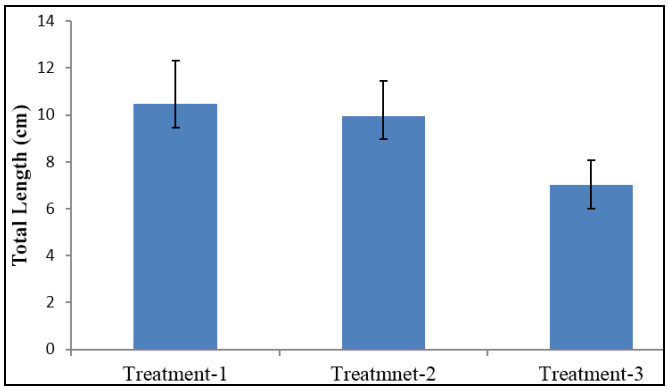

Fig 2: shows increase in average total body length of fingerlings each 10 days of duration

High growth performance was observed in terms of weight; length and weight gain of *Tor macrolepis* fingerlings in T1 where the stocking density was lower as compared to T2 and T3, although same food was supplied at equal ratio in all the treatments due to reason of competition for food at higher density treatments. T1 having low density considering the suitable stocking density for the fish growth in aquarium culture, as the number of fingerlings increases for the same stocking area, its effects the growth performance of mahseer (Islam *et al*. 2002) [8]. The treatments having high number of fingerlings with a high food concentration cause a stressful

situation (Rahman and Rahman, 2003) [13]. In favor to the present study Chatta *et al*. (2015); Niwipie *et al*. (2015); Rahman *et al*. (2013) and Rehman *et al*. (2005) [1, 13, 14, 16]; showed the higher weight gain of Mahseer (*Tor macrolepis*) fingerlings and African mud catfish (*Clarias gariepinus*) in nursery ponds and Pangas, *Pangasius hypophthalmus* in cemented tanks respectively. In case of "*Oreochromis mossambicus*× *Oreochromis niloticus*" also showed that stocking density of 200 fish was recorded the high weight gain due to the suitable feed and water. In this experiment, crude protein level having 40% dry weights were used in supplementary feeding for the best growth of *Tor macrolepis* fingerlings. It was recorded by the (De Silva and Gunasekera, 1991; Bazaz and Keshavanath, 1993) [17, 18] that 40% crude protein level used in the diets of mahsser for the best growth performance. Sunder *et al*. (1998); Joshi *et al*. (1989) [19, 20] recorded the best growth for *Tor putitora* at 45.5% and 35% crude protein level respectively. Islam, (2002) [21] recorded the lower growth in supplementary feeds containing 20.3-29.5% crude protein for semi-intensive culture of *T. putitora*. (Rahman and Rahman, 2003) [13]. It was the first successful attempt to produce Golden mahseer fingerlings in aquarium with low-cost supplementary feeds. T1 having low density of *Tor macrolepis* fingerlings shows higher survival rate may be due to the fact that higher density treatments fingerlings have higher competition for food and space in the aquaria resulted in less growth Similar results were obtained by Rahman and Rahman (2003) [13]. The present study reveals that Indus Golden Mahseer can be reared in aquaria but in limited stocking densities. Further research should be done on stoking densities of this critically endangered species to in ponds, cages and hapas to understand its biology and growth performance in a better way. When the stocking density will be suitable the production will be enhanced'

Conclusion

It was concluded that the present study of Indus golden Mahseer (*Tor macrolepis*) rearing in aquarium can be cultured in aquarium obtaining best growth having low stocking density. When the stocking density increase the fish growth is affected because of the competition for food and place.

Acknowledgements

We wish to thank our Parents, Brothers, other colleagues and field workers who provided many helps for successfully conducting the experiment. Grateful thanks to Assistant Prof. Dr. M. Zubair Anjum, Dept. of Biology and Zoology, PMAS-AAU Rawalpindi, Pakistan for critically reviewing the manuscript and for constructive suggestions.

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