

Original Research Article

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Effect of Stocking Density on the Growth, Survival and Yield of Carp Fry Reared in Pens

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ABSTRACT

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Optimal stocking density of *Catla catla* and *Labeo rohita* fry in pen based nursery management system in reservoirs had been evaluated in the present study. The study was conducted in four selected sites *i.e.* Bendharwadi, Savarli-1, Savarli-2 and Dighad in Dimbhe reservoir, Pune District, Maharashtra. *C. catla* and *L. rohita* fry of 48-57 mm and 5.5-5.6 g were stocked in the ratio of 1:1 and reared for 55 days under four stocking densities: 11.5, 12, 12.5 and 16 fry per m² respectively in pens installed in Savarli-2, Bendharwadi, Dighad and Savarli-1 sites. During the experimental period, the fishes were fed with 36 % protein diet twice daily at the rate of 2-3% body weight. All the water quality and soil quality parameters were within the acceptable range in all the pen culture sites. At the end of experiment there was significant difference was ($p < 0.05$) observed in growth and weight gain at different stocking densities. Highest Specific growth rate, body length gain and weight gain was recorded in Saverli- 2, while lowest were recorded in Savarli-1 pen. Highest survival percentage and number was recorded in Bendharwadi pen, whereas the lowest was recorded in Saverli-1 pen.

Introduction

Fish is the source of cheaper protein and one of the largely traded food commodities. In addition to providing food security, the fisheries and aquaculture sector provides livelihood and income to millions of people. As the growth of fisheries sector is limited, the demands of the growing population had put a tremendous pressure on the sector and expansion of aquaculture activities is the only

option to cater these growing demands. Cage culture and pen culture are those activities which can be helpful to supplement the aquaculture production in the areas with limited land based resources for aquaculture (World Bank, 2013).

Culture of fish in enclosures known as Pen culture is originated in the early 1920's in

Japan (Alferez, 1977) and is widely spread to different countries like china (Beveridge, 1984) and Philippines in the 1970s (Baguilat, 1979). At present, pen culture is commercially practised only in few countries like China, Indonesia, Malaysia, Philippines, Thailand and USA (Chua and Teng, 1977; Beveridge, 1984).

In India, the pen culture attempts in oxbow lakes had started in the year 1978 (Banerjee and Pandey, 1978). Rearing of carp hatchlings in pens was reported by Abraham (1980) and since then several experiments had been conducted on the pen culture in swampy tanks, beels and reservoirs (Swaminathan and Singit 1982; Yadava *et al.*, 1983).

In situ carp seed rearing was attempted in Bhavanisagar and Tungabhadra reservoirs in pens for rearing spawn and fry of carps and in Pillaimadom lagoon in Mandapam, near Rameswaram to culture mullets and milk fish (Ayyappan, 2006). Although the several attempts have been successfully made to raise the seeds of carps in the reservoirs and other water bodies, the technology has not yet been standardized.

Pen culture gives a potent opportunity to improve the productivity of reservoirs and support the sustenance of the local communities thriving nearby the reservoirs and in near future provides nutrition, livelihood and rehabilitation to the poor farmers.

Despite the advancements made in some countries for the construction of pens, the country like India it construction is still depending on the locally available traditional materials. In India, Pens are still constructed in the same way as they were traditionally followed. At present, mesh nets like polyethylene or other nylon materials are replaced with split bamboo fences. The construction of pens are made by attaching the sets of posts

with long wooden pegs in every few meters and they are carefully pinned to the substrate in such a way that fish cannot escape from it. Generally pens are built in the shallow (<10m) waters, with 3–5m deep, and 1–50 ha in size and soft substrates are preferred (IRDC, 1979).

The pen-cultures, especially for raising stocking materials offer a great scope for the utilization of available resources for fisheries enhancement leading to significant improvement in the socioeconomic status of fishers. But recently due to exploitation by capture fishery, environmental pollution and related other issues, the production of flora and fauna in open water bodies especially reservoirs has been declined. In view of the above, the following study had been done to demonstrate and standardize the rearing of carp fry in pens in the Dhimbe reservoir of Pune, Maharashtra to standardize the technology with respect that reservoir for the benefit of the local fishers.

Materials and Methods

The present study was conducted at Dhimbe reservoir, Maharashtra, India located at 19° 06' N, 73° 44' E and the pens were erected in four different sites in the reservoir *i.e.*, Saverli- 1, Saverli- 2, Dighad and Bendharwadi. Pen structures were carefully designed and installed to minimize siltation and to maintain the water depths adequate to the requirements of experimental animals. In the present study, the pens of 6 mm mesh size with knotless, treated webbing were constructed using wooden ballies, bamboo poles. The distance between each pole was 2.5 meter. During experimental period the water levels observed in all pens was 2 meters. Carp fry were procured from Mahad and Karad village of Raigarh and Satara district of Maharashtra state. Once received the required levels of water in the pen, *C. catla* and *L. rohita* fry of 48-57 mm and 5.5-

5.6 g were stocked in the ratio of 1:1 and reared for 55 days under four stocking densities: 11.5, 12, 12.5 and 16 fry per m² respectively in pens installed in Savarli-2, Bendharwadi, Dighad and Savarli-1 sites. During the experimental period, the fishes were fed with 36% protein diet containing 10% rice bran, 40% Ground nut oil cake, 7.0% maize, 20% Soyabean, 20% Acetes, 2% vitamin mixture and 1% mineral mixture @ 2–3 % body weight twice daily. Feeding was done by bag feeding method by fixing bamboo poles randomly in the pen. The wooden ballies and bamboo poles of pens were routinely monitored and maintained during the experimental period.

The water quality parameters and plankton abundance were estimated following the method of APHA (1996). Growth and survival data was collected every fortnight during the experiment. The weight gain, total length, specific growth rate, survival, and biomass were calculated by using the following formulae:

Weight gain= Final weight- Initial weight
Length gain= Final length- Initial length

$$\text{SGR} = \frac{\text{Log} \square \text{ Final weight} - \text{Log} \square \text{ Initial weight}}{\text{Number of days}} \times 100$$

$$\text{Survival (\%)} = \frac{\text{Total number of harvested animal}}{\text{Total number of stocked}} \times 100$$

Biomass (kg/pen) = Number of fingerlings × Final weight

Data on growth and survival were statistically analyzed using one-way Analysis of Variance (ANOVA) at 95% level of confidence. Duncan's multiple range used to determine the significant differences between the means among stocking densities. Statistical package SPSS version 11 was used for analysis.

Results and Discussion

Water quality parameters

The observed water quality parameters were optimum for the growth, survival and production of carp fry and fingerlings. The Physico-chemical parameters of water recorded inside the pens during the experiment were given in the table 1.

All the physico-chemical parameters of water such as temperature, pH, dissolved oxygen, free carbon dioxide and total alkalinity showed slight variation inside the pens and surrounding areas of Dimbhe reservoir and were in the optimum range for growth and survival of carps *Catlacatla* and *Labeorohita*. Dissolved oxygen was found in the range of 6.4 to 7.1 mg/l which is within the optimum range for cyprinids suggested by Huet (1972) and Boyd *et al.*, 1998. The water temperature ranged from 18 °C to 28 °C which falls in the range considered to be suitable for fish culture (Bettoli *et al.*, 1985).

pH of Dimbhe reservoir was found to be in the range of 7.3 to 7.5 which was in the acceptable range (7-8.5) as suggested by Swingle (1967) and Boyd *et al.*, (1998). Total alkalinity remained in the range of 40 to 42 mg/l which was in the suitable range for fish culture (Boyd *et al.*, 1998). Total hardness recorded during the study was in the range of 52 to 55 mg/l which was in the normal range. The recorded ammonia nitrogen, phosphate phosphorous was within the optimum range suitable for fish culture (Banerjee, 1967). Total organic carbon was found in the range of 0.018 to 0.03 mg/l and total suspended solids were found in around 0.05 mg/l which is acceptable range for the aquaculture (Boyd *et al.*, 1998).

Table.1 Abiotic and biotic parameters recorded in the pens at Dimbhe reservoir during the experimental period

Parameter	Bendharwadi	Saverli -1	Saverli -2	Dighad
Water temperature (⁰ C)	24	22	23	24
Transparency (cm)	90	80	90	110
pH	7.5	7.7	7.6	7.4
Total Alkalinity (mg/ l)	41.00	40.30	42.14	42.64
Total Hardness (mg/ l)	55.20	54.30	55.80	55.20
Dissolved Oxygen (mg/l)	6.70	6.70	6.90	7.00
Free carbon dioxide (mg/l)	Nil	Nil	Nil	Nil
Ammonia- N (mg/l)	0.24	0.24	0.25	0.24
Phosphate –P (mg/l)	0.01	0.11	0.01	0.01
TOC (mg/l)	0.04	0.03	0.03	0.04
TSS (mg/l)	0.05	0.05	0.05	0.05
Plankton (nos/l)				
Phytoplankton	2822.4	2803.2	2899.2	2707.2
Zooplankton	316.8	288	268.8	278.4

Table.2 Growth parameters at the end of the experimental period under different stocking densities in pens

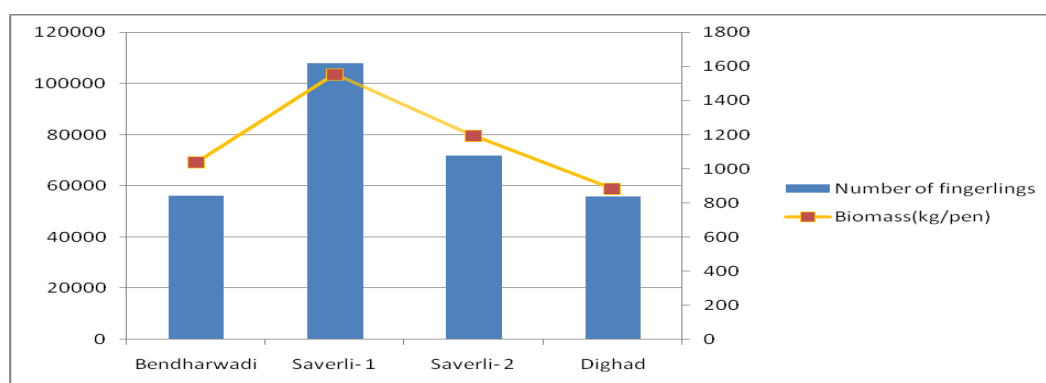
Pen site and size (ha)	Stocking density number/pen (per m ²)	Initial stocking size		Size at the end of the experiment		Length gain (mm)	weight gain (g)	SGR (%)
		Mean Length (mm)	Mean Weight (g)	Mean Length (mm)	Mean Weight (g)			
Bendharwadi pen (0.5)	60,000 (12 m ²)	52.2 ± 0.53 ^b	5.6 ± 0.061	101 ± 0.36 ^b	15.7 ± 0.37 ^b	49.2 ± 0.71 ^{ab}	10.1 ± 0.38 ^b	1.9 ± 0.05 ^b
Saverli-1 pen (0.8)	1,30,000 (16 m ²)	57.2 ± 0.25 ^a	5.63 ± 0.065	105 ± 0.31 ^a	14.4 ± 0.26 ^c	47.4 ± 0.25 ^b	8.77 ± 0.25 ^c	1.74 ± 0.034 ^c
Saverli-2 pen (0.66)	77,000 (11.5 m ²)	49.2 ± 0.42 ^c	5.5 ± 0	100 ± 0.48 ^b	16.6 ± 0.21 ^a	51.2 ± 0.71 ^a	11.1 ± 0.21 ^a	2.05 ± 0.023 ^a
Dighad pen (0.48)	60,000 (12.5 m ²)	48.1 ± 0.59 ^c	5.6 ± 0.047	96.2 ± 0.92 ^c	15.8 ± 0.27 ^b	48.1 ± 1 ^b	10.2 ± 0.25 ^b	1.92 ± 0.028 ^b

Values ±SE in the column with different superscript letters are significantly different (P < 0.05).

Table.3 Survival and biomass at the end of the experimental period under different stocking densities in pens

Pen site and size (ha)	Stocking density Number/pen	Survival at the end of the experiment		Biomass(kg/pen)
		Number of harvested fingerlings	% survival	
Bendharwadi (0.5)	60,000	56,300	93.83	1039.30
Saverli- 1 (0.8)	1,30,000	1,08,000	83.08	1555.20
Saverli- 2 (0.66)	77,000	71,872	93.34	1194.66
Dighad (0.48)	60,000	56,000	93.33	883.12

Fig.1 Biomass of fingerlings in terms of number in different pens at Dimbhe reservoir



Stocking density and growth parameters

The carp fry were stocked in the ratio of 1:1 under four stocking densities: 11.5, 12, 12.5 and 16 fry per m² respectively in pens installed in Saverli-2, Bendharwadi, Dighad and Saverli-1 sites. The stocking density was kept to a minimum to increase the growth performance and survival.

The growth parameters like mean body length, weight gain and specific growth rate at different pen culture sites at different stocking densities were given in table 2. At the end of the experiment, highest mean length of the

fingerlings was recorded (105 ± 0.31 mm) in Saverli-1 pen and lowest in (96.2 ± 0.92 mm) in Dighad. Highest mean weight was recorded in Saverli-2 (16.6 ± 0.21g) and lowest in Saverli-1 (14.4 ± 0.26g). Highest body length gain and weight gain was observed in Saverli-2 pen (51.2 ± 0.71mm and 11.1 ± 0.21g); whereas, lowest were recorded in Saverli-1 pen (47.4 ± 0.25mm and 8.77 ± 0.25g). Highest SGR of 2.04 ± 0.02 was recorded in Saverli-2 while lowest of 1.74 ± 0.03 was recorded in Saverli-1 pen (Table 2). At the time of stocking of carp fry (*Catla* and *Labeo rohita*) the mean length was 48–57 mm in all the pens respectively. At the end of the

experiment, the final length ranged from 96–105 mm with an increase of 47-50mm during the culture period. The results were similar with other works carried out in reservoirs where a growth rate of 25 mm/per month in *C. catla*, 20 mm in *L. rohita* was recorded in culture of fry at Getalsud reservoir (Banerjee and Govind 1979). Natarajan *et al.*, (1979) observed a growth ranging between 30.2–45.6 mm in 21–28 days of rearing of hatchlings and between 103.6–121.6 mm in 90 days of rearing of fry in cages.

Survival and biomass

The percentage survival rate and total biomass recovered from each pen at the end of the experiment were listed in the table 3 and figure 1. Highest survival of fingerlings in the pen experiment in terms of percentage recorded in Bendharwadi pen (93.83 %) whereas, the lowest (83.08%) was recorded in Saverli-1pen. Highest production of 1,08,000 in terms of number of fish were recorded in Saverli-1pen and the lowest of 56000 numbers was recorded in Dighad pen. Highest and lowest productions in terms of biomass were 1555.20 kg/pen in Saverli-1 and 883.12kg/pen in Dighad pen respectively. In the present experiment, it is concluded that even though the highest number and biomass were recovered from Saverli-1 the growth performance and survival of the fingerlings was not good in the pen due to high stocking density. Saverli-2 had shown good survival and growth. Highest mean length and weight were also recorded from Saverli-2. Biomass recovery from the Saverli-2 was also good even with the lowest stocking density. Hence the pen culture stocking density with good growth performance and survival is recommended for the culture of carps in the reservoir under study. Hence the stocking density of 11 no. s /m² is recommended for good growth and survival.

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