

Rearing of Freshwater Fish '*Catla catla* (Hamilton, 1822)' Spawn to Fry in Green Water System with Harvested Rain Water in Cement Tanks

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ABSTRACT

The present study on the effect of green water system with harvested rain water on growth performance of freshwater fish *Catla catla*. Spawn of *Catla* with an initial length 5.50 ± 0.04 mm and weight 10.99 ± 0.30 mg were stocked at the rate of 6, 8, 10 and 12 no.l⁻¹ in cement tanks (2x1x1m). The green water system containing live phytoplankton viz., Chlorophyta, Cyanophyta and zooplankton viz., Rotifera, Cladocera, Copepoda and Protozoa were used. The results of the study indicated that the maximum average length gain was $(357.89 \pm 3.08\%)$, weight gain $(779.53 \pm 18.03\%)$, specific growth rate $(5.56 \pm 0.08\%)$ and survival $(45.20 \pm 0.13\%)$ and were recorded significantly ($P < 0.05$) at stocking density of 6 spawn l⁻¹ as compared to the other stocking densities. The growth of spawn to fry was observed to decrease with increase in the stocking density. Observations on the water quality revealed that the dissolved oxygen value decreased with an increased stocking density. Whereas, the value of ammonia-nitrogen, nitrite-nitrogen, and nitrate-nitrogen increased with the increase in the stocking density. The study showed that better growth and survival of *Catla catla* spawn to fry stage with stocking density of 6 spawn l⁻¹ reared for a period of 16 days in cement tank. The overall results of this study indicated that green water system with harvested rain water has a potential for rearing fish seeds.

Keywords: *Catla catla*, Spawn, Fry, Aquaculture, Chlorophyta, Rotifera, Rain water, Cement tank.

INTRODUCTION

Freshwater fish culture a promising enterprise was gradually realized, non-availability of quality of fish seed and lack of scientific culture constrains the development of carp farming¹. Presently, freshwater fish culture is gaining importance in the state of Maharashtra in India². It has been observed farmers the state are taking keen interest to practice freshwater aquaculture. However, the major constraint is on the supply and access to quality freshwater fish seed³. The Konkan region of Maharashtra falls under high rainfall zone, the pre-monsoon showers (March-May) accounts for 25% of annual rainfall, while bulk of the rainfall (67%)

occurs during June-September, which constitutes the monsoon season 3-4 months⁴.

The physical, biological and chemical characteristics of water quality are which determines aquaculture operations. In short it can be concluded that effective water quality management is one of the important factor that contributes to the success of fish culture, and determines pond productivity⁵. Though Konkan region falls under the high rainfall category, the major part of water is drained and mixed in sea water due to its topography. Considering this situation, it is necessary to concentrate on harvesting rain water which can be used for producing of freshwater fish seeds.

Green water system, in which green algae consisting of planktons are allowed to grow and make available natural microscopic food to the fish larvae⁶. Green water tank culture of tilapia is an appropriate method for producing commercial level of tilapia, as phytoplankton and other small microscopic organism available within the water column are grazed on by tilapia and it helps to recycling waste nutrients and lowering feed conversion ratios⁷. Green water system provides plankton feeds to fish, shrimp and shellfish in the world's most widespread and sustainable aquaculture approach⁸.

Reviewing the literature it was observed that there is limited information on the direct use of harvested rain water for fish seed production. However, no study has been found on the nursery rearing of freshwater fish seed in green water system with harvested rain water in cement tank. The present study aims to assess the possibility of fry production of freshwater fish, *Catla catla* using green water system with harvested rain water in cement tank.

MATERIALS and METHODS

Study area

The present study was conducted at Wada Mirya finfish and shellfish hatchery of Marine Biological Research Station, at Latitude 17°00'.57".24N and Longitude 73°16'.50".47E, (Dr. Balasaheb Sawant Konkan Agricultural University), Ratnagiri, Maharashtra, India. The Konkan region of Maharashtra falls under high rainfall zone and large reservoirs area are available for culture based capture fish production.

Rain water harvesting method

The rain water falling on the roof of hatchery building was collected in cement tank through (U shaped) roof gutters attached to the edges of building roof (Figure 1). The roof gutters were fitted to PVC pipe for collecting the harvested water in large cement storage tank. The bolting silk of 40 µm mesh size bag were fitted to PVC pipe to filter the harvested rain water. The total catchment area of the roof was 432 m². During the first week of monsoon the roof was cleaned with rain water and then in second week of monsoon rain water was harvested

and stored in three different rectangular cement tanks with a total storage capacity of 1, 50,000 l. As per the requirement, harvested rain water was taken into the experimental cement tank.

Development of Green water system

The outdoor rectangular cement tanks having dimensions of 5 m×1.5 m×1.5 m (two tanks) and two small size tanks having dimension 2m×1m×1m were used for development of green water system separately. Mixed plankton culture was maintained by adding inoculum obtained from Bhairi Temple Lake, nearby to the experimental station, to the harvested rain water. The slurry comprising of ground nut oil cake (GNOC) and rice bran (RB) (1:1) at the rate of 0.015 mg fry⁻¹ day⁻¹ for first three days before the stocking of fish seed to grow and multiply natural live feed⁹. Aeration pipes were arranged in the culture tank to keep the culture afloat, in outdoor cultures.

Plankton samples

Water samples for phytoplankton (600 ml) were collected from three different points in the cement tank and fixed with Lugol's solution¹⁰ identified and counted using a hemocytometer under a microscope after overnight concentration to 0.2-0.4 ml¹¹. Zooplankton samples were collected using plankton net No.25 (67 µm mesh) from bottom to surface. Zooplankton samples were preserved first in procaine and then in 4% formalin before identification. The animals were counted in a 1ml Sedgewick-Rafter Chamber.

Stocking

In experiment, the five days old healthy spawn of *Catla catla* having average length 5.50±0.04 mm and average weight of 10.99±0.30



Fig. 1: Rain water harvesting through (U Shape) gutter

mg were stocked at four different stocking densities viz. 6,8,10 and 12 spawn l⁻¹ in harvested rain water in cement tanks. Daily green water with mixed planktons was added in the experimental tank at the rate of 5% through daily exchange of 5% water from each experimental tank. In addition to live food, slurry of GNOC and RB in the ratio of 1:1 at the rate of 0.015 mg fry⁻¹ day⁻¹ for first 0-14 days⁹. GNOC and RB slurry were fed twice in a day during morning and evening. The experiment was conducted up to 16 days for the spawn to attain the fry stage. The experimental tanks were cleaned daily with the soft scrubber and siphoning of uneaten feed and fecal matter was performed after feeding.

Water parameters

Water quality parameters viz., temperature, pH, dissolved oxygen (DO) alkalinity (bicarbonate and carbonate), hardness (calcium and magnesium) were observed on daily basis while analysis of other

parameters like ammonia, nitrate and nitrite were done on weekly basis using standard methods⁵.

Growth parameters

At initial and final stages of the experiment, the fishes were counted from each replicate and their individual length and weight were recorded. Sampling was carried out at an interval of seven days to observe the growth of fishes. At the time of sampling, 75 fishes from each experimental tank were randomly collected for recording the length and weight of fishes. At the end of the experiment, the survived fishes from each experimental tank were counted which provided the observation of survival rate of fishes. The average value of length and weight were recorded for each treatment of the experiment for analysis of growth parameters, such as length gain, weight gain, and Specific Growth Rate (SGR) and survival (%) were calculated by using standard formulae¹².

Table 1: Water quality parameters

Parameter	Average Range	Treatments			
		T1	T2	T3	T4
DO (mg l ⁻¹)	4.24-4.43	4.34 ± 0.012	4.33 ± 0.013	4.32 ± 0.014	4.32 ± 0.013
Temperature (°C)	23.3-22.5	22.80 ± 0.051	22.86 ± 0.055	22.91 ± 0.056	22.95 ± 0.061
pH	7.4-7.8	7.51 ± 0.040	7.57 ± 0.042	7.58 ± 0.046	7.63 ± 0.048
Calcium Hardness (mg l ⁻¹ as CaCO ₃)	14-14.9	14.48 ± 0.050	14.54 ± 0.054	14.60 ± 0.060	14.66 ± 0.064
Magnesium Hardness (mg l ⁻¹ as CaCO ₃)	17.9-18.91	18.44 ± 0.054	18.54 ± 0.054	18.61 ± 0.056	18.67 ± 0.059
Carbonate Alkalinity (mg l ⁻¹ as CaCO ₃)	16.15-16.9	16.39 ± 0.033	16.49 ± 0.038	16.57 ± 0.043	16.63 ± 0.044
Bicarbonate Alkalinity (mg l ⁻¹ as CaCO ₃)	18.1-18.9	18.38 ± 0.031	18.46 ± 0.035	18.57 ± 0.041	18.63 ± 0.046
Ammonia-nitrogen (mg l ⁻¹)	0.003-0.05	0.018 ± 0.008	0.020 ± 0.009	0.022 ± 0.010	0.024 ± 0.011
Nitrite-nitrogen (mg l ⁻¹)	0.002-0.005	0.0030 ± 0.001	0.0032 ± 0.002	0.0035 ± 0.001	0.0039 ± 0.001
Nitrate-nitrogen (mg l ⁻¹)	0.20-0.42	0.26 ± 0.026	0.27 ± 0.030	0.30 ± 0.042	0.32 ± 0.048

(T₁:6 spawn l⁻¹, T₂:8 spawn l⁻¹, T₃:10 spawn l⁻¹ and T₄:12 spawn l⁻¹).

Statistical Analysis

Standard error of the average length, weight, SGR and survival of the fry of catla for each replicate were calculated. Data obtained from the experiment for growth parameters and survival was analyzed by one way ANOVA. Differences were considered significant at an alpha level of 0.05, Student's Newman Keul multiple range tests was used to determine the significant difference between the treatments

RESULTS

Water quality of green water system with harvested rain water

The live mixed two group of phytoplankton viz., Chlorophyta and Cyanophyta were dominant,

while four group of zooplankton viz., Rotifera, Cladocera (*moina* and *daphnia*), Copepoda and Protozoa also dominated in the green water system.

In the experiment of harvested rain water the dissolved oxygen, temperature, pH, calcium hardness, magnesium hardness, carbonate alkalinity, bicarbonate alkalinity, ammonia-nitrogen, nitrite-nitrogen, and nitrate-nitrogen ranged from values of 4.24-4.43 mg l⁻¹, 22.5-23.3 °C, 7.4-7.8, 14-14.9 mg l⁻¹ as CaCO₃, 17.9-18.91 mg l⁻¹ as CaCO₃, 16.15-16.9 mg l⁻¹ as CaCO₃, 18.1-18.9 mg l⁻¹ as CaCO₃, 0.003-0.05 mg l⁻¹, 0.002-0.005 mg l⁻¹, 0.20-0.42 mg l⁻¹ respectively. The water quality parameters observed were recorded during the experiment (Table 1, Figure 2).

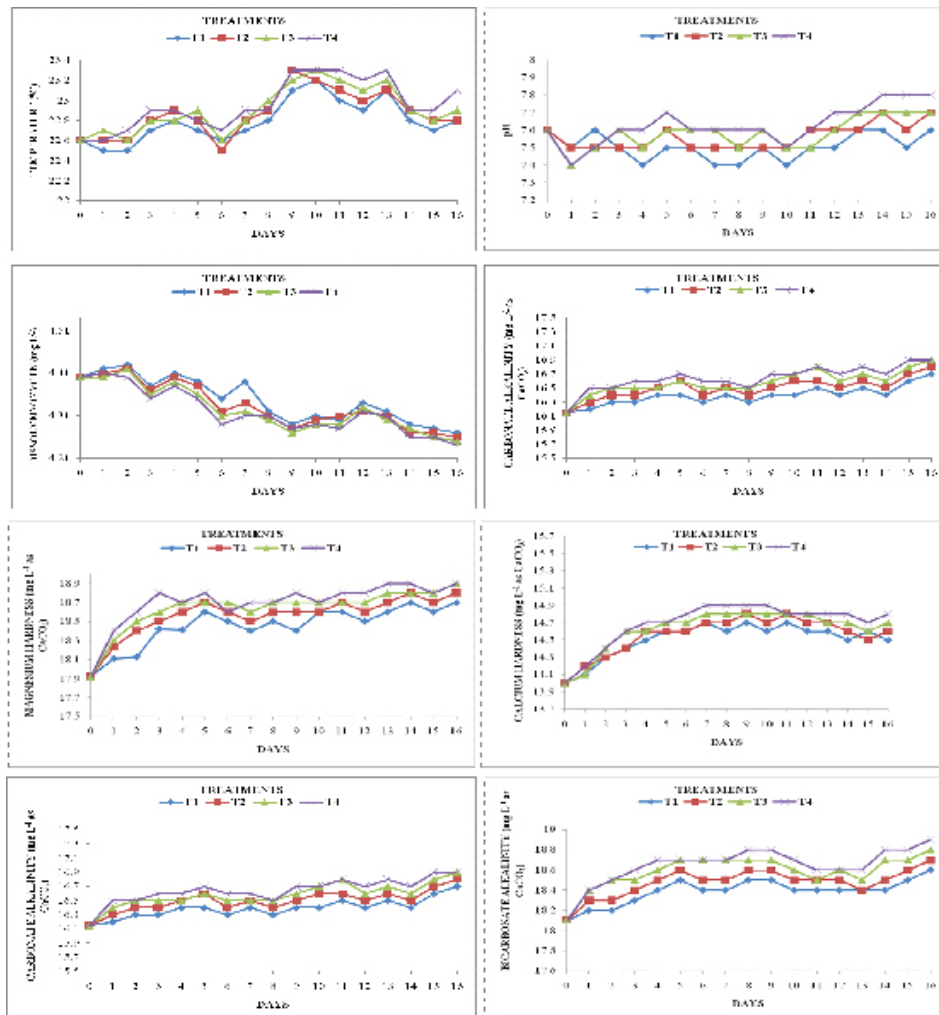


Fig. 2: Water quality parameters

Growth performance

The average initial length, final length and length gain (%), average initial weight, final weight and weight gain, average specific growth rate (SGR) and survival of *Catla catla* spawn stocked at four different densities, i.e. T₁ (6 Spawn l⁻¹), T₂ (8 spawn l⁻¹), T₃ (10 spawn l⁻¹), and T₄ (12 spawn l⁻¹) are depicted in Figure 3. At the end of the experimental period, the growth performance parameters such as weight gain, specific growth rate, length gain and survival rate of *Catla catla* fry, grown in green water system with harvested rain water in cement tanks (Table 2, Figure 3)

The maximum and minimum average length gain, weight gain, specific growth rate, survival values were 357.89±3.08%, 779.53±18.03%,

5.56±0.08%, 45.20±0.13% and 240.68 ±4.68%, 51 2.70±20.87%, 4.62±0.09%, 26.50±0.07 % in T₁ and T₄ respectively.

DISCUSSIONS

Water quality of green water system with harvested rain water

Rain water harvesting can be achieved by using predesigned catchment areas to increase the efficiency of runoff and maximize the amount of collected rainfall¹³. The fate of millions of rain-fed farms is greatly improved by adopting the effective rainwater conservation and management practices¹⁴. Water quality influences health, survival, growth and production of fishes¹⁵. The temperature of the

Table 2: Growth Parameters

Treatment	Weight Gain (%)	Specific Growth Rate (%/day)	Length gain (%)	Survival rate (%)
T1	779.53±18.026 ^a	5.55±0.052 ^a	357.89±3.076 ^a	45.20±0.13 ^{SD}
T2	653.54±3.403 ^b	5.15±0.011 ^b	324.54±2.063 ^b	39.68±0.07 ^{SD}
T3	576.57±2.871 ^c	4.88±0.010 ^c	277.17±3.172 ^c	29.21±0.05 ^{SD}
T4	512.70±20.866 ^d	4.62±0.087 ^d	240.68±4.672 ^d	26.50±0.07 ^{SD}

(Student's Newman Keul multiple range test, P< 0.05; N=4)

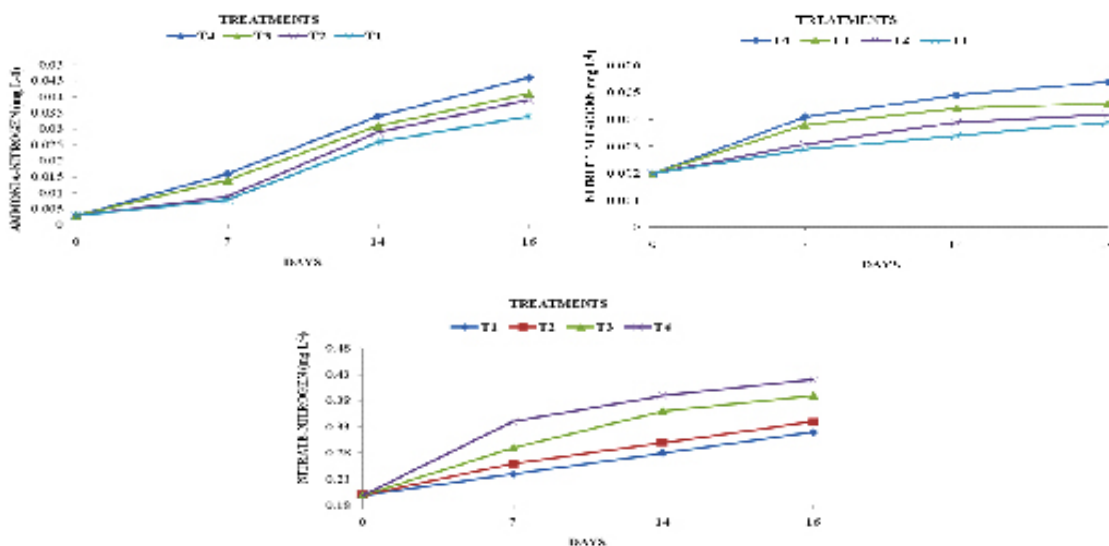


Fig. 3: Variation of ammonia-nitrogen, nitrite-nitrogen, and nitrate-nitrogen (mg l⁻¹) in green water system with harvested rain water

green water system with harvested rain water in the experimental cement tanks ranged from 22.5 to 23.3 °C in all the treatments during experimental period. The similar result was found with 23-30°C¹⁶. The pH of the green water system with harvested rain water in the experimental cement tanks ranged from 7.4 to 7.8, in all the treatments. During the experiment pH increased from acidic to alkaline in harvested rain water and faster growth of *Catla catla* spawn to fry was observed.

The daily average dissolved oxygen ranged between values of 4.24-4.43 mg l⁻¹ during experimental period. The dissolved oxygen was found to decrease over the culture period in all the densities. The decrease in the dissolved oxygen with the increasing stocking density was reported and the results are comparable with¹⁷ and such a similar result was found in glass aquaria with re-circulatory system. The low dissolved oxygen results in water quality changes play an important role in affecting growth and survival of fish¹⁸.

The daily average calcium hardness and magnesium hardness ranged between values of 14-14.9 and 17.9-18.91 mg l⁻¹ respectively. The values were found to be in an optimal range and this might be due the use of harvested rain water containing calcium hardness and magnesium hardness. The marginal increase in calcium hardness and magnesium hardness were observed during culture period and the values were within the acceptable limit.

The daily average carbonate alkalinity and bicarbonate alkalinity (mg l⁻¹ as CaCO₃) ranged between values of 16.15-16.91 and 18.1-18.9 mg l⁻¹ as CaCO₃ during experimental period. The optimum ranges of physico-chemical parameters of water for tropical fishes such as temperature, pH, dissolved oxygen, free CO₂, total alkalinity and total hardness were stated as 24-28°C, 7.5-7.8, 6.0-8.0 ppm, <5, 75-120 ppm as CaCO₃ and 60-1000 ppm as CaCO₃ respectively¹⁹.

The average ammonia-nitrogen, nitrite-nitrogen and nitrate-nitrogen (mg l⁻¹) ranged between values of 0.003-0.05, 0.002-0.005 and 0.20-0.42 mg l⁻¹ during experimental period.

The increased values of ammonia with the increase in the stocking density were reported by¹⁷. Ammonia less than 0.05 mg l⁻¹ as NH₃-N, nitrite less than 0.02 mg l⁻¹ as NO₂-N and nitrate less than 50 mg l⁻¹ as NO₃-N are found to be optimal for most of the freshwater fishes²⁰. The water provided was of good quality throughout the experimental period water quality has a complex side effect on high stocking density²¹.

Growth performance

The maximum average length gain of 357.89±3.08% were observed in T₁. Whereas T₄ showed the minimum average length gain of 240.68±4.68%, which showed significantly different ($P<0.05$) among all the treatments of stocking densities. The maximum average weight gain of 779.53±18.03% was observed in T₁, where as T₄ showed the average weight gain of 512.70±20.87%, which showed significantly different ($P<0.05$) among all the treatments of stocking densities. The maximum specific growth rate of 5.56±0.08% was observed in T₁ whereas T₄ showed the minimum specific growth of 4.62±0.09%, which showed significant difference ($P<0.05$) in the specific growth rate (%) *Catla catla* spawn stocked at different densities. In this study, it was observed that rearing of *Catla catla* spawn to fry stage at low stocking density showed significantly high growth rate in terms of length gain, weight gain and specific growth rate. Similar observations were recorded related to growth *Oreochromis niloticus* fry by using cages in open pond water system¹⁶, *Ctenopharygodon idella*¹⁵ by using reservoir water in aquaria. In the present study growth and survival were reduced by increasing stocking density. The similar results were found of *Oreochromis niloticus*²² by using fiber glass aquaria with recirculatory system; *Catla catla* and *Labeo rohita*, *Cirrhinus mrigala* and *Labeo rohita*¹⁸ using glass aquaria; *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala* and *Cyprinus carpio*²³ in rain fed medium ecosystem.

Fish fry appeared healthy at the end of experimental trials with survival ranging from 26.50±0.07 to 45.20±0.13%, which are significantly different among all the treatments of fish while there were a number of mortalities unrelated to diet. The maximum survival (45.20±0.1250%) was found at low stocking density of 6 spawn l⁻¹. Significantly the

observation was that the survival of fry was found to be decreased with increasing stocking density. Similar observations were also found in glass aquaria¹⁵ and in outdoor concrete tank¹². However, the variation in the growth and survival between all the above mentioned studies and present study may be due to the variation in stocking density, feed composition and feed type in culture system.

CONCLUSION

The overall observations and results of this present study showed that underutilized rain water can be used for rearing freshwater fish seed by developing green water system in cemented tanks. The stocking density of spawn *Catla catla* at the rate of 6 no l⁻¹ achieved better growth and survival in green water system with harvested rain water in cement tank and there was no significant changes

on water quality parameters. The water quality parameters were found to be within an optimum range during the spawn to fry stage rearing period of 16 days in green water system with harvested rain water in cement tank. It is concluded that, the green water system with harvested rain water would be the low cost alternative to production of freshwater fish seed for sustainable development of small scale freshwater fishery and to meet the demand for fish seeds.

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