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Growth Performance and Mortality of Different Life Stages of Carp Fish Seed in Freshwater Fish Culture System

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ABSTRACT

Due to the non-availability of good quality fish seed of Indian Major Carps (IMCs), majority of fish farmers of district Saran, Bihar are bound to stock their ponds with either fry or poor quality fingerlings at higher densities procured from local or interstate vendors. Consequently, this results in poor growth, increased mortality rate and reduced fish production. An on-farm trial was conducted to assess the growth performance, total yield and economic analysis of carp fish culture/ seed rearing of different life stages in fresh water fish culture system in Saran district during September, 2019 to March, 2020 in 9 earthen ponds of area 0.1 ha and depth 1.5 m each at three farmers' ponds at similar location. Treatments were designated as T_1 - farmer's practice (stocking of IMCs fry at the rate of 15000 no/ha), T_2 - stocking of IMCs fingerling at the rate of 8000 no./ha) and the recommended practice T_3 - stocking of IMCs yearlings at the rate of 4000 no./ha). All the treatments groups were fed @ 3% body weight with rice bran (RB) and mustard oil cake (MOC) in 1:1 ratio twice daily. Physicochemical parameters of water such as temperature, pH and dissolved oxygen were found to be within optimum range for carps. The average fish production recorded in T_3 treatment was higher, thus indicating a faster and better growth performance of fish yearlings compared to fry (T_1 group) and fingerling stage (T_2 group) of fish. Gross profit to the tune of Rs. 2.31, 5.31 and 5.93 lakh per hectare were recorded from rearing IMCs fry, fingerlings and yearlings stages, generating a net profit of Rs. 1.06, 3.06 and 3.98 lakh and a benefit-cost ratio of 1.85, 2.36 and 3.04, respectively.

Key Words: Growth, Major carps, Mortality, On-farm trial, Physicochemical parameters, Profit.

INTRODUCTION

The total world fisheries and aquaculture production is estimated to have reached around 179 MT, of which 96.4 MMT comes from capture fisheries, whereas; aquaculture sector (both inland and marine) contributes 82.1 MMT production (FAO, 2020). The global human population is also increasing exponentially and is estimated to cross 7.8 billion by year 2020 (Worldometer, 2020), thereby causing an imbalance between the population growth and the resources available for them to feed on. Animal protein is considered amongst the best protein source for human consumption. Fish and shellfish are excellent sources of protein contributing about 58% of total animal protein intake (Abbas *et al,* 2010). Most of the fish provides approximately 18-20% of protein or about one-third of the average daily recommended protein intake for human consumption (Arino *et al,* 2013). Fish is regarded as the most valuable and less expensive source to supplement the protein provisions to malnourished population of the world (Sumaira *et al*, 2010). Therefore, fish production has captured a greater attention due to the worldwide scarcity of animal protein, thus making it essential to enhance and improve fish production to meet the human food demand, while ensuring its sustainability.

In aquaculture, various culture practices are being used to improve the fish production. Based on the number of species being cultured, the fish culture is classified into monoculture and polyculture. Monoculture is the practice of culturing a single

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species of fish in a water system. Species cultured in monoculture system includes *Clarias sps*, *Oreochromis sps*, *Heteropneustes sps,* and many more. The advantage of this method is that a species-specific feed can be used to meet the requirement of the particular fish being cultured, especially in the intensive culture system. In polyculture system, multiple fish species are cultured together in the same pond or tank. Culturing multiple fish species ensures better utilization of live natural food produced at different strata and zones in the pond without any harm to each other. Polyculture systems increase the utilization of the natural foods in fish ponds by stocking a proper combination of two or more fish species, especially planktivorous and benthivorous fish, at proper densities (Rahman, 2015). Fishes used in polyculture involves a combination of Chinese carps (silver carps, grass carps, bighead carp) and common carps. Composite fish culture system is also a kind of polyculture system which involves culture of IMCs such as *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala* along with the exotic major carps such as silver carp, grass carp and common carp.

The growth performance of IMCs can be improved by providing accessible enough amount of natural food and balanced artificial diet. Keeping in view the production performance of polyculture system, an on-farm trial (OFT) on composite fish culture was conducted in order to determine which life stage of fish when stocked in pond exhibits maximum growth performance to achieve the highest yield.

MATERIALS AND METHODS

The present study was conducted over a period of six months from 20th September, 2019 to 20th March, 2020 in 9 earthen fish ponds of 3 different farmers having three ponds each at similar locations in Saran district, Bihar, India. The ponds having area 0.1 ha and depth 1.5 m each were used for culturing a combination of IMCs (catla, rohu and mrigal) of different life stages (fry, fingerling and yearling). The trial included three treatment groups, each in triplicates, designated as T_1 as practiced largely by farmers (stocking of IMCs fry at the rate of 15000 no./ha), T_2 (stocking of IMCs fingerlings at the rate of 8000 no./ha) and the practice recommended to farmers T_3 (stocking of Indian major carp yearlings at the rate of 4000 no./ha).

To stabilize the pH and disinfect these ponds, liming was done with quicklime (CaO) at the rate of 200 kg/ha by dusting method (Hora and Pillay, 1962). Ponds were filled with tube well water up to 1.5 m which is optimum water depth for carp culture and this level was maintained throughout the experimental period. Subsequently, all ponds were fertilized using cow dung, mustard oil cake and urea applied at a rate of 10t/ha, 150 kg/ha and 100 kg/ha, respectively. For stocking in ponds of treatment groups T_1 and T_2, fish seeds were procured by farmers from local vendors, whereas for T_3 group, yearlings were procured by KVK Saran from renowned hatchery Baba Matsya Hatchery, Muzaffarpur, Bihar and provided to the farmers for stocking. Fish seed was stocked as per the densities mentioned for different treatment groups, in the early morning hours after following all the necessary acclimatization and quarantine procedures. Fish were fed at the rate of 3 per cent of their body weight with an artificial feed containing a mixture of rice bran (RB) and mustard oil cake (MOC) in 1:1 ratio twice daily. Quantity of feed fed was adjusted based on the mean fish biomass of replicate ponds in each treatment, estimated after monthly sampling and considering an assumed survival of 80 per cent.

All the ponds were sampled monthly using random sampling method to monitor the growth performance and mortality of fishes. After recording the data, the fishes were released back in to their respective ponds. At the end of experiment, the species-wise number and total weight of fish were recorded for each pond for calculation of total yield.

Table 1. Physicochemical characteristics of the ponds.

Sampling no. and month	Temperature range (°C)	pH range	Dissolved Oxygen range (mg/L)	Water transparency (cm)
1. September	26.2-22.5	8.4-8.1	4.8-4.6	22.4-19.2
2. October	21.4-18.6	7.7-7.5	6.3-6.0	20.7-16.3
3. November	16.5-13.8	6.8-6.6	7.2-6.9	15.3-11.6
4. December	10.3-7.7	6.4-6.1	8.8-8.5	12.6-8.8
5. January	15.2-13.4	7.2-7.0	7.9-7.5	13.8-9.7
6. February	22.6-19.9	7.9-7.6	5.8-5.5	19.8-14.7
7. March	28.7-25.8	8.6-8.2	4.2-3.9	25.4-22.6

Estimation of physicochemical parameters of water

Water quality parameters *viz.*, temperature, water transparency, pH and dissolved oxygen were recorded at regular intervals during the experimental period.

Temperature and pH

The temperature of the pond water and that of the atmosphere was recorded with the help of an alcohol thermometer and expressed in °C. The pH was measured with the help of pH meter (JENKO-607) and expressed on a scale of 0 to 14.

Water transparency

The light penetration was determined with the help of "secchi disc" and expressed in cm.

Dissolved oxygen

The dissolved oxygen was measured by azide modification of Wrinkler technique as reported by American Public health Association (APHA, 1998) and expressed in mg/L or ppm.

Dissolved oxygen (mg/L) = $\times 100$

RESULTS AND DISCUSSION

Water temperature was observed between the range 10.3 °C to 28.7 °C. For water temperature, the maximum value was observed during the month of March while the minimum value was observed during December month. Water temperature was found to be inversely correlated with dissolved oxygen; justifying the fact that solubility of oxygen in water is reduced with rising temperature (Bilgrami *et al*, 1985).The pH value in all the ponds ranged between 6.5-8.6 (Table 1) which was within the optimum range for carps (Saha, 2010). Average dissolved oxygen concentration ranged from 4.2-8.8 mg/L (Table 1). The concentration of dissolved oxygen was found to be lowest during the month of March whereas the highest DO was recorded during December. All the physicochemical factors of water measured were within the favourable limits for carp culture.

The minimum value of water transparency was measured during the months of December and January ranging 12.6 cm to 8.8 cm in all the ponds while the maximum values recorded were within 25.4 cm to 22.6 cm range in the month of March. This change in the depth of light penetration/water occurred because in the winter months of December and January, the atmospheric temperature was low due to which the light intensity was minimum but in March, the atmospheric temperature started increasing with the onset of summer and therefore, the light intensity was more. Thus the light penetrated up to a larger depth in the pond.

At the end of the experimental trial, the weight of total fish produced per 0.1 ha was measured and from that value an estimated production per hectare was calculated for each treatment. Then total

Table 2. Average fish yield (kg/ha), mortality and economics of fish farming during the experimental trial.

Treatments	Final fish wt. kg (1)	Final fish wt. kg (2)	Final fish wt. kg (3)	Total yield (kg/ha)	Mean of final fish produced (kg/pond)	Gross profit Rs/ha/yr (lakh)	Input cost/ ha (lakh)	Net Profit Rs/ha/yr (lakh)	B:C ratio	Mortality %
T_1 (fry)	1560	1680	1720	4960	1653.33	2.31	1.25	1.06	1.85	32.125
T_2 (fingerlings)	3780	3760	3850	11390	3796.67	5.31	2.25	3.06	2.36	22.125
T_3 (yearlings)	4220	4180	4320	12720	4240.00	5.93	1.95	3.98	3.04	11.75

Note: Local sale price of fish per kg was Rs. 140/-. Total cost of production includes cost of labour for pond preparation and management, fertilization, liming, netting, etc. and material cost like fish fingerlings, feed, fertilizer, lime, etc.

production was calculated and the mean of total production gave an idea of average production per pond.

It was observed that maximum production and profit was obtained in T_3 (ponds stocked with IMCs yearlings @ 4000 no./ha followed by T_2 stocked with carp fingerlings (Table 2). The results were in accordance with the findings of Hussain *et al* (2013) who stated that in order to increase the per hectare production of fish, important measures that need to be adopted are stocking of advanced fingerlings/ yearlings by stunting the growth of fish seed during first year followed by heavy stocking and multiple harvesting after the fishes attain a size of approx. 500 g. Similarly, Ramaswamy *et al* (2013) also reported that stunted fingerlings exhibit better growth in the grow-out phase with high survival rates. The mortality rate was observed to be highest in T_1 treatment compared to T_2 and T_3 (Table 2). This might be due to the fact that fish fry stage is usually more susceptible to predation, disease, under nutrition and less tolerant to environmental fluctuations (De and Saha, 2009). Based on the monthly sampling, it was also found that the maximum weight gain was observed during the month of March and this could be attributed to higher water temperature (Cotton *et al,* 2003), while the lowest weight gain was observed during December month. Nath and Saikia (2017) also reported similar results concluding that body metabolism, its growth and development is highly temperature dependant.

Carps are known to grow faster during their second year. Therefore, ponds which were stocked with 8-12 m old stunted fishes (yearlings) of 100-150 g, instead of fry or fingerlings as practiced in the traditional system showed higher growth rate. Even though stunted yearlings have several advantages, many farmers have reported the problem of maturation at a smaller size. Early maturation is a major problem in many farmed fish species which has a negative impact on growth performance, flesh composition, external appearance, behaviour and health (Taranger *et al,* 2010). Stunted yearlings have higher demand as they utilize seasonal grow-out ponds efficiently and the fishes can be sold at a higher price too (Charan *et al* 2012).

Average total cost of production over the experimental period for fry, fingerlings and yearlings was Rs. 2.40, 2.25 and 1.95 lakh, respectively (Table 2). Variation in the cost of production in different years was due to variation in cost of inputs (Hussain *et al*, 2013). Mean yield obtained from the three treatments were 1653.33 kg/ha, 3796.67 kg/

ha and 4240.00 kg/ha, respectively. Gross profit to the tune of Rs. 2.31, 5.31 and 5.93 lakh/ha were recorded from carp fry, fingerlings and yearlings culture, with a net profit of Rs. 1.06, 3.06 and 3.98 lakh, respectively. This gave an average benefit-cost ratio of 1.85 in fry culture, 2.36 in fingerling culture and 3.04 in the yearling's culture (Table 2). These results showed that IMCs stunted yearlings culture could be a beneficial venture for optimum utilization of land and water resources resulting in higher production and economic gains. Adoption of this stocking strategy will open avenues to supplement the income of the farmers and enhance fish production.

CONCLUSION

It was recorded that IMCs yearlings showed faster growth in six months culture period as compared to their fry and fingerling counterparts. Stunted yearlings are better stocking material for carp culture because of their higher survival rate due to lower vulnerability to predation, diseases and are more tolerant to environmental fluctuations as well. Also, they require less time to reach marketable size leading to higher production and profitability.

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