Fishery Technology 58 (2021) : 77 - 82

Effect of Tank Colour on Growth Performance and Survival during Larval Rearing of Koi Carp (*Cyprinus carpio*)

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Abstract

Cyprinus carpio commonly referred as Koi carp is one of the most traded fish in the ornamental aquaculture industry. The study describes the effect of different tank colour on growth and survival of koi carp spawn to fry by rearing them in different coloured tank at stocking density of 3 numbers/litre for 45 days. The initial weight and length of spawn was 3.68 ± 0.012 mg and 7.23 ± 0.163 mm respectively. Adlibitum feeding was done with commercial feed (powder) and live food twice daily. The highest mean length and weight after 45 days of rearing were recorded in green colour tank whereas lowest in red colour tank. The SGR was however lowest in orange colour tank. It may be due to the lowest stress level and better vision for feed intake in green colour tank as compared to others. This study concludes that the green is the best suitable colour for tanks use for koi carp larval rearing.

Keywords: tank colour; growth; koi carp; larval rearing; survival

Introduction

Ornamental aquaculture is a booming industry which supports livelihoods of rural people by providing additional income. Larval rearing is one of the basic requirements for any successful aquaculture practice. Higher survival rate of fish larvae will enable the farmers to supply sufficient seed as per market demand and also make the venture lucrative. Color vision is an important feature for fish enabling them to discriminate details in the ambient surrounding (Luchiari & Pirhonen, 2008). Ambient color (e.g. tank color) is one of the environmental factors that can influence growth performance, survival and stress response of fish under culture conditions (Browman & Marcotte, 1987; Karakatsouli et al., 2007a; Luchiari & Pirhonen 2008; Jýrsa et al., 2009; Luchiari et al., 2009; El-Sayed & El-Ghobashy 2011; Banan et al., 2011).

Larvae of fishes are considered as visual feeders (Blaxter, 1986). Tank background colour has been proved to affect larval growth and survival in many fish species and shellfish (Martin-Robichaud & Peterson, 1998; Tamazouzt et al., 2000; Rotllant et al., 2003; Rabbani & Zeng, 2005 and Opiyo et al., 2014). In contrast to larval fishes, comparatively few studies have examined the impact of tank color on the performance of juvenile and adult fishes, as most of the larval rearing is done in tanks where background may be changed easily.

It also affects its body physiology, skin pigmentation, stress response, and food intake. Tank colour are received through eyes and pineal glands of fish regulate the secretion of melatonin hormones a-melanocyte-stimulating hormone (aMSH) (Balm et al., 1995; Rotllant et al., 2003 and Melanin-concentrating hormone (MCH) (Amiya et al., 2005), which in turn stimulate cortisol release and stress response from hypothalamus–pituitary–interrenal (HPI) axis (Lamers et al., 1992; Rotllant et al. 2003).

Received 16 June 2020; Revised 16 December 2020; Accepted 14 December 2021

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Koi Carp, *Cyprinus carpio* is a semi-tropical freshwater fish belong to family *Cyprinidae*. Koi carp is popular worldwide due to its hardy nature and adaptation to different environment and water conditions. The first maturity of koi carp reported at the average weight of 200-250 g (Haniffa et al., 2007). Best suited temperature range for koi carp growth and reproduction is 26-28ºC. The broodstock development of koi carp requires separate rearing of male-female with proteinases feed (30-35% protein feed twice a day). To examine the effect of tank colour on larval rearing (spawn to fry), an experiment was conducted with different colour tank for 45 days.

Materials and Methods

This experiment was conducted at the ornamental fish hatchery unit of ICAR- Central Institute of Freshwater Aquaculture (ICAR-CIFA), Bhubaneswar, Odisha, India. Koi carp spawn for this experiment were produced at ornamental fish hatchery unit of ICAR-CIFA. The initial weight and length of spawn were 3.68±0.012 mg and 7.23±0.163 mm respectively.

In present study five day old spawn (5 days post hatch) were stocked in different coloured tanks (plastic tubs with 20 liter capacity) i.e. (1) Black (2) Blue (3) Orange (4) Red (5) Green and (6) White. The koi carp spawn were stocked with random selection method @ 3 number/litre in each treatment with triplicate replication. The tubs were covered with mosquito nets to protect the spawn from escape and predation. Continuous aeration was provided to the tanks and siphoning was done twice a week with 30% water exchange.

The water quality parameters such as temperature, pH, CO_2 (Carbon dioxide), alkalinity, P_2O_5 (Phosphorus pentoxide), NH_4N (ammonical nitrogen), NO_3 (Nitrate), conductivity and dissolved oxygen were recorded weekly following standard procedure (APHA, 2005).

Adlibitum feeding was done twice a day with commercial feed "Optimum" (protein 36% and lipid 4%) in powder form along with infusoria for first week. Second week onwards small size mixed zooplankton along with commercial powder feed were fed.

Sampling was carried out at 15 day interval. Feeding was stopped 12 h before handling. The weight was taken with electronic balance (Sartorius, Germany). For weighing, tared 100 ml beaker (filled with same water where fishes were reared) was used to minimise handling stress. The length of spawn was taken by keeping it on wet graph paper (laminated). Sampled animal were kept back in the respective experimental tanks. There was no mortality during sampling.

Growth parameters were recorded at the time of sampling on 15th, 30th and 45th day. Mortality during the experiment were recorded for estimation of the larval survival. The growth response was assessed by using the following formulae (Wangmi et al., 2009).

$$\text{Weight gain per day (g/day)} = \frac{(FW) - (IW)}{n}$$

$$\text{Length gain per day (mm/day)} = \frac{(FL) - (IL)}{n}$$

$$\text{Specific growth rate (SGR)} = \frac{[\ln(FW) - \ln(IW) \times 100}{n}$$

Whereas FW=final body weight, IW=initial body weight, FL=final body length, IL= Initial body length and n= experimental period in days

All experimental data were expressed as mean±SE of three replicate groups. The data were statistically analysed by statistical package SPSS (IBM-SPSS statistics version 20, Chicago, IL, USA) in which data were subjected to one-way analysis of variance (ANOVA). To determine signiûcant differences ($p<0.05$) among the treatments means, Duncan's multiple range test was carried out.

Results and Discussion

The physicochemical water quality parameters such as pH, CO_2, alkalinity, P_2O_5, NH_4N, NO_3, conductivity and dissolved oxygen were found to be in optimum range during the experimental period (Table 1).

The mean body length of koi carp spawn at the time of stocking was 7.23 ± 0.163 mm. The mean body length of spawn on 15th day was highest in green colour tank followed by blue whereas lowest in red (Table 2). No significant difference ($p>0.05$) was recorded in black, white and orange colour tanks. On 30th day as well on 45th day also same pattern was observed

The mean body weight at the time of initial stocking was 3.68±0.012 mg. During the whole experimental

Table 1. Physicochemical parameters during the experiment period

Parameters	Range
Temperature (°C)	24-26
pH	7.6-8.0
CO_2 mg C^{-1}	3.5-4.0
Alkalinity (mg l^{-1})	120-130
Hardness (mg l^{-1})	140-150
P_2O_5 (mg l^{-1})	0.020-0.027
NH_4N (mg l^{-1})	0.03-0.06
NO_3N (mg l^{-1})	0.01-0.04
Conductivity (μS cm^{-1})	330-350
Dissolved Oxygen (mg l^{-1})	6.8-8.0

period the highest mean body weight was recorded in green colour tank whereas lowest in red colour tank (Table 3). The mean body weight in green colour tank was not significantly ($p>0.05$) different from other colour tank except red colour.

After 45 days rearing of koi carp spawn, the highest weight gain (8.89±0.056 mg/day) was recorded in green colour tank (Fig. 1) whereas lowest in red (7.33±0.334 mg/day).

Length gain in green colour tank was significantly higher ($p<0.05$) than other tank colours except blue colour tank (Fig. 2). The highest length gain was recorded in green colour tank (0.44±0.020 mm/day) whereas lowest in red colour tank (0.33±0.011mm/day).

The specific growth rate (SGR) was presented in Fig. 3. The highest SGR was recorded in green colour tank whereas lowest in red colour tank. However there was no significant ($p>0.05$) in SGR among green, blue and white colour tank.

The survival of spawn at the end of experiment was recorded highest in green colour tank (33.33±5.879%) whereas the lowest in orange colour tank (17.78 ± 2.223%). The survival in red tank was second highest and not significantly different ($p>0.05$) from green tank (Fig. 4)

Table 2. Mean body length (mm) of Koi carp spawn reared in different colour tank at different time point

Tank Colour	Initial	15th Day	30th Day	45th Day
Black	7.00^{a}±0.577	14.00^{b}±0.289	17.33^{b}±0.441	24.33^{a}±0.600
Blue	7.17^{a}±0.440	15.17^{c}±0.334	18.67^{bc}±0.600	25.83^{bc}±0.927
Orange	7.50^{a}±0.288	13.83^{b}±0.166	17.00^{b}±0.289	24.50^{a}±0.500
Red	7.17^{a}±0.440	12.50^{a}±0.289	15.00^{a}±0.500	22.17^{a}±0.600
Green	7.00^{a}±0.577	15.50^{c}±0.578	19.67^{c}±0.927	26.67^{c}±0.601
White	7.50^{a}±0.288	14.00^{b}±0.289	17.67^{b}±0.440	25.17^{bc}±0.334

Note: Data are expressed as Mean ± SE. Columns with different superscripts are significantly different ($p<0.05$).

Table 3. Mean body weight (mg) of Koi carp spawn reared in different tank color at different time point

Tank Colour	Initial	15th Day	30th Day	45th Day
Black	3.70^{a}±0.029	57.67^{ab}±1.452	118.33^{ab}±1.667	150.00^{ab}±5.773
Blue	3.70^{a}±0.029	64.00^{ab}±5.821	130.00^{ab}±5.773	174.00^{ab}±10.898
Orange	3.67^{a}±0.014	58.00^{ab}±7.505	118.33^{ab}±4.409	155.33^{ab}±4.618
Red	3.68^{a}±0.044	40.00^{a}±4.041	83.33^{a}±7.688	101.67^{a}±13.370
Green	3.69^{a}±0.031	73.33^{b}±2.403	151.67^{b}±4.409	201.33^{b}±6.839
White	3.66^{a}±0.030	66.67^{b}±2.185	136.67^{b}±4.409	185.67^{b}±6.359

Note: Data are expressed as Mean ± SE. Columns with different superscripts are significantly different ($p<0.05$).

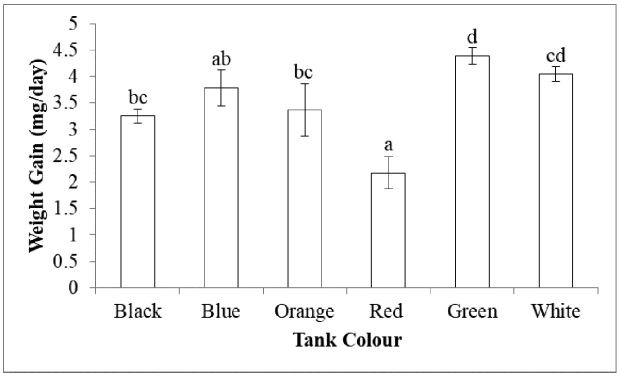

Fig. 1. Weight gain (mg/day) of koi Carp, *Cyprinus carpio* in different colour tank on 45th day(Footnotes)

Note: Bars with different superscripts are significantly different (P<0.05).

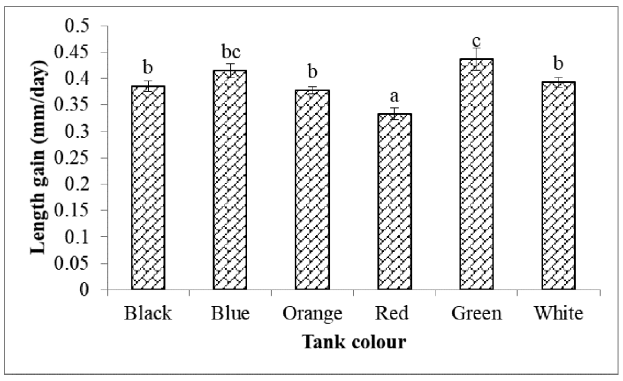

Fig. 2. Length gain (mm/day) of koi Carp, *Cyprinus carpio* in different colour tank on 45th day

Note: Bars with different superscripts are significantly different (p<0.05).

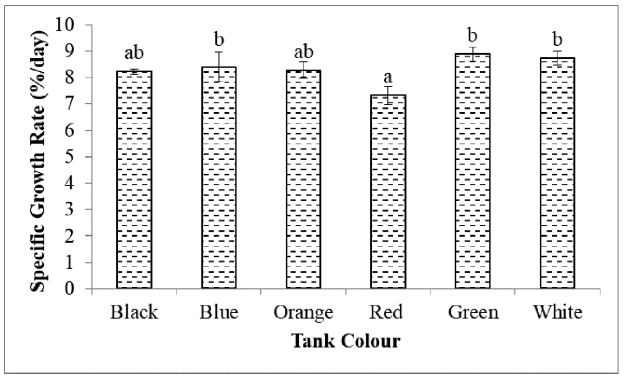

Fig. 3. Specific growth rate (SGR) of koi Carp, *Cyprinus carpio* in different colour tank on 45th day

Note: Bars with different superscripts are significantly different (p<0.05).

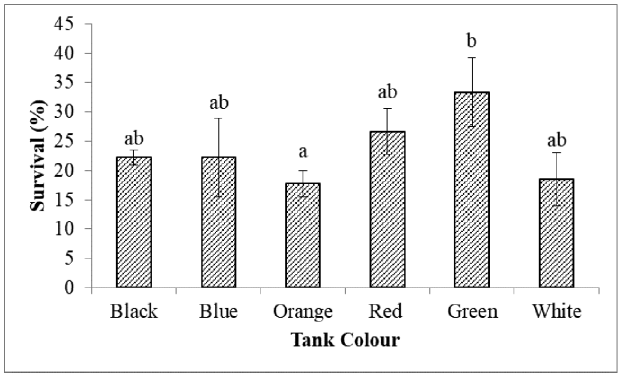

Fig. 4. Survival (%) of koi Carp, *Cyprinus carpio* in different colour tank on 45th day

Note: Bars with different superscripts are significantly different

Most of the fish larvae are visual feeders, so optimization of rearing conditions to enable them to distinguish, capture and consume prey items are essential parts of seed production technique. Reports on different species indicate that factors such as prey density; light orientation, intensity and wavelength; tank hydrodynamics and color, as well as the color and orientation of prey items, effect the ability of larvae to detect, capture and ingest food items (Ostrowski, 1989; Durey et al., 1996; Martinez -Cardenas & Purser, 2007 and Salze et al., 2008).

In present experiment the spawn were reared in different colour tanks. The highest growth performance was observed in green colour tank and the lowest in red colour tank, which was significantly different (p<0.05) from others. The highest growth performance in green colour tank may be due to the lowest level of stress and better vision of fishes for feed intake. Earlier study on koi carp with reference to light spectra revealed that blue and green lights are suitable for better growth and improving the non-specific immune system of koi carp (Bairwa et al., 2017).

Previous studies on other fishes (Sumner, 1911; Sumner & Doudoroff, 1938, Papoutsoglu et al., 2000; Strand et al., 2007; El-Sayed & El-Ghobashy, 2011) also reported that tank colour can also be a source of stress for fish influencing their behavior and metabolic activities. Both behavioral and physiological stress responses are energy draining process which may increase energy expenditure of fish and thus reduce somatic growth and feed efficiency. Fishes behave differently in varying light intensity/ wavelength, diurnal and seasonal variation which in turn effect the growth of the fish (Puvanendran & Brown, 2002).

The highest survival was recorded in green colour tank whereas lowest in orange colour tank but it was not significantly ($p>0.05$) different among tank colours. Better survival in green colour tank may be due comparatively lower stress and better vision for feed intake which resulted in low mortality of experimented fishes. As there was no significant difference ($p>0.05$) in survival of koi carp spawn in different colour tanks , it indicates that stress level due to tank colour was not strong enough to cause significant mortality in particular tank colour. Ferosekhan et al. (2020) also showed that for larval rearing of important catfishes like magur and pangas, black and green colour tanks respectively are preferred for better growth and survival.

Papoutsoglou et al. (2000) pointed that several other biotic and abiotic factors also influence growth performance in addition to tank colours depending upon experimental conditions. Scattering in yellow colour tank illuminated by solar or artificial fluorescent light has provided better visibility for prey catching in case of milkfish larval rearing (Bera et al., 2019). Barcellos et al, (2009) reported that jundiá (*Rhamdia quelen*) fingerling should maintain in blue colour wall tanks for better survival and health. All the above findings indicate that colour preferences of fishes are species specific as per their natural habitats, behavior, feeding habits etc.

Based on the present experiment, it could be summarized that green colour tank is better for larval rearing of koi carp as compared to any other colour in terms of growth and survival. Further study may be required to evaluate the effect of tank colour on molecular level.

Acknowledgements

The authors are thankful to Indian Council of Agricultural Research (ICAR), New Delhi for providing funds and to the Director, ICAR-Central Institute of Freshwater Aquaculture for his kind support and encouragement.

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