



Standardization of Stocking Density of *Cyprinus Carpio* Var. *Koi* (Linnaeus, 1758), Spawn Reared In Non-Aerated System

Saroj Kumar Swain¹, Sushreeta Sahoo², Priyanka Patra² and Mukesh Kumar Bairwa^{1*}

¹ICAR-Central Institute of Fresh water aquaculture, Bhubaneswar, Odisha - 751 002, India

²College of Fisheries Rangailunda, Bhubaneswar - 751 003, Odisha, India

Abstract

In India, ornamental fish breeding and culture without aeration in rural areas is common. An experiment was conducted for 45 days to standardise the stocking density of koi carp spawn rearing (4 day old, length 7.58 ± 0.10 mm, weight 4.56 ± 0.98 mg) in ferrocement tanks (300 l) without providing aeration. These spawn were fed with mixed zooplankton *ad libitum*. There were three treatments with different stocking densities *viz.*, 2 number l^{-1} (T_1), 4 number l^{-1} (T_2) and 6 number l^{-1} (T_3) respectively. In present study, significantly higher ($p < 0.05$) growth and survival rate was found in T_1 compare to other treatments. There was no significant difference ($p > 0.05$) in water quality parameters in different treatments. The results of present study concludes that stocking density of koi carp 2 number l^{-1} spawn could be suggested for rearing to fry stage without aeration.

Keywords: Growth, survival, koi spawn, non-aerated system

Introduction

Keeping ornamental fishes in aquarium has become a common hobby, especially in urban areas. Many aquarium fish species are cultured, but koi carp has got its own demand in the local market. Koi carp (*Cyprinus carpio*) is a member of the Cyprinidae family and order Cypriniformes. The term "Koi" refers to many strains of ornamental carp that have been genetically selected over many generations

(Feldlite & Milstein, 1999). It is an ornamental mutation of common carp (*Cyprinus carpio*), a native from Asia, especially China and Japan. It may look like a big Gold fish, but it can be distinguished from its barbells at the sides of the mouth and from its size. They grow up to 100 cm total length with an elongate body measuring 3 to 4 times its width.

In fish culture, rearing of spawn in nurseries is an important and crucial step. Adverse environmental conditions (Bairwa et al., 2017) and improper management often lead to severe consequences resulting in heavy mortality of fry to an extent of 90-98% (Alikhunhi et al, 1964). Optimal stocking density is one of the basic factors and it should be the resultant value of the environmental requirements of a given fish species and economic efficiency (Holm et al., 1990; Kuipers & Summerfelt, 1994).

Fish stocking density is the most sensitive factor determining the productivity of a culture system as it affects growth rate, size variation and mortality. Stocking at higher densities results in higher production and minimises the total land requirement and water usage. The high stocking density may have adverse effects on growth (Trzebiatowski et al., 1981) and survival (Lakshmanan et al., 1967; Jhingran, 1991). Therefore, it is necessary to pre-determine and standardise the optimum stocking density for each species in order to obtain the best possible output. In comparison to food-fish production, the densities at which ornamental fishes have been kept are rather low. By considering the rural setup of farmers, where there is lack of electricity and aeration, the experiment was designed without the provision of aeration to assess the growth and survival at different stocking densities. This study was undertaken to standardise the stocking density

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*E-mail: mukeshbairwa2@gmail.com

of koi carp spawn rearing, fed with only planktons without using any aerators and water exchange through out the experiment.

Materials and Methods

The study was conducted in an ornamental fish hatchery. All the preparation needed for induced breeding of koi carp was done in the hatchery. The breeding tank set up, water quality parameter, working space etc. were assured before the breeding program. Since the eggs are adhesive, the spawning mediums (plastic filaments) were placed at the surface and bottom of the tank. The brood fish were collected from the brooder tank reared separately sex-wise and used for hormone administration. The males and females weighing 450 and 700 g were injected intraperitoneal with ovaprim at a dose of 0.2 ml kg⁻¹ and 0.4 ml kg⁻¹ respectively by using insulin syringe at 6.00 pm. The brooders were separated early in the morning hours and were placed in a separate tank for further post-natal care. The adhesive eggs attached to nylon filaments were kept in aerated environment for hatching. After 46 h at 27°C temperature the hatching was successful. The newly hatched spawn were kept undisturbed for 3 days till complete absorption of yolk sac. On the 4th day the spawn were fed with sieved (100 µ mesh) zooplankton which were predominately rotifer larvae. The 5th day old spawns (average weight 4.56 mg and average length 7.58 mm) were taken for stocking in circular ferrocement tanks of 300 l in 3 different stocking densities in triplicate.

The experimental design consisted of three treatments with different stocking densities *viz.*, 2 number l⁻¹ (T₁), 4 number l⁻¹ (T₂) and 6 number l⁻¹ (T₃)

respectively. The water quality parameters such as temperature, dissolved oxygen, pH, alkalinity, hardness were checked at weekly intervals. Length and weight of the spawn at measured at 15 days interval from each tank. The growth response and survival were assessed by using the following formulae

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

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

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

$$\text{Survival} = \frac{\left(\frac{\text{Number of spawn at starting of rearing}}{\text{Number of spawn at starting of rearing}} \right) - \left(\frac{\text{Number of dead spawn during rearing}}{\text{Number of spawn at starting of rearing}} \right) \times 100}{\text{Number of spawn at starting of rearing}}$$

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

Results and Discussion

The physico-chemical parameters of water such as temperature (°C), pH, dissolved oxygen (mg l⁻¹), free carbon dioxide (mg l⁻¹), ammonia (mg l⁻¹), nitrate-N (mg l⁻¹), alkalinity (mg l⁻¹) and Hardness (mg l⁻¹) were estimated and presented in Table 1. Water temperature ranged from 24°C-27°C while pH was in the range of 7.33 to 7.37 through out the experimental period (Table 1).

Dissolved oxygen concentration was in the range of 5.8 to 6.25 mg l⁻¹ whereas Ammonia-N and Nitrate-

Table 1. Physico-chemical parameters of water for experiment during the experimental period of 45 days

Parameters	T ₁	T ₂	T ₃
Temperature (°C)	25.55 ± 0.43	25.55 ± 0.41	25.53 ± 0.39
DO (mg l ⁻¹)	6.15 ± 0.04	6.08 ± 0.07	6.08 ± 0.46
pH	7.37 ± 0.15	7.33 ± 0.18	7.35 ± 0.19
P ₂ O ₅ (mg l ⁻¹)	0.2 ± 0.01	0.1 ± 0.01	0.1 ± 0.02
Free CO ₂ (mg l ⁻¹)	4.76 ± 1.19	3.73 ± 1.19	4.08 ± 1.17
Alkalinity (mg l ⁻¹)	86.59 ± 1.29	94.00 ± 3.77	95.00 ± 3.68
Hardness (mg l ⁻¹)	92.59 ± 1.35	95.00 ± 3.45	100.00 ± 3.32
NH ₄ -N(mg l ⁻¹)	0.04 ± 0.01	0.04 ± 0.02	0.03 ± 0.01
NO ₃ -N(mg l ⁻¹)	0.03 ± 0.01	0.02 ± 0.01	0.03 ± 0.02

N content were in the range of 0.02 to 0.07 mg l⁻¹ and 0.02 to 0.05 mg l⁻¹ respectively. Alkalinity and hardness were recorded at a range of 84 to 110 mg l⁻¹ and 92 to 100 mg l⁻¹ respectively.

The mean body weight of spawn at the time of stocking was 4.56±0.98 mg. The mean body weight of spawn on 15th day in each treatment was significantly different (p<0.05) from each other (Table. 2). The highest mean body weight was recorded in T₁ treatment whereas lowest in T₃ treatment. Same pattern was followed on 30th day and 45th day of sampling.

The mean body length of koi carp spawn at the time of stoking was 7.58±0.10 mm. The mean body length of spawn on 15th day was highest in T₁ and lowest in T₃ treatment. Spawn from T₂ and T₃ treatment did not show significant difference in length (p>0.05). Same pattern of length was also observed on 30th day and 45th day. There was no significance difference between T₂ and T₃ treatments (Table 3).

In present experiment, the highest weight gain (48.23±0.72 mg day⁻¹) was recorded in T₁ treatment, whereas lowest in T₃ treatment (38.12±0.68 mg day⁻¹). The weight gain in T₁ was significantly different (p<0.05) from other treatments (Fig. 1).

Length gain in T₁ treatment was significantly higher than other treatments (Fig. 2). In the present study the highest length gain was recorded in T₁ treatment (0.66±0.02 mm/day) whereas it was (0.54±0.02 mm day⁻¹) in T₃ treatment.

Specific growth rate (SGR) in present study was recorded highest in T₁ treatment (13.67±0.06), whereas it was lowest in T₃ (13.13±0.07) treatment. The SGR of T₁ was significantly different (p<0.05) from other treatments (Fig. 3).

The survival at the end of experiment was highest in T₁ treatment (61.38±0.73%) whereas lowest in T₃

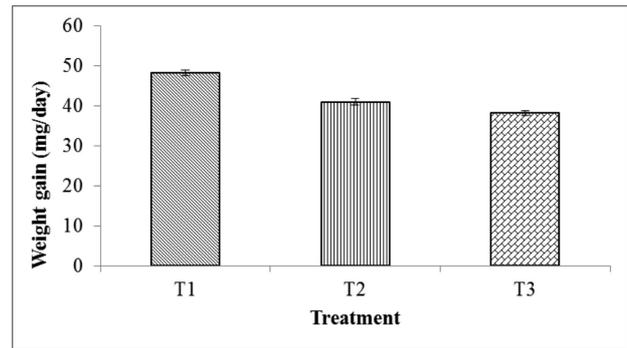


Fig. 1. Weight gain (mg/day) of koi carp, *Cyprinus carpio* spawn reared in different stocking density

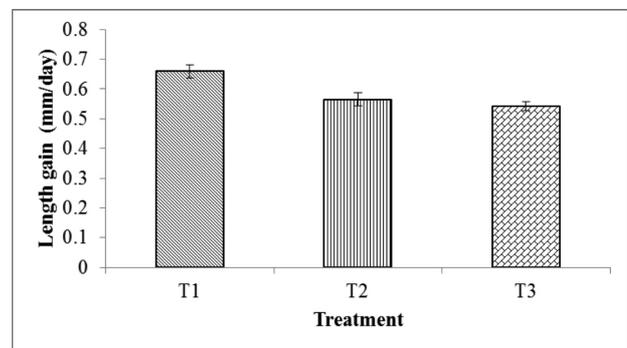


Fig. 2. Length gain (mm/day) of koi carp, *Cyprinus carpio* spawn reared in different stocking density

treatment (37.59±0.81%). The survival in T₁ treatment was significantly different from other treatment (Fig. 4).

In the present experiment, the spawn (4 day of post hatching) were reared in circular cement tanks with different stocking density with no aeration. The highest mean body weight and mean body length were recorded in T₁ treatment and it was significantly different from other treatment treatments. This may be due the lowest density in T₁ treatment

Table 2. Mean body weight (mg) of koi carp, *Cyprinus carpio* spawn reared in different stocking density at different time point

Treatment	Zero day	15 th day	30 th day	45 th day
T1	4.58 ^a ±0.15	80.67 ^c ±1.98	205.90 ^c ±2.92	2175.00 ^c ±32.63
T2	4.42 ^a ±0.20	73.67 ^b ±1.31	184.33 ^b ±5.70	1845.05 ^b ±36.12
T3	4.67 ^a ±0.17	69.00 ^a ±1.24	168.58 ^a ±3.88	1720.00 ^a ±30.66

Mean values (Mean±SE) in the same column with different superscripts differ significantly (p<0.05). All mean values are expressed as mean± SE.

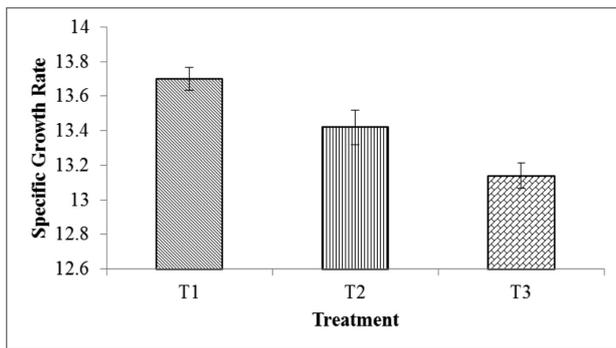


Fig. 3. Specific growth rates of koi carp, *Cyprinus carpio* spawn reared in different stocking density

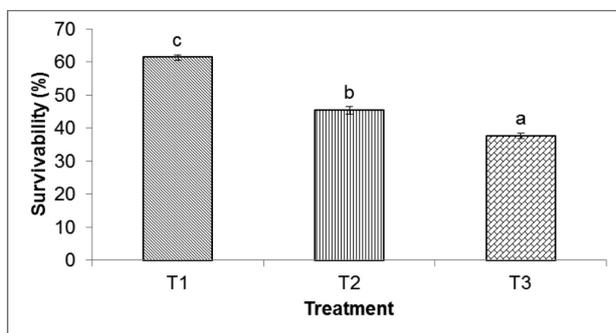


Fig. 4. Survival rate (%) of koi carp, *Cyprinus carpio* spawn reared in different stocking density at the end of experiment

compare to other rearing treatment. Stocking density has direct effect on food supply, space for living and water quality (Lingen, 1989). Havey (1980) also found that there was significant inverse linear relationship between stocking rate and growth. Retardation of growth under high stocking densities has been explained by several workers. Forselius (1973) linked such depression in growth to unavailability of proper space. Physiological stress may also cause poor growth performance under high stocking densities in T₂ and T₃ treatment, as observed in *Salmo gairdneri* (Wedemeyer, 1976) and *Oncorhynchus kisutch* (Fagerlund et al., 1981).

In the study the weight gain (mg/day), SGR and length gain (mm/day) was significantly higher in spawn stocked with 2 number l⁻¹ (T₁) treatment compared to other treatments. Shelton et al. (1981) found that increasing stocking density had a profound negative impact on the growth of grass carp, *Ctenopharyngodon idella*, in small impoundments. This study also supports the earlier studies with other fish species (Degani 1993; Stone et al. 2003). Among ornamental fishes, a similar effect of

population density on growth rate was found by Olivier & Kaiser (1997) with juvenile swordtails, *Xiphophorus helleri*, fed to satiation, and Degani (1993) with angelfish, *Pterophyllum scalare*, although, the latter experiment was conducted indoors and the initial size of fish were more than 1 g.

Survival was affected by the stocking density. The lowest survival was recorded in T₃ (6 number l⁻¹) treatment and highest in T₁ (2 number l⁻¹) treatment. The lower survival in T₂ and T₃ treatment may be due the competition for space and food. Water quality parameters did not show significant variation in the experimental tanks under different stocking densities which indicated that higher stocking densities as employed in the present experiments (4 and 6 numbers⁻¹) did not impose any environmental stress.

In conclusion it can be suggested that rearing of koi carp spawn to early fry can be done at 2 number l⁻¹ stocking density. Keeping in view the high cost of aerator and unavailability of same to resource poor farmer in India this study can be helpful for raising koi carp spawn without aeration. However further studies are required to find the optimum density of koi carp spawn rearing with aeration for commercial production.

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References

- Alikunhi, K.H., Sukumaran K.K., Parameswaran S. and Banerjee S.C. (1964) Preliminary observations on commercial breeding of Indian carps under controlled temperature in the laboratory. Bull. CIFRI. Barrackpore, No. 3, 191 p
- Bairwa, M.K., Saharan, N. Rawat, K.D. Tiwari, V.K. and Pani Prasad, K. (2017) Effect of light spectra on growth performance and immune response of koi carp, *Cyprinus carpio* (Linnaeus, 1758) Fish. Technol. 54: 100-106
- Degani, G. (1993) Growth and body composition of juveniles of *Pterophyllumscalare* (Liechtenstein) (Pisces: Cichlidae) at different densities and diets. Aquaculture and Fish. Manag. 24: 725-730
- Fagerlund, U.H.M., McBride, J.R. and Stone, E. T. (1981). Stress related effects of hatchery rearing density on coho salmon. Trans. Am. Fish. Soc. 110: 644-64

- Feldlite, M., and Milstein, A. (1999). Effect of density on survival and growth of cyprinid fish fry. *Aquacult. Int.* 7: 399-411
- Forselius, S. (1973) Studies on anabantoid fish. I-III. *Zool. Bidr. Uppsala*, 32: 93-589
- Havey, K.A. (1980) Stocking rate and the growth and yield of landlocked Atlantic Salmon at long pond, Maine. *Trans. Amer. Fish. Soc.* 109(5): 502- 510
- Holm, J.C., Refstie, T. and Bo, S. (1990) The effect of fish density and feeding regimes on individual growth rate and mortality in rainbow trout (*Oncorhynchus mykiss*) *Aquaculture* 89: 225-232
- Jhingran, V.G. (1991) *Fish and Fisheries of India* 3rd edn., Hindusthan Pub. Co., New Delhi, 727 p
- Kuipers, K.L. and Summerfelt, R.C. (1994) Converting pond-reared walleye fingerlings to formulated feeds: effects of diet, temperature, and stocking density. *J. Appl. Aquacult.* 4: 31-57
- Lakshmanan, M.A.V., D.S. Murty, K.K. Pillai and S.C. Banerjee (1967) On a new artificial feed for carp fry. *FAO Fish. Rep.* 44(3): 373-387
- Lingen, Z. (1989) Rearing of fry fingerlings. Integrated Fish Farming in China. NACA Technical Manual No. 7, A World Food Day Publication of the Network of Aquaculture Centres in Asia and the Pacific, Bangkok, Thailand. 278p
- Olivier, A. and Kaiser, H. (1997) A comparison of growth, survival rate, and number of marketable fish produced of swordtails, *Xiphophorus helleri* Heckel (Family *Poeciliidae*), between two types of culture systems. *Aquacult. Res.* 28(3), 215-221
- Shelton, W. L., Smitherman, R. O. and Jensen G. L. (1981) Density related growth of grass carp, *Ctenopharyngodon idella* (Val.) in managed small impoundments in Alabama *J. Fish Biol.* 18 (1): 45-51
- Stone, N., E. McNulty, and E. Park (2003). The effect of stocking and feeding rates on growth and production of feeder goldfish in pools. *North Am. J. Aquacult.* 65: 82-90
- Trzebiatowski, J., Filliak J. and Jakubowski, R. (1981) On effect of stocking density on growth and survival of rainbow trout. *Aquaculture J.* 22: 289-295
- Wedemeyer, G. A. (1976) Physiological response of juvenile coho salmon (*Oncorhynchus kisutch*) and rainbow trout (*Salmo gairdneri*) to handling and crowding stress in intensive fish culture. *J. Fish. Res. Board Can.* 33: 2699-2702