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Effect of feeding frequency on growth, survival and feed utilization in mrigal, *Cirrhinus mrigala*, and rohu, *Labeo rohita*, during nursery rearing

G. Biswas, J.K. Jena*, S.K. Singh, P. Patmajhi, H.K. Muduli

Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar-751002, India

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Abstract

The effect of feeding frequency on growth, survival and feed utilization in mrigal, *Cirrhinus mrigala*, and rohu, *Labeo rohita*, during raising fry were studied in 50-m^2 cement nurseries provided with 10 cm soil base. Feeding frequency of one, two and three times daily as three treatments were evaluated against a control without feeding in triplicate tanks in two separate trials of 15 days each. Hatchery produced spawn were stocked at the density of 10 million/ha. With the survival levels lying in the narrow ranges of 44.01–46.71% in mrigal and 53.03–56.65% in rohu, no significant differences ($P>0.05$) were recorded between the treatments. Similarly, the growth in terms of length and the feed conversion ratios did not differ significantly ($P>0.05$) among treatments and were in the ranges of 34.6–34.9 mm and 27.5–28.9 mm, and 0.80–0.81 and 1.33–1.47 in mrigal and rohu, respectively. The study suggests that feeding frequency of one time daily is sufficient for nursery raising of carp fry in field condition in presence of natural food in the form of plankton.

Keywords: Feeding frequency; Growth; Survival; Nursery; Carp

1. Introduction

The growth of fish at all stages is largely governed by the kind of food, ration, feeding frequency, food intake and its ability to absorb the nutrients. Among these, feeding frequency is an important aspect for the survival and growth of fish at the early stage (Mollah and Tan, 1982). Optimum feeding frequency seems to be dependent on fish size and higher frequency of feeding was found to be advantageous for higher growth and survival in younger age groups (Murai and Andrews, 1976; Hancz, 1982; Folkvord and Ottera, 1993). The fishes should have the access to feed up to satiation for their optimum growth. However, over-feeding leads not only to reduction in feed conversion efficiency and increase in input cost, but also accumulation of wastes that adversely affects the water quality.

* Corresponding author. Tel.: +91 674 2465421; fax: +91 2465407.

E-mail address: jkjena2@rediffmail.com (J.K. Jena).

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Carps being the mainstay of Indian aquaculture, availability of seed of desired quality and size is of paramount importance. Over 18,500 million carp fry presently used in pond aquaculture comes from outdoor nurseries (Ayyappan and Jena, 2003). Further, the practice of seed rearing has received increased attention by the farmers over the years due to higher profit realization. Normally, single species seed rearing is practiced in carp nursery for a period of 15–20 days with stocking density of 3–5 million ha^{-1} in earthen ponds and 10–20 million ha^{-1} in ferro-cement tanks (Ayyappan and Jena, 2001). Plankton being the most preferred food for carp at early stages, pond fertilization is carried out intermittently for its sustained supply during seed rearing. Since natural food is not sufficient to nourish the spawn stocked at higher density, supplementary feed is provided to ensure their optimum growth and survival. Powdered mixture of rice bran and groundnut oil cake at 1:1 ratio is the most commonly used supplementary feed, provided daily at four times of the initial spawn biomass (carp spawn weighs 1.4–1.6 mg) during initial 5 days and eight times in the subsequent rearing period (Jena et al., 1996).

Supplementary feed being the most critical input, judicious feed management enhances the production performance and reduces the production cost. Several studies have been carried out to evaluate the effect of feeding frequency on growth, survival, feed intake, body composition, etc. in different fish species (Mollah and Tan, 1982; Singh and Srivastava, 1984; Chiu et al., 1987; Kiron and Paulraj, 1990; Webster et al., 1992; Burtle and Newton, 1993; Goldan et al., 1997; Hung et al., 2001; Dwyer et al., 2002; Dada et al., 2002). However, information on carps is limited only to a few species like common carp, *Cyprinus carpio* (Charles et al., 1984) and bighead, *Aristichthys nobilis* (Carlos, 1988). Most of these studies are confined to laboratory trials, where growth of fishes is contributed only through supplementary feed. However, information on effect of feeding frequency in field trials, where natural food also contributes, is almost non-existent. The present studies were carried out in two Indian major carp species viz., mrigal (*Cirrhinus mrigala*) and rohu (*Labeo rohita*) to assess the role of feeding frequency on growth, survival and feed utilization during nursery raising of fry in field condition.

2. Materials and methods

Studies were carried out at the Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar (Lat. 20°11′06″–20°11′45″ N, Long. 85°50′52″–85°51′35″ E), India during June–August 2002 in 12 cement tanks of 50 m^2 (10 m × 5 m) each. The impact of feeding frequency on production performance of mrigal (*C. mrigala*) and rohu (*L. rohita*) during nursery rearing was evaluated in two separate experiments of 15 days each. Hatchery produced spawn (3-day-old larvae) were stocked at the density of 10 million ha^{-1}. Supplementary feed (Table 1) was provided at 400% and 800% of the initial biomass of spawn per day from 1st to 5th and 6th to 15th days, respectively. Keeping the daily ration same, differential feeding frequencies were considered as the variable. Feeding frequency of one, two and three times per day were considered as treatments, T_1, T_2 and T_3, besides a control (T_c) without provision of supplementary feed. The experiments were carried out in triplicates and tanks of each treatment were selected at random. Feed was provided at morning (T_1, T_2 and T_3), noon (T_3) and evening (T_2 and T_3) hours in one, two and three equal splits of the daily ration as per the treatments. The three different treatments with feeding frequency of one, two and three times for Experiment I with mrigal and Experiment II with rohu were designated as MT_1, MT_2 and MT_3 and RT_1, RT_2 and RT_3, respectively. The corresponding controls for the two experiments were MT_C and MR_C.

The tanks were provided with 10 cm soil base and filled with filtered pond water to a depth of 1.0 m and the level was maintained throughout by periodic filling. Fertilization was carried out in both treatment and control tanks with recommended doses of 750 kg ha^{-1} groundnut oil cake, 200 kg ha^{-1} cattle wastes

Table 1
The feed ingredients and proximate composition of the supplementary feed

Feed formula	(%)	Proximate composition	
Groundnut oil cake	40	Moisture (%)	10.36
Rice bran	37	Protein (% dry matter)	24.51
Wheat flour	15	Lipid (% dry matter)	5.20
Fish meal	5	Ash (% dry matter)	14.32
Vegetable oil	2	Energy (kcal g^{-1})	4.33
Vitamin–mineral premix	1		

and 50 kg ha^{-1} single super phosphate in split doses, 50% of which applied as basal dose 4 days prior to stocking and the rest 50% in two subsequent splits after stocking of spawn, i.e., on 6th and 11th day (Jena et al., 1998a,b). Predatory insects from the tanks were removed by using 1/8-in. mesh size drag net prior to stocking.

Mean initial length (mm) and weight (mg) of the spawn were recorded by taking measurement of 50 samples. Growth in terms of length and weight were further assessed through periodic samplings at 5-day intervals. Mean increment in length and weight were computed from random samples of 25 animals from each tank. The health status of the fry were also assessed during the sampling. Water samples from the tanks were collected during 8:00–9:00 a.m. at every 5-day intervals for analysis of important physico-chemical parameters. Temperature, transparency, dissolved oxygen, pH, total alkalinity, total hardness, free carbon dioxide, total ammoniacal-nitrogen, nitrite-nitrogen, nitrate-nitrogen and phosphate-phosphorus were recorded following standard methods (APHA, 1998). Plankton samples were also collected during each water sampling by filtering 50 l of water from each tank with the help of a bolting silk net (No. 25, mesh size 64 μ) and analyzed by 'Direct Census Method'.

The sediment samples collected prior to stocking and after harvest were analysed by following standard methods for analyzing pH, conductivity, organic carbon, available phosphorus and available nitrogen. The biochemical analysis of feed was carried out for moisture, total ash, crude protein, crude fat (ether extract), gross energy contents following standard methods (AOAC, 1990), and results are presented in Table 1. Data were subjected to analysis through PC-SAS Programme for Window, release v6.12 (SAS Institute Inc., Cary, NC, USA) at a significance level of 0.05. Analysis of variance was performed with the General Linear Model procedure. Duncan's Multiple Range Test (Duncan, 1955) was used for comparison of treatments.

3. Results and discussion

The water and soil parameters in different treatments (Table 2) did not show any marked variations among the treatments, attributed to provision of similar fertilisation regime. The recorded parameters in both the experiments were within the optimum ranges for fry rearing (Jena et al., 1998a,b). Periodic application of phase manuring enhanced the productivity of the tanks considerably, which could be noticed from the sustained plankton growth during the experiment. During sampling all through the experiment, no infection or disease was encountered in either of the experiment.

The size of fish species at their early stages usually refers to its length rather than weight due to its practical implications. In Experiment I with mrigal, the growth in terms of length and weight was significantly higher in all the treatments with supplementary feeding compared to that of control (Table 3). However, no significant variations in length/weight ($P>0.05$) were observed among the treatments, only except weight of MT_1 (433.4 ± 79.6 mg) that recorded significantly higher growth ($P>0.05$) over the other two.

In Experiment II with rohu, the maximum growth (length/weight) of 28.9 ± 2.2 mm/247.7 ± 63.5 mg was recorded in RT_1 with one-time feeding compared to RT_2 (27.5 ± 2.1 mm/226.9 ± 43.6 mg) and RT_3 (28.2 ± 2.6 mm/235.21 ± 70.7 mg) (Table 4), while control (RT_C) with no feeding showed minimum growth of 20.1 ± 3.1 mm/70.0 ± 29.6 mg. Similar to that of mrigal, all the three treatments in rohu showed significantly higher length and weight ($P<0.05$) than those of control. However, no significant variations in length/weight ($P>0.05$) were observed among the treatments. The growth trends of fry in mrigal and rohu recorded at different time intervals are presented in Figs. 1 and 2, respectively.

The significantly lower growth in controls over the treatments in both the experiments with rohu and mrigal was attributed to insufficiency of natural food for sustenance of larvae at such high stocking density. In both the experiments, though treatment with one-time feeding recorded comparatively higher weight over treatments with two and three times feeding, they were not duly reflected in term of length. The non-significant difference in growth among the treatments in both the experiments infers that differential feeding frequency do not have much influence on growth of the fish in such environment where intermittent fertilization substantially contri-

Table 2
Variations in water and soil quality parameters in two experiments with rohu and mrigal during nursery rearing

Parameters	Experiment I				Experiment II			
	MT_1	MT_2	MT_3	MT_C	RT_1	RT_2	RT_3	RT_C
Water quality parameters								
Water temperature (°C)	32.4 ± 0.4	32.6 ± 0.4	32.4 ± 0.4	32.6 ± 0.4	31.3 ± 1.3	31.3 ± 1.2	31.3 ± 0.9	31.3 ± 1.2
pH	7.7 ± 0.1	7.6 ± 0.2	7.6 ± 0.2	8.0 ± 0.2	7.5 ± 0.2	7.5 ± 0.1	7.5 ± 0.1	7.8 ± 0.4
Dissolved oxygen (mg l^{-1})	3.5 ± 1.3	3.3 ± 1.1	3.4 ± 1.1	4.5 ± 0.5	3.9 ± 0.7	3.9 ± 0.6	4.0 ± 0.6	4.0 ± 0.5
Transparency (cm)	25 ± 2	27 ± 4	27 ± 5	30 ± 5	27 ± 3	30 ± 3	29 ± 3	29 ± 4
Free carbon dioxide (mg l^{-1})	10.5 ± 0.9	10.2 ± 1.3	9.7 ± 1.7	7.5 ± 2.3	7.2 ± 1.8	6.3 ± 2.1	7.3 ± 2.1	7.3 ± 2.3
Total alkalinity (mg $CaCO_3$ l^{-1})	122 ± 6	123 ± 4	121 ± 4	112 ± 8	103 ± 5	104 ± 3	105 ± 3	101 ± 4
Total hardness (mg $CaCO_3$ l^{-1})	110 ± 7	118 ± 2	109 ± 2	101 ± 6	98 ± 7	95 ± 4	100 ± 3	95 ± 3
Total ammoniacal-nitrogen (mg l^{-1})	0.43 ± 0.20	0.44 ± 0.21	0.45 ± 0.20	0.41 ± 0.17	0.47 ± 0.10	0.47 ± 0.10	0.48 ± 0.11	0.45 ± 0.07
Nitrite-nitrogen (mg l^{-1})	0.01 ± 0.001	0.01 ± 0.001	0.01 ± 0.001	0.01 ± 0.001	0.026 ± 0.006	0.026 ± 0.006	0.025 ± 0.005	0.03 ± 0.006
Nitrate-nitrogen (mg l^{-1})	0.36 ± 0.05	0.37 ± 0.04	0.38 ± 0.05	0.37 ± 0.03	0.44 ± 0.04	0.44 ± 0.05	0.43 ± 0.05	0.42 ± 0.05
Phosphate-phosphorus (mg l^{-1})	0.77 ± 0.15	0.91 ± 0.06	0.71 ± 0.23	0.53 ± 0.24	0.68 ± 0.16	0.78 ± 0.11	0.79 ± 0.11	0.74 ± 0.14
Plankton (nos l^{-1})	1377 ± 786	1045 ± 584	1137 ± 466	1071 ± 598	3874 ± 3028	3230 ± 2352	3316 ± 2568	3365 ± 2263
Soil quality parameters								
pH	7.4 ± 0.1	7.3 ± 0.1	7.4 ± 0.2	7.3 ± 0.1	7.4 ± 0.1	7.4 ± 0.1	7.4 ± 0.1	7.4 ± 0.1
Conductivity (μ mhos)	209 ± 63	274 ± 112	223 ± 1340	246 ± 61	160 ± 54	168 ± 54	170 ± 68	157 ± 47
Organic carbon (% C)	1.9 ± 0.3	2.0 ± 0.1	2.0 ± 0.1	1.9 ± 0.1	1.7 ± 0.3	2.0 ± 0.2	1.9 ± 0.1	1.9 ± 0.2
Available phosphorus (mg P 100 g^{-1})	4.0 ± 0.4	4.4 ± 0.3	4.2 ± 0.6	4.1 ± 0.3	4.0 ± 0.5	4.2 ± 0.3	3.4 ± 0.8	3.9 ± 0.7
Available nitrogen (mg N 100 g^{-1})	18.8 ± 3.0	20.1 ± 2.7	18.7 ± 2.6	18.1 ± 1.8	17.2 ± 2.4	18.4 ± 2.4	20.1 ± 1.9	18.1 ± 2.4

The values are expressed as mean ± S.D.

Table 3
Stocking and harvesting details of mrigal in treatments with different feeding frequency

Treatment	Replicate	Initial size (mm/mg)	Final size (mm/mg)	Survival (%)	FCR	SGR (% day^{-1})
MT_1	1	6.5 ± 0.2/1.5 ± 0.3	36.0 ± 1.0/444.3 ± 67.0	42.52	0.81	37.94
	2	6.5 ± 0.2/1.5 ± 0.3	33.2 ± 1.7/416.1 ± 75.4	45.15	0.81	37.50
	3	6.5 ± 0.2/1.5 ± 0.3	34.5 ± 1.9/430.9 ± 93.8	44.37	0.80	37.74
	Mean	6.5 ± 0.2/1.5 ± 0.3	$34.6 \pm 1.9^{a}/433.4 \pm 79.6^{x}$	44.01 ± 1.38^{a}	0.80 ± 0.01^{a}	37.73 ± 0.22^{a}
MT_2	1	6.5 ± 0.2/1.5 ± 0.3	35.6 ± 2.5/411.5 ± 74.6	47.00	0.91	37.43
	2	6.5 ± 0.2/1.5 ± 0.3	34.9 ± 3.6/410.2 ± 175.5	48.02	0.65	37.41
	3	6.5 ± 0.2/1.5 ± 0.3	34.0 ± 2.5/406.8 ± 110.6	45.12	0.87	37.35
	Mean	6.5 ± 0.2/1.5 ± 0.3	$34.9 \pm 2.8^{a}/409.4 \pm 125.3^{y}$	46.71 ± 1.47^{a}	0.81 ± 0.14^{a}	37.40 ± 0.04^{a}
MT_3	1	6.5 ± 0.2/1.5 ± 0.3	35.6 ± 2.1/417.2 ± 85.1	44.22	0.83	37.52
	2	6.5 ± 0.2/1.5 ± 0.3	34.9 ± 3.6/396.2 ± 16.7	47.25	0.81	37.18
	3	6.5 ± 0.2/1.5 ± 0.3	34.0 ± 2.5/406.6 ± 134.3	46.85	0.80	37.35
	Mean	6.5 ± 0.2/1.5 ± 0.3	$34.9 \pm 2.4^{a}/408.4 \pm 101.7^{y}$	46.11 ± 1.65^{a}	0.81 ± 0.01^{a}	37.35 ± 0.17^{a}
MT_c	1	6.5 ± 0.2/1.5 ± 0.3	19.8 ± 2.2/53.7 ± 14.8	37.10	–	23.86
	2	6.5 ± 0.2/1.5 ± 0.3	18.5 ± 1.8/49.5 ± 13.5	39.00	–	23.31
	3	6.5 ± 0.2/1.5 ± 0.3	18.1 ± 2.5/50.0 ± 12.6	27.12	–	23.37
	Mean	6.5 ± 0.2/1.5 ± 0.3	$18.9 \pm 2.3^{b}/51.1 \pm 13.3^{z}$	34.41 ± 6.38^{b}	–	23.51 ± 0.30^{b}

Means bearing different superscripts differ significantly in a column ($P<0.05$); values are expressed as mean ± S.D.

butes the sustained production of natural food. The higher density of plankton recorded throughout the culture period might have subsided the effect of feeding frequency. The trend for final weights in relation to feeding frequency noted in this study was similar to the observations of Carlos (1988) and Abud (1990). Kaiser et al. (1995) also reported feeding frequency not to have any significant effect on growth of *Clarias gariepinus* larvae and juveniles. However, working on channel catfish fry Murai and Andrews (1976) reported requirement of more frequent meals in small fish for maximum growth. Similarly, Mollah and Tan (1982) and Charles et al. (1984) recorded higher growth in *Clarias macrocephalus* and *C. carpio* fry, respectively, fed at higher feeding frequency.

Table 4
Stocking and harvesting details of rohu in treatments with different feeding frequency

Treatment	Replicate	Initial size (mm/mg)	Final size (mm/mg)	Survival (%)	FCR	SGR (% day^{-1})
RT_1	1	6.4 ± 0.2/1.5 ± 0.3	28.3 ± 2.2/247.3 ± 67.1	51.00	1.42	33.95
	2	6.4 ± 0.2/1.5 ± 0.3	29.1 ± 2.4/245.8 ± 77.9	56.43	1.26	33.90
	3	6.4 ± 0.2/1.5 ± 0.3	29.6 ± 1.9/251.0 ± 39.6	53.40	1.31	34.04
	Mean	6.4 ± 0.2/1.5 ± 0.3	$28.9 \pm 2.2^{a}/247.7 \pm 63.5^{x}$	53.61 ± 2.72^{a}	1.33 ± 0.08^{a}	33.96 ± 0.07^{a}
RT_2	1	6.4 ± 0.2/1.5 ± 0.3	27.5 ± 1.8/226.5 ± 49.5	53.32	1.51	33.47
	2	6.4 ± 0.2/1.5 ± 0.3	26.0 ± 1.9/216.2 ± 37.2	60.44	1.35	33.05
	3	6.4 ± 0.2/1.5 ± 0.3	28.9 ± 1.4/237.8 ± 38.7	56.20	1.32	33.68
	Mean	6.4 ± 0.2/1.5 ± 0.3	$27.5 \pm 2.1^{a}/226.9 \pm 43.6^{x}$	56.65 ± 3.58^{a}	1.39 ± 0.10^{a}	33.40 ± 0.32^{a}
RT_3	1	6.4 ± 0.2/1.5 ± 0.3	28.5 ± 2.8/254.0 ± 75.9	51.38	1.36	34.12
	2	6.4 ± 0.2/1.5 ± 0.3	27.4 ± 1.5/213.4 ± 40.4	52.22	1.67	32.96
	3	6.4 ± 0.2/1.5 ± 0.3	28.8 ± 3.3/233.5 ± 88.1	55.48	1.37	33.56
	Mean	6.4 ± 0.2/1.5 ± 0.3	$28.2 \pm 2.6^{a}/235.2 \pm 70.7^{x}$	53.03 ± 2.17^{a}	1.47 ± 0.18^{a}	33.55 ± 0.58^{a}
RT_c	1	6.4 ± 0.2/1.5 ± 0.3	20.3 ± 1.6/67.5 ± 25.4	40.29	–	25.29
	2	6.4 ± 0.2/1.5 ± 0.3	19.9 ± 2.3/69.6 ± 33.2	39.20	–	25.49
	3	6.4 ± 0.2/1.5 ± 0.3	20.1 ± 4.4/73.0 ± 31.8	37.74	–	25.81
	Mean	6.4 ± 0.2/1.5 ± 0.3	$20.1 \pm 3.1^{b}/70.0 \pm 29.6^{y}$	39.08 ± 1.28^{b}	–	25.53 ± 0.26^{b}

Means bearing different superscripts differ significantly in a column ($P<0.05$); values are expressed as mean ± S.D.

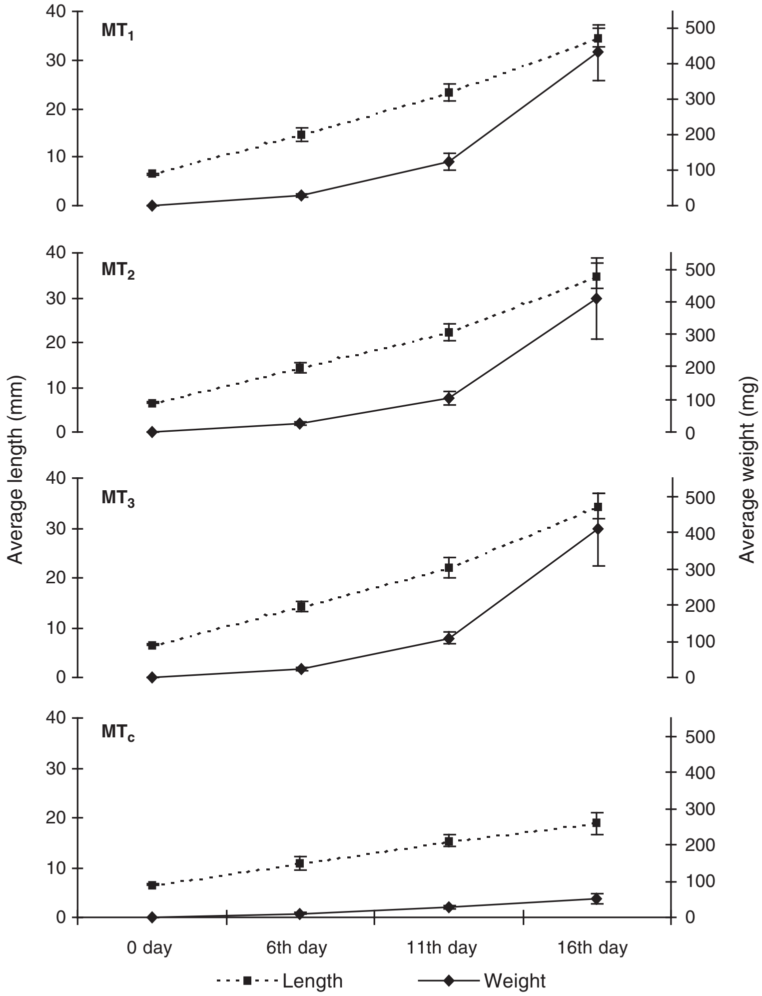

Fig. 1. Growth increment of mrigal in treatments with different feeding frequency.

Significantly low ($P<0.05$) survival of fry in control compared to the treatments in both the trials was obviously due to insufficiency of food. However, the contributions of plankton in such young stages cannot be ignored as discernible from the comparatively encouraging mean survival of 34.41 ± 6.38% and 39.08 ± 1.28% in control tanks with mrigal and rohu, respectively. As that of growth, no significant difference ($P>0.05$) in survival levels among the treatments in both the experimental trials (Tables 3 and 4) suggests minimal influence of feeding frequency on survival of the fish, attributed to the reasons discussed earlier. Working with juveniles of gilthead sea bream, *Sparus aurata,* Goldan et al. (1997) reported similar result of no significant effect of feeding frequency on survival rate.

Similar to the growth and survival levels, FCR and SGR values also did not show any significant ($P>0.05$) difference between the three treatments with one, two and three feeding frequency per day. Our observation of FCR not influenced by feeding frequency is also in agreement with the report of Webster et al. (1992) in cage-reared channel catfish and Wang et al. (1998) in hybrid sunfish. Similarly, the minimal affect of feeding frequency on SGR in the present study corroborates the findings of Carlos (1988), Jarboe and Grant (1996) and Dada et al. (2002).

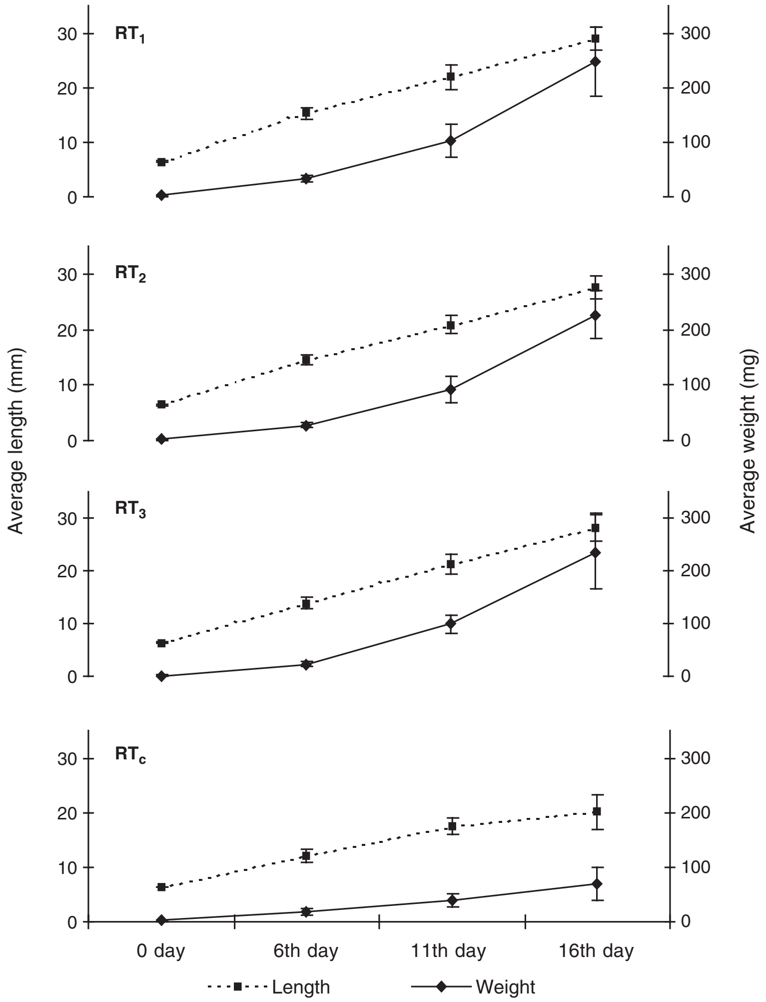

Fig. 2. Growth increment of rohu in treatments with different feeding frequency.

The nursery rearing practice of Indian major carps in India, Bangladesh and other parts of Asia, though commonly involves intermittent fertilisation resulting in sustained plankton production, the followed feeding frequency varies from one to three times per day. Our study on rohu and mrigala during nursery rearing in field condition revealed almost similar growth, survival and feed utilization irrespective of feeding frequency of the one, two or three times per day. The findings have practical significance in minimising the labour requirement in feed management during carp seed rearing. It is further inferred that one-time feeding may be sufficient in nursery where phase manuring is a common practice to augment plankton production.

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