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Effects of Water Depth on Growth Performance of Indian Major Carps at a Poly Culture System in Bangladesh

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Abstract

The main aim of this study was to assess the effects of water depth on the growth performance (length and weight) of table size Indian major carp (*Gibelion catla*, *Labeo rohita*, and *Cirrhinus mrigala*) fishes. Fishes were recorded under different depth (1.20 m, 1.80 m and 2.80 m) for about eight months from February 2016 to September 2016. Water depth was considered as treatment 1 (T_1) for 1.20 m, treatment 2 (T_2) for 1.80 m and treatment 3 (T_3) for 2.80 m, respectively. Randomized Complete Block Design (RCBD) with two replications of each treatment was differentiated at significant level 5%. Various water quality parameters such as water temperature, dissolve oxygen, transparency, and pH were also recorded. The survival rate was found maximum (99.23±0.4%) for *Labeo rohita* fish at 2.80 m water depth and lowest (95±2.1%) survival rate was observed for *Gibelion catla* fish at 1.20 m water depth. Results of this study showed that *Gibelion catla*, *Labeo rohita* and *Cirrhinus mrigala* fish cultivated at four feet depth of water produces lowest average weight of 1398 g, 1048 g and 1050 g, respectively with an average length of 47 cm, 49.2 cm and 46.4 cm, respectively.

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The maximum average weight of fish 3667 g, 2700 g and 2800 g were obtained at 2.80 m depth of water with the maximum average length of 63.2 cm, 60.0 cm and 58.6 cm for *Gibelion catla*, *Labeo rohita* and *Cirrhinus mrigala* fish, respectively. From this study, it can be observed that the fishes cultivated at low depth of water yielded lowest, and shorter in length in contrast to the carps cultivated at higher depth of pond water. However, the growth of *Gibelion catla* was notably high among other carps.

Keywords: Depth; Growth Performance; Indian Major Carps; Poly Culture System.

1. Introduction

Bangladesh is one of the resourceful countries in the South-East Asia where different types of fish species are cultivated for fulfilling high quality protein requirement. Carp fish is one of the most significant fish species for aquaculture all over the world and represent the species of choice due to its high growth rate, ease in reproduction, tolerance to environmental stress and its market demand. Though there are at least 265 freshwater fish species in the country [1]. But only 4 native and 12 exotic carp species are cultured in Bangladesh [2]. Usually, large carp including Rui (*Labeo rohita*), Mrigel (*Cirrhinus mrigala*), Catla (*Gibelion catla*), grass carp and silver carp are common aquaculture species in Bangladesh [3,4]. Fish naturally tend to select the habitat that is most suitable for their physiological requirements. This behavior is known as 'habitat selection' or 'environmental regulation' [5]. The optimum fish production is totally dependent on the physical, chemical and biological qualities of water to most of the extent. Hence, successful pond management requires an understanding of water quality. Water quality is determined by variables like temperature, transparency, turbidity, water color, carbon dioxide, pH, alkalinity, hardness, unionised ammonia, nitrite, nitrate, primary productivity, BOD (biological oxygen demand) and plankton population [6]. In addition to water quality ponds depth also significantly affect the growth rate and survival on fish cultivation [5]. Several researches have already carried out some researches regarding effect of water quality and depth of ponds on fish growth rate. The optimum pH range differs among species; however, the pH 6.5-9.0 range is generally accepted for fish culture [7]. The temperature at which the best growths of most carp for the tropical is 28-32°C [8]. According to Banerjea (1967) dissolve oxygen (DO) for the good production of fish should be above 5ppm [9]. Clerk (1986) reported that BOD range of 2 to 4 mgL^{-1} does not show pollution while levels beyond 5 mg L^{-1} are indicative of serious pollution [10]. According to Boyd and Lichtkoppler (1979), fishes are avoided free CO_2 levels as low as 5 mg L-1 , but most species can survive in waters containing up to 60 mgL^{-1} carbon dioxide, provided DO concentrations are high [11]. Ali and his colleagues (2013) pointed that the effect of water depth on Nile tilapia fingerlings and adults significantly affect the growth performance and survival rate [5]. However, the effect of pond depth on the growth of this three valuable carp fish has not yet been done so far. Therefore, this study was conducted to evaluate the effects of pond depth on the growth performance of Indian major carp's fishes (*Gibelion catla*, *Labeo rohita* and *Cirrhinus mrigala*).

2. Materials and Methods

2.1. Experimental site, experimental design and pond facilities

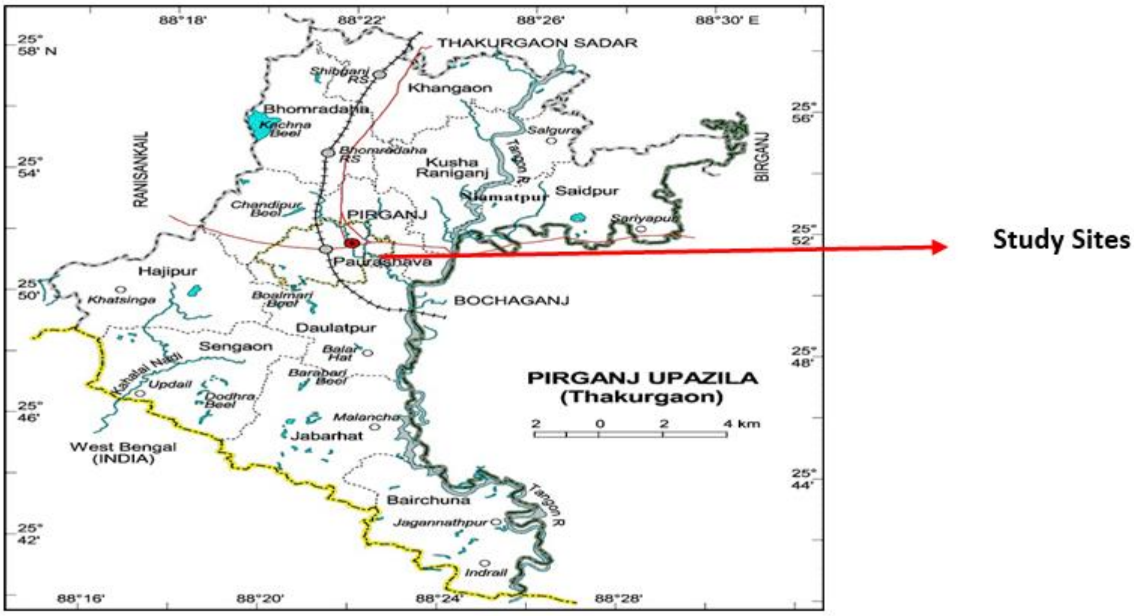

Figure 1: Experimental Location on the map of Thakurgaon Sadar Upazila of Thakurgaon District

The experiment was carried out for a period of eight months during 1st February to 30th September, 2016 in six different ponds located at Niamatpur, Thakurgaon (Figure 1). The experiment had 3 treatments with 2 replications for each. Water depth was considering as treatment (T1) for 1.20 m, treatment (T2) for 1.80 m, treatment (T3) for 2.8 m following randomized complete block design (RCBD). The ponds were rectangular in shape and the total surface area of these ponds was 650 decimals. Each pond had an inlet for watering but no outlet, free from aquatic vegetation, well-exposed to sunlight and sandy loam bottom. The stocked fish fed at morning and afternoon daily at the rate of 5% body weight with commercial pellet feed (30% crude protein) of name Nourish Poultry and Hatchery Ltd.

2.2. Pond preparation

Before starting the experiment, the ponds were dried and made free from aquatic vegetation. After drying, liming (CaO) was done in all the ponds at the rate of 250 kg/hectare. Ponds were then filled with ground water at required depth. Seven days after liming, Urea and triple super phosphate (TSP) were applied each at the rate of 39.0 and 37.0 kg/hectare, respectively. Seven days after fertilization, sumithion was applied in all the ponds at the rate 25 Liter/hectare.

2.3. Stocking

Experimental fishes were stocked in all ponds in the morning on 2nd February following the experimental design. Containers were kept floating in water about 30 min in the experimental ponds for acclimatization of temperature before releasing the carp fishes. The weight of approximately 10% of each species for each pond was measured and recorded for estimating initial stocking biomass as well as adjust feeding rate of fishes. Table 6 shows the stocking density in different ponds.

2.4. Post Stocking Management

Fertilization was done with Urea (50 kg/hectare) and TSP (25 kg/hectare) at fortnightly basis during the study period. TSP was dissolved in water for 24 hours before and Urea was dissolved in a bucket in the morning and then applied by spreading with a mug on the pond surface. Fertilization was done fortnightly.

2.5. Study of physico-chemical parameters of water

The physico-chemical parameters of pond water were recorded fortnightly throughout the experimental period between 10 A.M. and 12 A.M. Physical parameters such as; water temperature (°C), transparency (cm), and water depth (m), dissolved oxygen (mg/L) and pH were measured at the pond site on each sampling day. Depth of water of the experimental ponds was estimated with the help of a graduated wooden scale.

2.6. Growth parameters

The growth parameters like weight gain, specific growth rate and survival rate was calculated according to the following equation:

$$\text{Weight gain (g)} = \text{Mean final weight (g)} - \text{Mean initial weight (g)} \quad (1)$$

$$\text{Specific growth rate, SGR (\%)} = \frac{\ln W_2 - \ln W_1}{T} \times 100 \quad (2)$$

Where, InW2 – InW1 is the difference of logarithm of initial and final weight and Tis the duration of the experiment (days).

$$\text{Survival rate, } SR\ (\%) = \frac{\text{Final total number of fish}}{\text{Initial total number of fish}} \times 100 \quad (3)$$

2.7. Statistical analysis

The data were analyzed by Statistical Analysis System (SPSS Windows version 22). Treatment means were compared at $p<0.05$ according to the Duncan's New Multiple Range Test (DNMRT) and Least Significant Difference (LSD).

2.8. Approval

This experiment was performed under the Department of Fisheries Management in accordance with university rules and regulations. Approved and revised by the post graduate defence committee of Hajee Mohammad Danesh Science & Technology University, Dinajpur-5200, Bangladesh (approval and certified no. 914).

3. Results and Discussion

3.1. Analysis of physico-chemical parameters

The monthly values of water temperature throughout the experimental period are shown in Table 1. It was found that, between the temperature range of 18-30ºC, the growth of the fishes was high. This finding was concurred with Nazish and Mateen (2010) as they reported that the freshwater fish have an optimum growing temperature in the range of 25-30°C at which they grow quickly [12]. However, there was no significant difference in temperature of water in the month of April and May. In July lowest temperature was recorded at 18ºC while the highest temperature (30ºC) was noted in May. Similar findings in temperature of pond water were reported by Nwipie and his colleagues (2015), Kohinoor and his colleagues (2012) [13, 14].

Table 1: Monthly temperature variation (mean±SD) of pond water under different treatments. Different subscript alphabet indicates significant difference (p<0.05) among different temperature within same treatment

Month	Treatments		
	T_1	T_2	T_3
February	$22.30±0.2^{c}$	$21.50±0.5^{c}$	$20.00±1^{c}$
March	$25.93±0.06^{b}$	$24.63±0.6^{ab}$	$23.33±1.53^{b}$
April	$29.30±0.25^{a}$	$28.10±0.40^{a}$	$26.00±1.0^{a}$
May	$29.90±0.10^{a}$	$28.67±.30^{a}$	$27.33±.57^{a}$
June	$23.53±.50^{b}$	$22.53±0.42^{c}$	$20.67±.60^{b}$
July	$20.10±0.1^{c}$	$18.67±0.3^{c}$	$18.00±1.0^{b}$
August	$22.50±0.1^{c}$	$21.10±.36^{c}$	$19.00±1.0^{c}$
September	$27.77±0.20^{ab}$	$26.13±0.35^{b}$	$24.50±0.5^{c}$

The change of dissolved oxygen in pond at different depth of water is shown in Table 2. Low dissolve oxygen (5.4 ppm) was found in the month of February at T1 treatment while maximum dissolve Oxygen (9.07 ppm) was found in the month of July at T3 treatment. Similar findings were also reported by Bhatnagar and Singh (2010) that DO level greater than 5 ppm is essential to support good fish production [8].

Table 2: Monthly dissolved oxygen variations (mean±SD) of pond water under different treatments. Different subscript alphabet indicates significant difference (p<0.05) among different dissolved oxygen values within same treatment

Month	Treatments		
	T_1	T_2	T_3
February	$5.50±0.1^{c}$	$5.80±0.1^{b}$	$6.10±0.10^{b}$
March	$6.20±1.52^{b}$	$6.50±0.05^{b}$	$6.67±0.57^{b}$
April	$6.33±0.15^{b}$	$6.87±0.0.06^{b}$	$7.20±0.05^{a}$
May	$6.20±0.0.10^{b}$	$6.53±0.57^{b}$	$7.06±0.06^{a}$
June	$6.50±0.10^{b}$	$6.90±0.0.10^{b}$	$7.33±0.57^{a}$
July	$7.03±0.57^{a}$	$7.70±0.10^{a}$	$8.50±0.57^{a}$
August	$6.90±0.10^{a}$	$7.60±0.10^{a}$	$8.33±0.06^{a}$
September	$6.20±0.10^{c}$	$6.40±0.20^{b}$	$6.76±0.057^{b}$

The transparency values throughout the experiment were shown in Table 3. Low transparency (28.12 cm) was recorded at T3 treatment in February while high transparency (34.3 cm) was at T2 treatment in July. This result was in good agreement with Boyd (1982) that the transparency between 25 to 40 cm as appropriate for fish culture [15]. However, Azim and Wahab (2003) reported the transparency value as 36.2 cm in weed based carp polyculture pond [16].

Table 3: Monthly transparency variations (mean ± SD) of pond water under different treatments. Different subscript alphabet indicates significant difference ($p<0.05$) among different transparency within same treatment

Month	Treatments		
	T_1	T_2	T_3
February	28.13 ± 0.15^{c}	28.16 ± 0.05^{c}	27.97 ± 0.15^{c}
March	29.30 ± 0.10^{b}	29.33 ± 0.06^{b}	29.16 ± 0.15^{b}
April	29.10 ± 0.1^{b}	29.40 ± 0.1^{b}	29.20 ± 0.06^{b}
May	28.20 ± 0.10^{c}	28.06 ± 0.11^{c}	28.10 ± 0.1^{b}
June	29.96 ± 0.15^{b}	30.40 ± 0.10^{b}	30.20 ± 0.05^{a}
July	34.06 ± 0.12^{a}	34.20 ± 0.10^{a}	34.23 ± 0.05^{a}
August	32.50 ± 0.10^{a}	32.27 ± 0.05^{a}	32.76 ± 0.49^{a}
September	29.20 ± 0.1^{b}	29.96 ± 0.15^{b}	29.10 ± 0.10^{b}

The water pH was measured during the whole experiment was shown in Table 4. Analysis of the data revealed that within the same treatment the change of pH was not significant from February to May for all the treatment. The highest pH value (8.6) was recorded at T3 treatment in the month of February while the lowest pH value (6.7) was recorded at same treatment in the month of July. From the experiment, it was observed that the maximum growth of fish occurred at a pH range of 6.7 to 8.6. The similar observations have been made by Singh [17].

Table 4: Monthly pH variations (mean ± SD) of pond water under different treatments. Different subscript alphabet indicates significant difference ($p<0.05$) among different pH values within same treatment

Month	Treatments		
	T_1	T_2	T_3
February	8.43 ± 0.11^{a}	8.50 ± 0.1^{a}	8.50 ± 0.10^{a}
March	8.23 ± 0.06^{a}	8.23 ± 0.05^{a}	8.10 ± 0.10^{a}
April	8.40 ± 0.1^{a}	8.30 ± 0.10^{a}	8.20 ± 0.10^{a}
May	8.06 ± 0.06^{a}	7.90 ± 8.1^{a}	8.10 ± 0.10^{a}
June	8.17 ± 0.15^{a}	7.90 ± 0.10^{a}	7.70 ± 0.10^{ab}
July	7.60 ± 0.10^{b}	7.10 ± 0.10^{b}	6.60 ± 0.10^{c}
August	7.80 ± 0.10^{ab}	7.50 ± 0.10^{b}	6.67 ± 0.55^{c}
September	8.10 ± 0.10^{a}	8.00 ± 0.10^{a}	8.00 ± 0.12^{a}

3.2. Growth parameters

The survival rate of *Gibelion catla*, *Labeo rohita* and *Cirrhinus mrigala* fishes are presented in Figure 2, Figure 3, and Figure 4, respectively. It was found that the effect of water depth on survival rate was remained significant ($p<0.05$). At the end of experiment, the highest survival rate (99.23%) was observed in T3 followed by T2 (99.0%) and the lowest survival rate (95.0%) was recorded in T1 for Gibelion catla fishes in Figure 2.

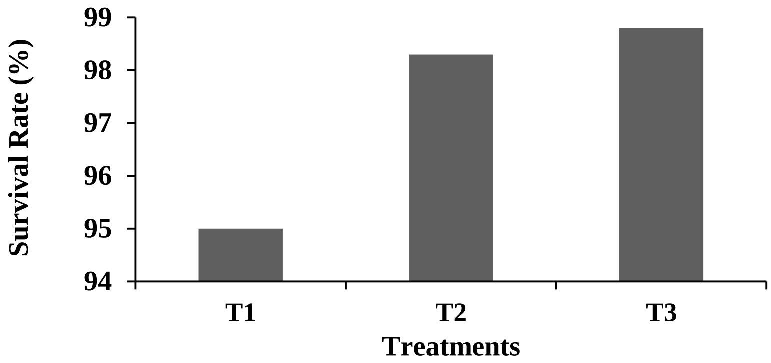

Figure 2: Survival rate of *Gibelion catla* fish at different water level

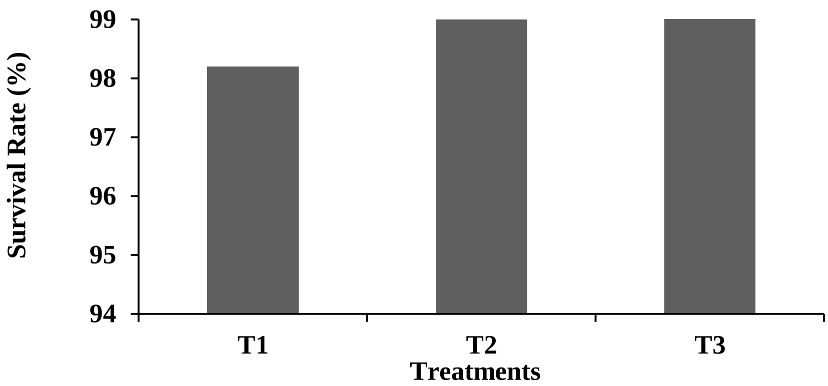

Figure 3: Survival rate of *Labeo rohita* fish at different water level

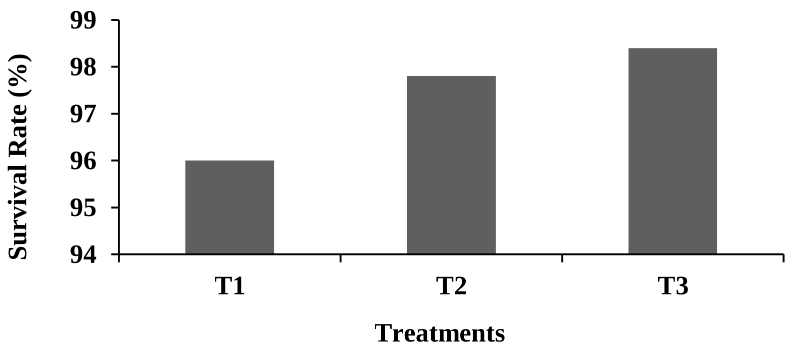

Figure 4: Survival rate of *Cirrhinus mrigala* fish at different water level

It was also observed that the survival rate was maximum at T3 and lowest at T1 as depicted in Figure 2. However, maximum survival (99.23%) rate was found for *Labeo rohita* fishes at T3 as shown in Figure 3. The survival rate of this present study was corresponding to Miah et. al.[18] and found the survival rate from 89.23-99.23% and similar findings were also reported by Mamun and Mahmud [19]. Specific growth rate of Gibelion catla, Labeo rohita and Cirrhinus mrigala fishes are presented in Figure 5, Figure 6 and Figure 7 respectively. It was found that the effect of water depth on specific growth rate was remained significant ($p<0.05$). The specific growth rate of *Gibelion catla*, *Labeo rohita* and *Cirrhinus mrigala* fishes in this experiment reveals that at the early stage of rearing the growth of fishes were high. The specific growth rate decreases at the end of the experiment for all the treatment (T1, T2 and T3). However, specific growth rate at T3 was higher while compare to the T1 and T2 for all carp fishes. Similar findings were also reported by Mamun and Mahmud [19].

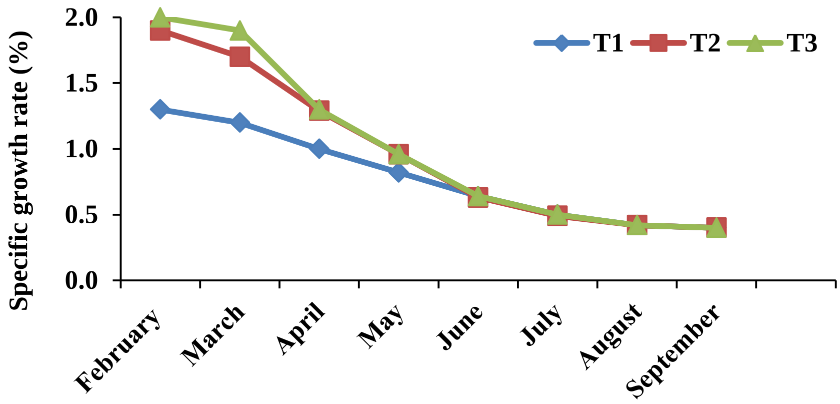

Figure 5: Monthly variations of specific growth rate of *Gibelion catla* fish

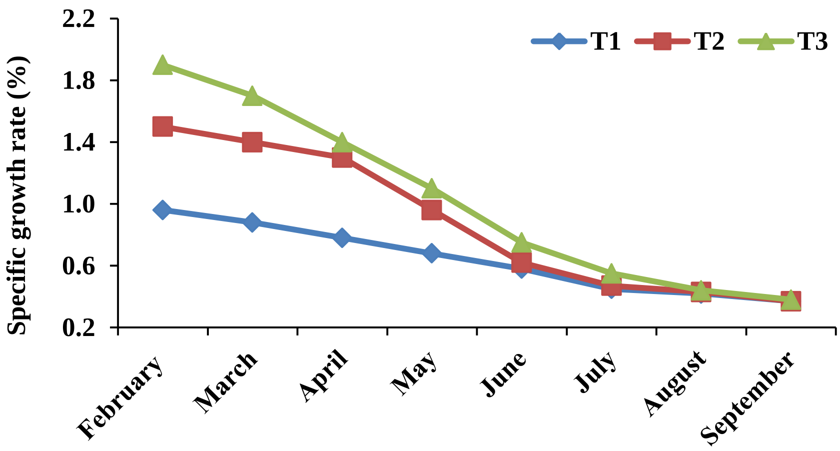

Figure 6: Monthly variations of specific growth rate of *Labeo rohita* fish

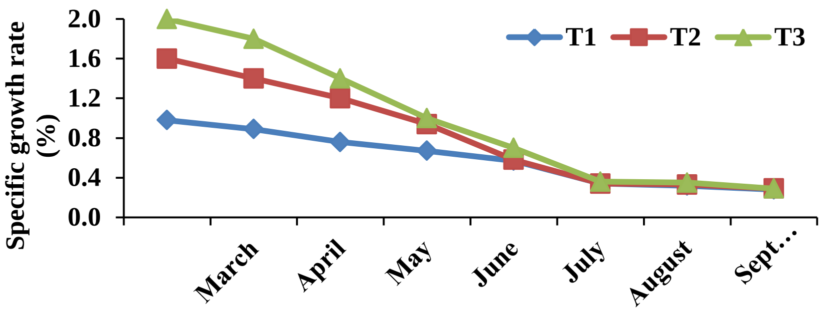

Figure 7: Monthly variations of specific growth rate of *Cirrhinus mrigala* fish

Average weight and length gain of *Gibelion catla*, *Labeo rohita* and *Cirrhinus mrigala* fishes are presented in Table 5. The individual average weight (2511±95.4 gm) gain was maximum for *Gibelion catla* fishes at T3 and minimum individual average weight (769±43 gm) gain was found for Cirrhinus mrigala fishes at T1 treatment.

Table 5: Growth performance of *Gibelion catla*, *Labeo rohita* and *Cirrhinus mrigala* fish (Mean±SD) in different treatments over the experimental periods. Different subscript alphabets indicate significant difference ($p<0.05$) among different species between each treatment

Species		Item	Treatments T_1	T_2	T_3
Gibelion catla	Initially	No. of fish (fish/hectare)	494±0	494±0	494±0
		Av. Individual weight of fish (gm/fish)	250±10	250±12	250±9
		Av. Individual total length of fish (cm/fish)	20±1.5	20±1.8	20±2.3
	Finally	No. of fish (fish/hectare)	469±0	484±0	485±0
		Av. Individual weight of fish (gm/fish)	979.50±80^{c}	1813.60±82.2^{b}	2511±1156^{a}
		Body weight gain (gm/fish)	729±78^{c}	1563.1±92^{b}	2260±1100^{a}
		Av. Individual total length of fish (cm/fish)	39.60±7.3^{c}	48.20±8^{b}	53.90±9.3^{a}
		Body length gain (cm/fish)	19.65±6.5^{c}	28.7±7^{b}	32±8.5^{a}
		Specific growth rate (%growth)	0.8±0.03^{b}	1.1±0.08^{a}	1.19±0.7^{a}
		Survival rate (%)	95±2.1^{ab}	98.3±3.2^{a}	98±0.8^{a}
Labeo rohita	Initially	No. of fish (fish/hectare)	1235±0	1235±0	1235±0
		Av. Individual weight of fish (gm/fish)	250±7	250±11	250±8
		Av. Individual total length of fish (cm/fish)	21±0.6	21±0.5	22±0.7
	Finally	No. of fish (fish/hectare)	1211±0	1216±0	1223±0
		Av. Individual weight of fish (gm/fish)	759.7±288^{c}	1307±558^{b}	1862.08±838^{a}
		Body weight gain (gm/fish)	508±92^{c}	1050±81^{b}	1621±732^{a}
		Av. Individual total length of fish (cm/fish)	39±6.2^{c}	46±7.4^{b}	50.54±9^{a}
		Body length gain (cm/fish)	17±0.41^{c}	23.8±6.8^{b}	28.50±7.1^{a}
		Specific growth rate (%growth)	0.63±0.04^{c}	0.9±0.008^{b}	1.12±0.1^{a}
		Survival rate (%)	98.2±0.3^{ab}	99.0±0.1^{a}	99.23±0.4^{a}
Cirrhinus mrigala	Initially	No. of fish (fish/hectare)	1235±0	1235±0	1235±0
		Av. Individual weight of fish (gm/fish)	250±9	250±11	250±10
		Av. Individual total length of fish (cm/fish)	21.40±0.5	20.80±0.8	22±0.2
	Finally	No. of fish (fish/hectare)	1186±0	1208±0	1215±0
		Av. Individual weight of fish (gm/fish)	759.70±273^{c}	1307.70±528^{b}	1862±793^{a}
		Body weight gain (gm/fish)	500.2±92^{c}	1058±52^{b}	1610±725^{a}
		Av. Individual total length of fish (cm/fish)	41±5.4^{c}	45.80±5.3^{b}	51.30±7.3^{a}
		Body length gain (cm/fish)	19.50±3.8^{c}	24±4.1^{b}	30.10±6.2^{a}
		Specific growth rate (%growth)	0.62±0.02^{b}	0.85±0.04^{a}	1.10±0.07^{a}
		Survival rate (%)	96.00±2.3^{b}	97.80±1.5^{a}	98.40±1.1^{a}

Analysis of the data also reveals that the individual average length gain was maximum (53.9±9.3 cm) for *Gibelion catla* fishes at T3 treatment and minimum (39±6.2 cm) individual average length gain was found for *Labeo rohita* fish at T1tratment (Table 5). The average specific growth was found maximum (1.12±0.1%) for Labeo rohita fishes at T3 treatment while lowest (0.62±0.02%) specific growth rate was found for *Cirrhinus mrigala* fish at T1 treatment. Analyzing of the data also reveals that survival rate of all table sizes carp fishes was found greater than 95%. However, the survival rate was found maximum (99.23±0.4%) for *Labeo rohita* fish at T3 treatment and lowest (95±2.1%) survival rate was found for *Gibelion catla* fishes at T1 treatment.

3.3. Effects of Water depth on the weight of Gibelion catla fish

Analysis of the data showed that the weight of Gibelion catla fish were significantly ($p<0.05$) affected by the single effect of water depth. It was observed that Gibelion catla fish cultivated on 2.80 m depth of water yielded higher fish weight while compare with the Gibelion catla fish cultivated at the lower water depth. Figure 8 showed that the mean weight of *Gibelion catla* fish increased linearly from 1.20 m to 1.80 m depth of water and from 1.80 m to 2.80 m depth of water mean weight of Gibelion catla fish decreased slightly as compared to 1.20 m to 1.8 m depth of water. Therefore, it was concluded that carp fish cultivated at higher water depth returned higher amount of fish weight in contrast to the fish cultivated at lower water depth. This result was in great concord with Ali and his colleagues who reported that the weight of Nile Tilapia is increased with the increase of water depth [5]. Similar findings were also reported by Stoll and his colleagues [20].

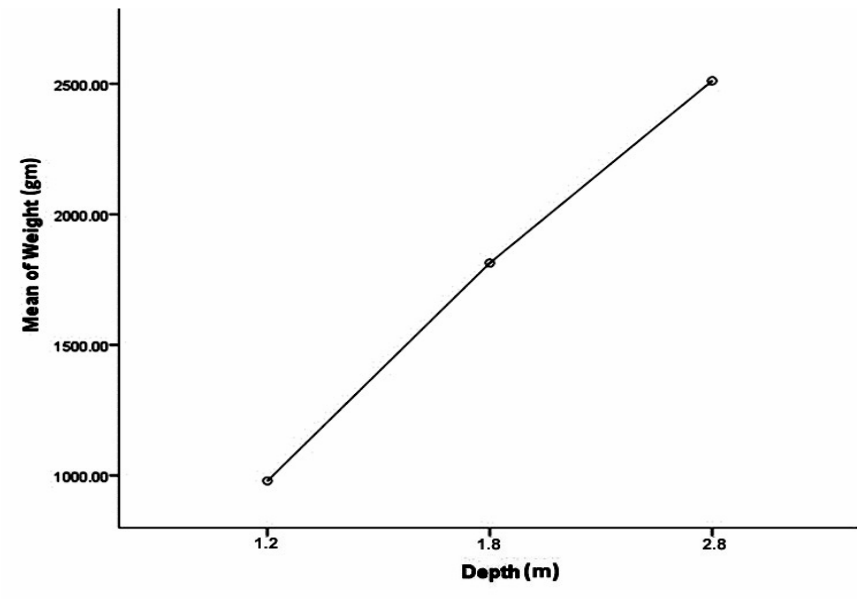

Figure 8: Weight of *Gibelion catla* fish at various water depths

3.4. Effects of Water depth on the length of Gibelion catla fish

The effects of water depth on the length of *Gibelion catla* fish found significant ($p<0.05$). The length of the *Gibelion catla* fish was found maximum when it was cultivated at 2.80 m depth of water and minimum was found while cultivation of fish was done at 1.20 m depth of water. Figure 9 exhibits that the length of *Gibelion* *catla* fish increased linearly from 1.20 m depth of water to 1.80 m depth of water but slightly decreased from 1.80 m to 2.80 m depth of water. Therefore, it was concluded that carp fish cultivated at higher depth (2.80 m) of water generates fish of larger in length while compare with carp fish cultivated at lower depth (1.20 m) of water yielded fish of smaller in length. The result was in agreement with Ali and his colleagues (2013) who reported that the length of Nile Tilapia is increased with the increase of water depth [5]. Similar observations were also Takash and Tadashi [21].

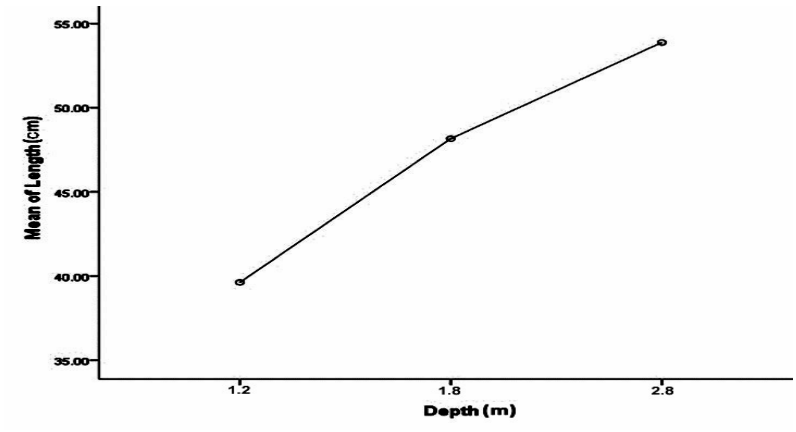

Figure 9: Length of *Gibelion catla* fish at various water depths

3.5. Effects of Water depth on the weight of Labeo rohita fish

Significant effect of water depth was observed in respect of weight (g) of Labeo rohita fish yield ($p<0.05$). It was observed that the weight of *Labeo rohita* fish was gradually increased with the increase of depth of water level. The highest weight of *Labeo rohita* fish was recorded when fish was cultivated at 2.80 m depth of water while lowest weight of *Labeo rohita* fish was recorded at 1.20 m depth of water. Figure 10 showed that the mean weight of *Labeo rohita* fish increased linearly from 1.20 m to 2.80 m depth of water. Therefore, it was concluded that carp fish cultivated at higher water depth (2.80 m) returned higher amount of fish weight in contrast to the fish cultivated at lower water depth (1.20 m). Similar findings were also pointed by Payne and his colleagues [22].

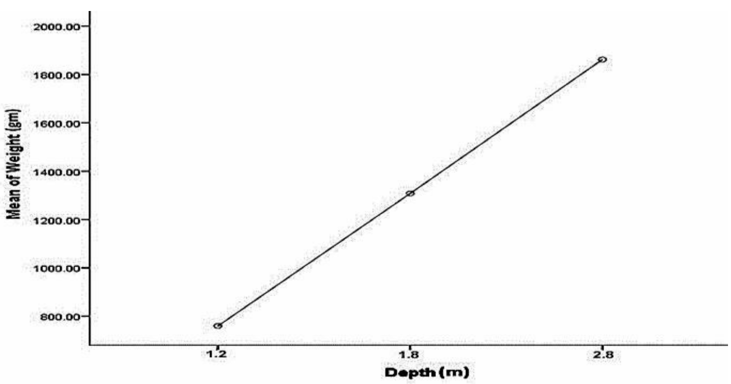

Figure 10: Weight of *Labeo rohita* fish at various water depths

3.6. Effects of Water depth on the length of Labeo rohita fish

Analysis of the data revealed that the depth of water significantly ($p<0.05$) affected the length of *Labeo rohita* fish. As the cultivation of fish was done at the low water depth, the length of the *Labeo rohita* fish yielded minimum value. Result showed that the Labeo rohita fish cultivated at 2.80 m depth of water yielded maximum mean length over the cultivation of *Labeo rohita* fish at 1.20 m. Figure 11 revealed that the length of *Gibelion catla* fish increased linearly from 1.20 m depth of water to 1.80 m depth of water but slightly decreased from 1.80 m to 2.80 m depth of water in contrast to 1.20 m to 1.80 m depth of water. Therefore, it was concluded that carp fish cultivated at higher depth (2.80 m) of water produced fish of larger in length while compare with carp fish cultivated at lower depth (1.20 m) of water. This result was full coincided with the reported values of Stoll and his colleagues that the depth of ponds should not be less than 100-200 cm for the maximum growth of tilapia fish [20].

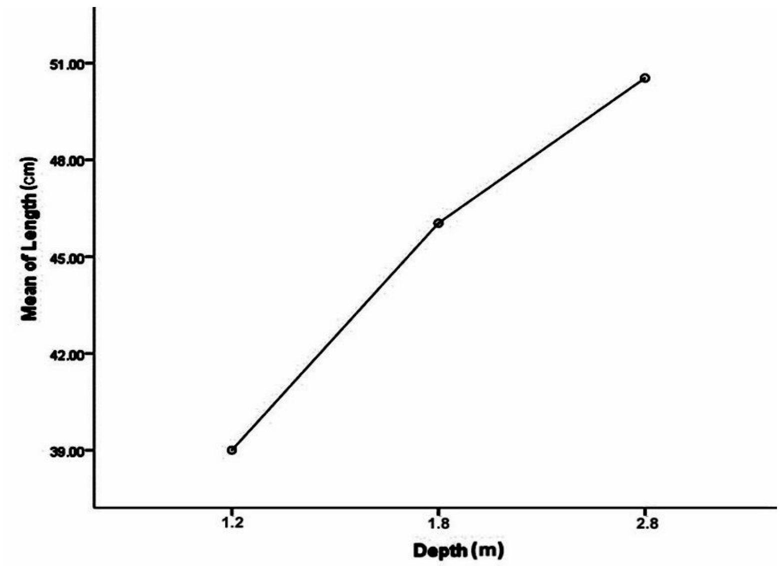

Figure 11: Length of *Labeo rohita* fish at various water depths

3.7. Effects of Water depth on the weight of Cirrhinus mrigala fish

Significant effect of water depth on the weight of Cirrhinus mrigala fish was observed ($p<0.05$). It was observed that the weight of Cirrhinus mrigala fish increased gradually as the depth of water increases. The highest weight (g) of *Cirrhinus mrigala* fish was noted when it was cultivated on pond with a constant 2.80 m depth of water and the lowest fish weight was recorded in correspond to the 1.20 m depth of water. Figure 12 showed that the mean weight of *Cirrhinus mrigala* fish increased linearly from 1.20 m to 2.80 m depth of water. Therefore, it was recommended that carp (*Cirrhinus mrigala*) fish cultivated at higher water depth (2.80 m) returned higher amount of fish weight in contrast to the carp fish cultivated at lower water depth (1.20 m). This result was in great concord with Ali and his colleagues (2013) who reported that the weight of Nile Tilapia is increased with the increase of water depth [5]. Similar conclusion was also reported by Takashi and Tadashi and Stoll and his colleagues [20,21].

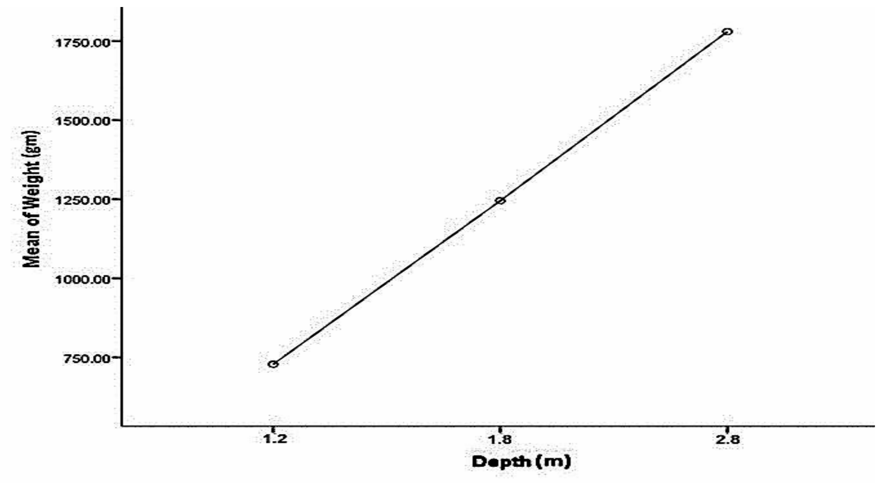

Figure 12: Weight of *Cirrhinus mrigala* fish at various water depths

3.8. Effects of Water depth on the length of Labeo rohita fish

The effect of water depth on the length of *Cirrhinus mrigala* fish found significant ($p<0.05$). The length of the *Cirrhinus mrigala* fish was found maximum when it was cultivated at 2.80 m depth of water and minimum was found while cultivation of paddy was done at 1.20 m depth of water. Figure 13 showed that the mean weight of *Cirrhinus mrigala* fish increased linearly 1.20 m to 2.80 m depth of water. Therefore, it was concluded that carp fish cultivated at higher depth (2.80 m) of water generates fish of larger in length while compare with carp fish cultivated at lower depth (1.20 m) of water yielded fish of smaller in length. The result was in full agreement with Ali and his colleagues (2013) who reported that the length of Nile Tilapia is increased with the increase of water depth [5]. Similar outcomes were also noted by Takashi and Tadashi and Stoll and his colleagues [20, 21].

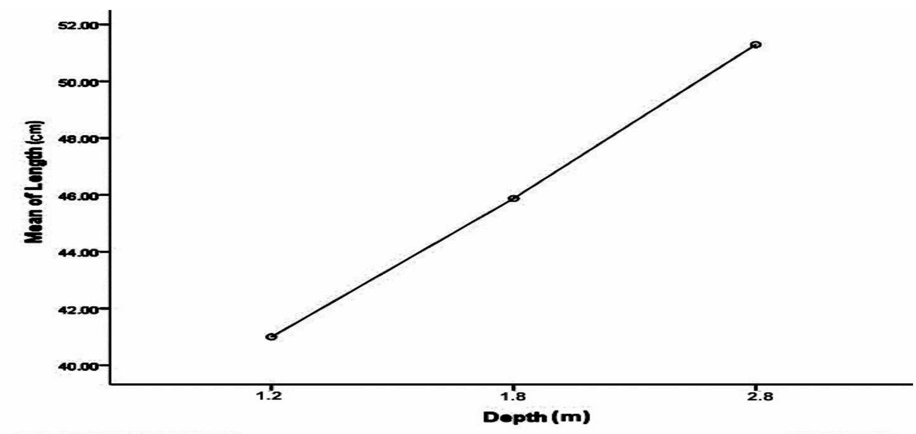

Figure 13: Length of *Cirrhinus mrigala* fish at various water depths

4. Recommendation

The outcome of this study suggests that the carp fish cultivated at 2.80 m depth of water will be beneficial and more economical for the farmer and more economy will be earned in compared to the 1.20 m and 2.80 m depth of water.

5. Conflicts of Interest

The authors declare no conflict of interest.

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