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Impact of physico-chemical parameters on growth of IMCS (in both length and weight) in a mixed culture system

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Abstract- The current world population demands rich source of protein in their dietary management day by day. Fish is one of the major aquatic animals that is enriched with digestive protein and cost benefit to buy. The fish culture is a lucrative venture in the current era. As fish is aquatic vertebrate so impact of water quality in relation to physico-chemical parameters play a major role in life of fish. The major physico-chemical parameters of water quality management are like pH, Temperature, DO, Total Hardness, Salinity, Ammonia, Turbidity etc plays major role in fish production. The optimal range of these parameters leads to the maximum production of edible fishes like IMCs. The present work focuses on the optimal ranges of certain major water quality parameters for IMCS (catla, rohu, mrigal) culture in cement tanks (Artificial system) by intensive method to promote the fish farmers and culturists to do more and more fish culture which will be economically healthy for them by improving their financial status. Finding of this study shows that the average ranges of the above parameters are pH=7.35, temperature=31-33°C, DO=5.86 mg/l, Salinity=0.26 ppt, Ammonia=0.02 mg/l, Total Hardness=163.12 mg/l & Transparency=35.125 cm were the best suited for the growth of the IMCs. The SGR of Catla, Rohu & Mrigal was 13.08%, 13.28% & 12.75% respectively in 45 days culture period. The total survival rate in this study is 80%.

Key words: IMCS, Intensive mixed culture, Water quality parameters, Growth performance, Cement tank.

INTRODUCTION

Aquaculture is one of the most vital criteria in the progress of economy of a nation. The production of livestock in Aquaculture is comparatively higher than in Agriculture. Now, at present the "Blue Revolution" plays very important role in the Agro-based cultivation. The main advantage of Aquaculture is that it gives more production in lesser area than Agriculture. So, Aquaculture should be practiced more and more in the near future for healthy economy growth of a nation.

Water plays the most vital role in aquaculture as it carries out the fisheries/fish culture in it. Fish has a sufficient protein providing aquatic animal that strengthens the public health and economic condition of a country. Fish carry out all its physiological activities like swimming, reproduction, feeding, excretion etc. throughout water. So, the increase in fish culture is totally dependable on water and its quantities. Water-qualities refer to all the physical, chemical and biological parameters. Physico-Chemical parameters contain pH, temperature, salinity, turbidity, hardness, BOD, DO, COD, ammonia that affects the fish growth in water. The fish sectors contribute in the national GDP, agricultural GDP and foreign exchange by exporting both fish and its by-products. Fish culture also helps in the improvement of the employment of the nation.

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All living organisms grows best in tolerable limits of water quality parameters in which they show optimal performance.[1] So, any changes in these parameters can lead to the failure of desirable health of fish. Due to increasing population, the fish culture should be enhanced more and more to meet the requirement of food supply as well as to improve the economy of farmers and fish cultivators. Poor water quality can result in low product quality, low profit and potential human health risks.

In India, there are many edible species among which IMCs being a Cash Crop always take the leading position in fish culture. As the IMCs are natural feeder (Plankton Feeder), they require less amount of artificial feed that helps the farmer not spending so much money for feeding the fishes. The physico-chemical parameters play very crucial role in the growth of IMCs. For example, Indian Major Carps (IMCs) grow more quickly at the temperature range of 28-35^{o}C and reach the sexual maturity at the age of 1.5-2 year.[2] The IMCs (Rohu, Catla & Mrigal) are the maximum edible fishes in Indian fish market and their cost ranges from Rs160-200/- per kg. So, IMCs' cultivation provides money both to its cultivators and sellers.

As the IMCs belong to different ecological niche, there is no competition for food among them. This helps the farmers to do their mixed cultivation in the same pond. As the population of India is increasing day by day, more cultivation of IMCs can meet the fish demand of India. IMCs can also be cultivated in smaller areas like tanks, as a result of which anyone can culture it. The proper growth of IMCs only depends on natural feed and Physico-Chemical parameters. But the Physico-Chemical parameters get changed several times because of the climatic changes in the aquatic environment. Any sudden/ drastic change in any parameter can lead to the death of fishes. So, it is very important for a IMCs cultivator to maintain the required amount of all the Physico-Chemical parameters in culture water.

Therefore, it is very important to study and maintain the effects of different types of Physico-Chemical parameters on the growth of IMCs in a mixed culture system for better commercial purpose.

MATERIALS & METHODS

1. STUDY AREA

Department of Fisheries Science, Centurion University of Technology and Management (CUTM) is situated in Paralakhemundi town in the district of Gajpati, Odisha having the co-ordinates 18.8069°N 84.1402°E on the north-east coast of India.

2. METHODOLOGY

At regular intervals of 3 days in 46 days (Dt.: 01/04/ 19-16/05/19) in the morning time, the water quality analysis was taken for the estimation of physico-chemical parameters of the water. Along with it, the measurement of both length & weight of IMCs (Catla, Rohu, Mrigal) were also taken at the same time.

The following water quality parameters were studied by the following methods:

1. Temperature= by Thermometer
2. pH=by Digital pH meter.
3. DO=using Standard Winkler Method by Titration.
4. Total Hardness= EDTA method
5. Transparency= Secchi Disk
6. Salinity=Normal Titration
7. Ammonia= By Ammonia Test Kit

3. EXPERIMENTAL BLUE PRINT

Cement tanks of 10×6×1.5 were selected for the intensive culture. A soil layer of 8 cm was given below the tank to avoid diseases and stress specially Argulosis. Ground water was used as the main water source for culture. There are 4 inlet plastic pipes and one large outlet source for water exchange.

4. STOCKING DENSITY

Stocking size= Fingerlings

Stocking rate= 3 sps. /m^2

So, total stocking= 3×60=180 sps.

Approximately 200 species were stocked.

Stocking rate= Catla: Rohu: Mrigal: 3:4:3

5. FEEDING

Total culture period= 50 days

Total sampling= 16 times

Sampling interval= 3 days

Table 1- Showing stocking density of IMCs

IMCS	STOCKING DENSITY
CATLA	60
ROHU	80
MRIGAL	60

The artificial feeds supplied to the Catla, Rohu and Mrigal were local made rice bran, mustard oil cakes and commercial floating feed (AVANTI COMPANY). The feeds were supplied in the required amount otherwise huge amount can also lead to the mortality of fingerlings. Feed waste and feed excreta were removed daily before feeding.[3]

Table 2- Showing feeding rate of IMCs

DAYS RANGE	PER BODY WEIGHT	AMOUNT OF FEED REQUIREMENT(g)/DAY
1-20	3%	650
21-40	2%	960
41-50	1%	600

6. FEED APPLICATION

Total amount of feed per day must be provided in morning and afternoon (or evening) time @ 50% total.

So, quantity of feed = 650/2= 325 gm (morning) & 325 gm (evening).

7. MEDICATION

i. After sampling, the species were treated under oxytetra cyclin solution as an antibiotic and stress-reliever.
ii. Disinfectant like $KMnO_4$ were used whenever required.
iii. Water exchange with fresh water supply=30%/day.
iv. Aeration was done regularly for sufficient oxygen supply.

8. GROWTH PARAMETERS

i. Mean Weight Gain (MWG) = W_f - W_i where W_i and W_f are initial and final body weights of fish (g) respectively.[4]
ii. Mean Length Gain (MLG) = L_2 - L_1 where L_2 and L_1 are final and initial body length of fish (cm) respectively.[5]
iii. Percentage Weight Gain (PWG) (%) = (Final Weight-Initial Weight) × 100/Initial Weight.[6]
iv. Percentage Length Gain (PLG) (%) = (Final Length-Initial Length) × 100/Initial Length.[6]
v. Specific Growth Rate (SGR) (%) = (lnw1-lnw0) x 100/Duration of experimental days, where w1 and w0 are final and initial body weights of fish (g) respectively and ln=natural logarithm.[7]
vi. Feed Conversion Ratio (FCR) = Feed intake by Fish (g)/Weight gain (g) where, weight gain=Final Weight-Initial weight.[4]
vii. Condition factor (K) = 100w/l3 where w and l are the observed total weight (g) and total length (cm) of a fish.[4]
viii. Survival rate (%) = no. of fish harvested/no. of fish stocked × 100.[5]
ix. Mortality (%) = no. of survival of fingerlings/no. of fingerlings stocked × 100

RESULTS

Economically fishes consider as a very important group of animals which provide a rich source of food, liver oil and a number of other by product like fish meal, fish manure, isin glass etc. The present work focuses on the optimal ranges of certain major water quality parameters for IMCS (catla, rohu, mrigal) culture in cement tanks (Artificial system) by intensive method to promote the fish farmers and culturists to do more and more fish culture which will be economically healthy for them by improving their financial status. Finding of this study shows that the average ranges of the above parameters are pH=7.35, temperature=31-33°C, DO=5.86 mg/l, Salinity=0.26 ppt, Ammonia=0.02 mg/l, Total Hardness=163.12 mg/l & Transparency=35.125 cm were the best suited for the growth of the IMCs. The SGR of Catla, Rohu & Mrigal was 13.08%, 13.28% & 12.75% respectively in 45 days culture period. The total survival rate in this study is 80%.

Table 3- Showing the range of different water quality parameters of culture water

Sl. No.	Sampling Date	Temperature °C	pH	DO mg/l	Salinity (ppt)	Ammonia mg/l	Total Hardness (mg/l.)	Transparency (cm.)
1.	1/4/19	29	6.9	6.7	0	0.0	110	42
2.	4/4/19	30	7.0	6.6	0	0.0	130	40
3.	7/4/19	30	7.0	6.5	0.1	0.0	150	40
4.	10/4/19	31	7.1	6.5	0.2	0.01	140	38
5.	13/4/19	32	7.2	6.4	0.1	0.01	140	35
6.	16/4/19	32	7.2	6.5	0.3	0.02	160	37
7.	19/4/19	30	7.0	6.4	0.5	0.02	180	35
8.	22/4/19	32	7.2	6.2	0.3	0.02	180	32
9.	25/4/19	33	7.4	6.0	0.4	0.03	160	30
10.	28/4/19	34	7.5	6.2	0.1	0.03	170	28
11.	1/5/19	33	7.4	5.9	0.2	0.04	180	32
12.	4/5/19	36	7.9	4.3	0.3	0.03	190	36
13.	7/5/19	35	7.7	5.8	0.5	0.03	190	34
14.	10/5/19	35	7.7	5.6	0.4	0.04	180	37
15.	13/5/19	35	7.7	5.5	0.4	0.04	170	33
16.	16/5/19	36	7.7	4.4	0.5	0.03	180	33
MEAN=		32.62°	7.35	5.86	0.26	0.02	163.125	35.125

Table 4- Showing growth (length & weight) of IMCS in mixed culture in cement tank

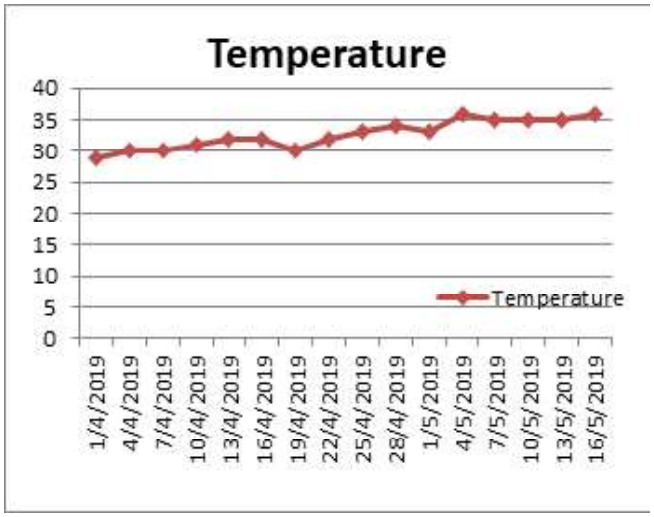
Sl. No.	Sampling Date	CATLA		ROHU		MRIGAL	
		Avg. Length (cm)	Avg. Weight (gm)	Avg. Length (cm)	Avg. Weight (gm)	Avg. Length (cm)	Avg. Weight (gm)
1.	1/4/19	10	75	8	80	6	60
2.	4/4/19	13	120	10	130	8.0	90
3.	7/4/19	17	160	12.5	170	9.5	110
4.	10/4/19	20	200	15.0	200	11.0	140
5.	13/4/19	22	230	17.0	227	13.0	160
6.	16/4/19	25	250	14.5	255	14.5	175
7.	19/4/19	27	270	22.0	280	16.0	185
8.	22/4/19	29.5	285	24.0	300	17.0	190
9.	25/4/19	31	300	25.5	330	18.0	195
10.	28/4/19	31.5	320	26.0	350	18.5	200
11.	1/5/19	32.0	335	26.5	365	19.0	210
12.	4/5/19	33	345	27.0	375	19.5	217
13.	7/5/19	33.5	350	27.25	383	20.0	225
14.	10/5/19	33.75	357	27.5	390	20.25	300
15.	13/5/19	34.0	362	28.0	395	20.5	305
16.	16/5/19	34.5	365	28.5	400	21.0	315
MEAN=		26.67	270.25	21.20	289.375	15.73	192.31

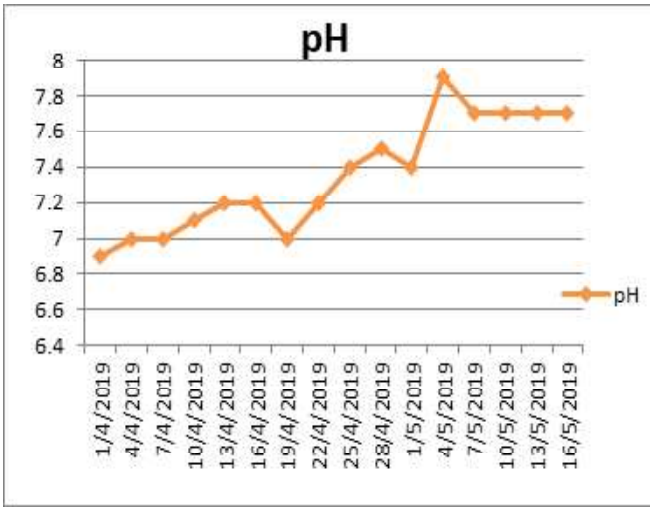
Table 5- Showing mean growth (length & weight) and percentage growth gain (length & weight)

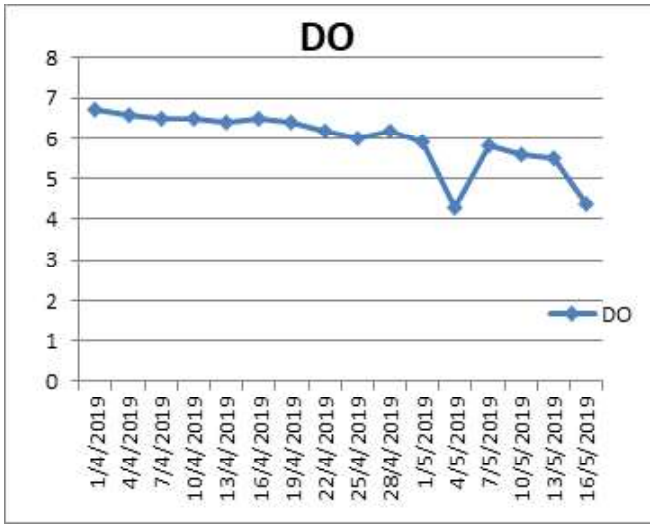
Sl. No.	Imcs	Avg.Initial Weight(G)	Avg.Final Weight(G)	Mean Weight Gain(G)	% Weight Gain (Pgw)	Avg. Initial Length (Cm)	Avg. Final Length (Cm)	Mean Length Gain(G)	% Length Gain (Plw)
1.	Catla	75	365	290	386.66	10	34.5	24.5	245.00
2.	Rohu	80	400	320	426.66	8	28.5	20.5	256.25
3.	Mrigal	60	315	255	340.00	6	21.0	15.0	250.00

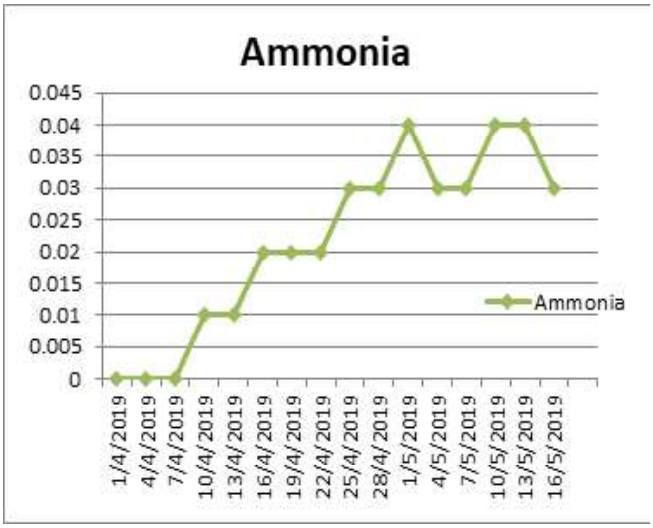
Table 6- Showing growth performance of IMCs in cement tank in mixed culture system

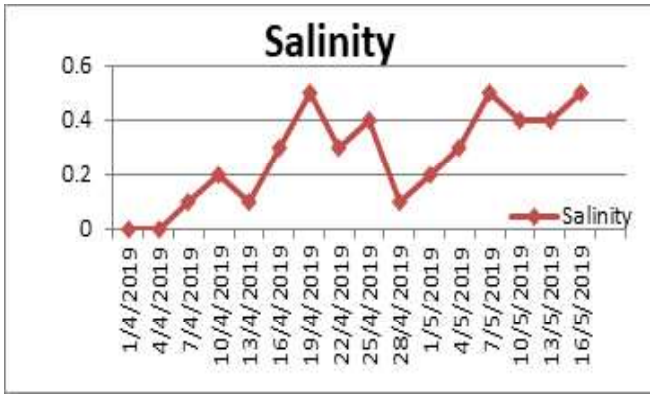
Sl. No.	Imcs	SGR (%)	Condition Factor (K)	Survival Rate (%)	No. of Survival	Mortality Rate (%)	No. of Mortality
1.	Catla	13.08	1.97	80	48	20	12
2.	Rohu	13.28	3.71		64		16
3.	Mrigala	12.75	7.55		48		12

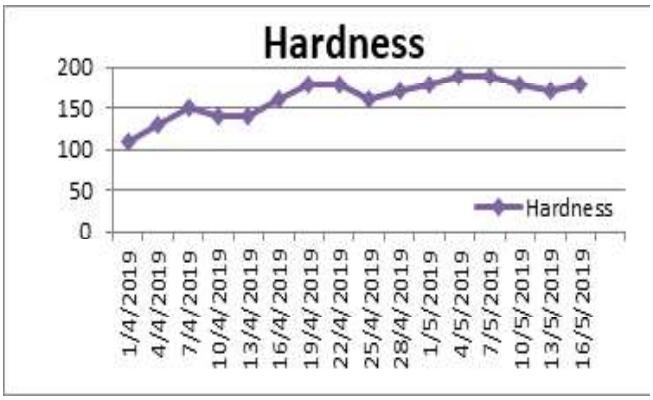


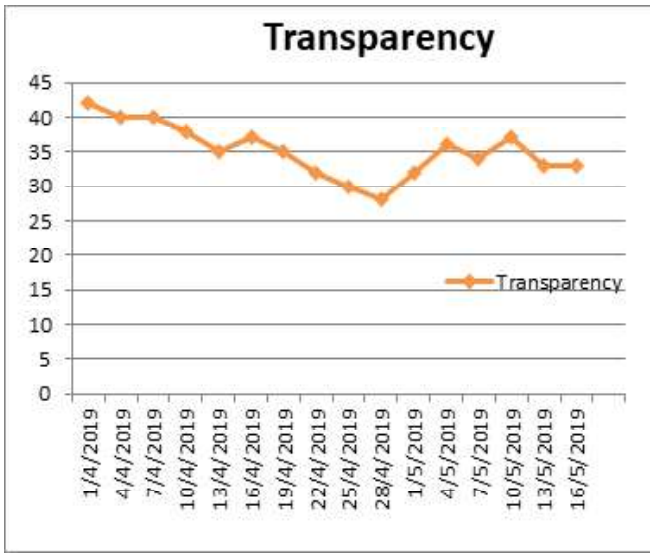


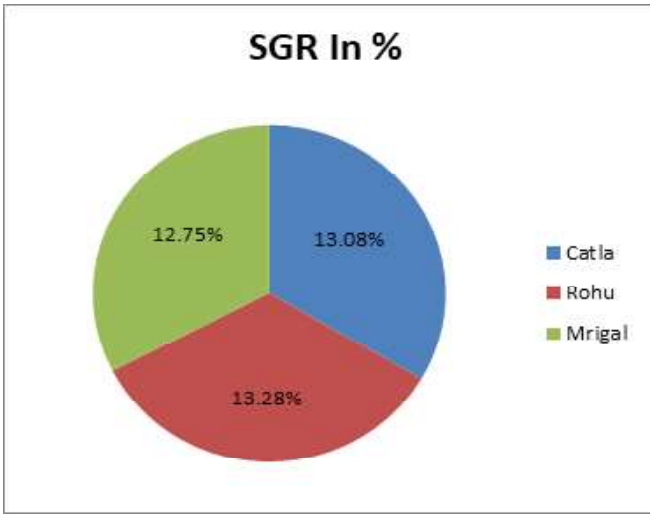












DISCUSSION

The initial weight of Catla, Rohu, Mrigal was 75gm, 80gm and 60gm, respectively and final weight was 365gm, 400gm and 315gm respectively.

Similarly, the initial length of Catla, Rohu & Mrigal was 10 cm, 8 cm, & 6 cm and the final length was also 34.5 cm, 28.5 cm & 21.0 cm respectively.

Verma and Mandal (2018)[5] reported a pH range in between 7.23-8.49. Rajkumar (2018)[8] stated that the pH ranged between 6.96-8.03 (average 7.47) was suitable for fish culture. According to Samad *et al.* (2017)[9], 7.07±0.22 is also suitable for fish pond. S. Samanta (CIFRI Manual) has noted that the productive water pH range is 6.5-9.0. The pH of the mixed culture tank was ranged from 6.9-7.9 which is totally in the favour of carp culture.

According to Premchand and Kiranmai (2017)[7], the water having DO in between 3.4-5.5 mg/L is moderately suitable for pisciculture. Bhoye *et al.* (2017)[3], stated that DO in between 4.24-4.43 (average) is less suitable for carp fingerlings. Verma and Mandal (2018)[5] showed that DO ranging between 5.0-6.2 was good for better productivity justifying our DO amount in tank water.

Supriya *et al.* (2016)[10], stated that IMCs can withstand salinity up to 10 ppt but for satisfactory growth salinity should not cross 5 ppt. Islam *et al.* (2014)[6] noted that the fish exhibited a normal response to treat between o-6% salinity level. At 8% salinity the fish showed moderate response. However, the good productivity of water should contain salinity<0.5 ppt. (CIFRI Manual). The range of salinity in our cultured tank was in between 0.0-0.5 ppt which is completely in favor of IMCs fingerlings growth.

Bhoye *et al.* (2017)[3] observed in experiment that the amount of Ammonia in water was in between 0.003-0.05 (average range). Kadhar *et al.* (2014)[1] showed that the Ammonia range can be 0.456-1.000 at 95% & 99% confident level respectively. In productive culture system, the nitrate content in Ammonia may go up to 2.5 ppm (CIFRI, Manual). The range of Ammonia in culture tank was ranging from 0.00-0.04 which was not toxic for IMCs culture.

According to Priyanka *et al.* (2018)[11], the IMCs perform maximum growth at 180 mg/L. Verma and Mandal (2018)[5], found ideal value of total hardness for IMCs fingerlings in mixed culture system in between 113.3-144.0 mg/L. S. Samant, (CIFRI Manual), stated that hardness is the measure of divalent basic cations(Ca & Mg mainly) in water. Ecosystem having moderately hard (62-120 mg/L) to hard (120-180 mg/L) water are productive. Yadav *et al.* (2017)[12] also showed the hardness can range from 170-198 mg/L. suitable for fish. The hardness level of water in mixed culture of IMCs was ranged from 110-190 mg/L in culture tank making the water completely suitable for fingerling survival and growth.

In the view of Verma and Mandal (2018)[5], the transparency of water in a culture system should be in between 16.0-72.3 cm. Samad *et al.* (2017)[9], in their experiment noted that the transparency of a good productive pond should be up to 40.83±1.34cm. In reservoir, the Secchi disk transparency is normally 100-150 cm while in the ponds it is 20-50 cm. (CIFRI Manual). So, the transparency of the mixed culture tank for IMCs fingerlings culture was ranged from 28-42 cm. This proves that the condition was completely suitable for the growth of fingerlings of IMCs in the mixed culture system in tank.

CONCLUSION

The present work shows that the physico-chemical parameters play very crucial role on IMCs growth (in both body length and weight). If we bring any sudden changes in the range of these parameters from their optimal value, it can lead to the mortality of cultured IMCs. This study also proves that farmers can also practice intensive culture of IMCs in their pond with high stocking density so that they will obtain maximum survival rate. So, they need to check all the water quality parameters mentioned above at regular interval for maximum yielding of IMCs.

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