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Observation of Water Quality Parameters on Induced Breeding of Bagrid Catfish in Bangladesh

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ABSTRACT

Induced breeding of Bagrid catfish, Mystus tengara, is not widely practiced in Bangladesh, and seed is not readily available. The study was conducted to identify the optimum range of water quality parameters to best induced breeding results in a hatchery in Pabna district, Bangladesh. Fish breeding and other related work have been done in the hatchery. The (mean ± SD) temperature, dissolved oxygen, and pH were ranged from 29.75±1.22°C to 33.94±0.18°C; 4.40±0.57 to 5.35±1.06 mg/l; and 7.10±0.14 to 7.40±0.28 in brood pond and 26.50±0.71oC to 31.00±1.41°C; 3.80±0.14 to 5.50±0.42; and 7.00±0.00 to 7.30±0.42 in overhead tank, respectively. The highest fertilization rate (80%) was observed in brood pond water at the 7th and 8th weeks at temperatures of 33.94±0.18° C and 32.00±1.07°C, as well as oxygen concentrations of 5.20±1.41 mg/l, 4.60±0.14 mg/l, and pH values 7.20±0.14, 7.20±0.00, respectively. In the 9th week of the experiment, the temperature, dissolved oxygen, and pH values of 28.00±1.41°C, 5.50±0.42 mg/l and 7.00±0.00, respectively, were shown to have the highest hatching rates. A strong positive correlation was found among dissolved oxygen, temperature, fertilization rate, and hatching rate. Particularly, the brood raising pond's water quality parameters showed a strong positive correlation with fertilization rate. On the other hand, water quality parameters of the overhead tank showed a strong positive correlation with hatching rate. This study will help hatchery technicians in comprehending the requirements for M. tengara species induced breeding in terms of water quality.

INTRODUCTION

Bagrid catfish belong to the family bagridae, which is under the Asian stripped dwarf catfish, a native and commercially important small indigenous fish species of Bangladesh (Mitu and Alam, 2016). Bagrid includes a lot of species all over the world. In Bangladesh, these are locally named after Tengra, shing and Magur, etc. People like bagrid catfish for their taste, enriched nutrients and availability throughout the whole year. Many vitamins and minerals are found in this species, such as sodium, potassium, calcium, iron, iodine, zinc, magnesium, and phosphorus (Hossain, 1999; Rao et al., 1999). Among Mystus sp., M. tengara is the most important native species of Bangladesh. But the main problem with bagrid catfish is the scarcity of seed in Bangladesh. Bagrid catfish have great potential if one could start producing seed (Wahab et al., 2003). Due to various factors like overexploitation, habitat destruction, and pollution, these species are facing a lot of threats. As a result, their numbers are decreasing day by day. Nowadays, these fish are costly because they are not available in the market. Induce breeding is not widely practiced in Bangladesh, though some hatcheries have begun in a limited number of locations. So, fruitful research is needed to develop good induced breeding techniques for M. tengara.

The factors which affect the fish health and activity in an aquaculture production system are water quality parameters. This means that we must specify the variables of water quality that are fundamental to culture. Fish rely on water to meet all of their demands on a daily basis. Different fish can survive themselves and reproduce at different levels of temperature, pH, oxygen concentration, salinity, hardness, and other water quality characteristics. Temperature is one of the most important breeding factors. Fish perform well during induced spawning procedures in water temperatures ranging from 26 to 28 degrees Celsius. Captive breeding of fish is the way through which we can protect any endangered wild species from being destroyed and make species available (Fleming, 1994). Earlier, a number of researchers have documented information on the feeding and breeding biology of Mystus sp. related to some information that was documented in previous reviews by some researchers, but till now, review reports are rarely found on the internet. So, with this in mind, this research has been planned to gather some information in order to induced breeding M. tengara. At the optimal DO level of fish habitat, the feeding rate was optimal (Boyd and Tucker, 1998). As a result, dissolved oxygen is important in fish breeding. Both alkaline and acidic conditions are lethargic to fish, such as pH 4, and pH 11, which is the death point of fish (Boyd, 1982). So, cell function and body activity also depend on pH. Finally, water quality parameters play a great role in fish breeding as fish totally depend on different water quality parameters. The breeding season for this catfish species starts in May and ends in September (Gupta and Banerjee, 2013).

The best month for the induced breeding of M. tengara will be identified in this research. As induced breeding of M. tengara is not practiced across a wide range, this species is going to be extinct in coming days. Research may help to conserve and protect this endangered species.

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From this point of view, this fish species is unique because it's a native species. From this sense of importance, this experiment carries a great value. So the motive of the research was to find the best optimum range of water quality parameters for induced breeding of bagrid catfish.

METHODS AND MATERIALS

Study side

The experiment was conducted at the renowned Tebunia BRAC Fish Hatchery in northern Bangladesh.

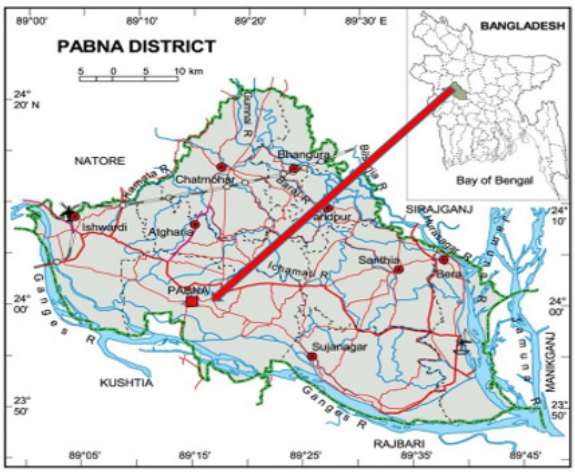

Figure 1: Map showing the study area

Brood fish rearing

Healthy and strong Bagrid catfish (Mystus tengara) were collected from challan beel through liaison with many farmers. All the broods were stocked in a pond which was prepared in a scientific way, such as by applying lime and fertilizer. The pond was dried before brood stocking. Broods were bought in November, 2020. All the fishes were reared in that for six months as we would try to understand the effect of water quality parameters on the induced breeding of M. tengara. These broods were one year old at the time of purchase. In April, when the experiment was started, the fish became 1.5 years old. Broods were provided with feed on a regular basis at an optimum level (1.5% of total body weight). The pH and dissolved oxygen of the brood rearing pond were measured 2 times a week, but the temperature was taken every day.

Brood collection from pond

On induced breeding date, mature male brood was identified by physically observing the slightly pointed genital papilla. On the other hand, mature females were identified by a swollen abdomen and squeezing slightly along the ventral side of the fish to come out of eggs.

Induced breeding Mystus tengara

A synthetic inducing agent (salmon gonadotrophin releasing hormone) was applied to the broods of both the male and female. The male was induced through injection after one of our female injections and was kept in the tanks. Before injecting the hormone, the weights of the brooders were taken and recorded. The female and male weights ranged from 50 to 90 grams and 40 to 70 grams, respectively. The same hormonal doses were used for the whole year for this experiment. The hormonal doses of female fish were 0.8 mg/kg body of fish, and it was 0.4 mg/kg body of fish for male fish. Hormone was applied to the fish's body through the pectoral fin during the evening time. After injection, the fish were released into marked tanks in 1:1 (male: female). Within 10–14 hours, all the females ovulated the eggs in the tank. A hapa was prepared by georgette cloth and set up in the bottom of a cemented rectangle tank to transfer the eggs after fertilization into the hatching jar. Fertilization rate and hatching rate were also measured by using the following formula:

i. Fertilization (%) = (No. of fertilized eggs*100)/Total number of eggs (Alam et al., 2006)

ii. Hatching (%) = (No. of hatchling*100)/No. of eggs in subsample (Islam et al., 2011)

Measurement of water quality parameters

As mentioned in the above section, temperature, pH, and dissolved oxygen were measured both in the brood rearing pond and overhead tank water. Temperature was monitored twice daily, whereas pH and dissolved oxygen were tested twice weekly, but two times (morning and afternoon) on a particular day. Additionally, up until hatching out, these water quality parameters were twice daily measured in the hatching jar.

Case summary of induced breeding of Mystus tengra

The fertilization rate (%) and hatching rate (%) were calculated in this experiment to find out the relationship of induced breeding M. tengara with water quality parameters. After the collection of eggs, 1 gram eggs were taken and separated to determine the number of fertilized and unfertilized eggs. The fertilization rate and hatching rate were calculated by using the formula mentioned earlier. A descriptive chart related to breeding activities of Mystus tengra is shown in tables 2 and 3.

Data analysis

The collected data were compiled, tabulated, and analyzed in the proper order before being statistically analyzed. The effects of water quality parameter data in inducing the breeding of Mystus tengara were correlated and ANOVA tested by using Microsoft Excel 10 and SPSS version 26.

RESULT

Water quality parameters

Three water quality parameters, such as temperature, pH, and DO, were considered in this experiment. The mean temperature varied from 29.75±1.22 to 33.94 ±0.18 °C in pond water and 26.50±0.71 to 31.00±1.41° C in overhead tank water, respectively. Mean dissolved oxygen varied from 4.40±0.57 to 5.35±1.06 in pond water and 3.80±0.14 to 5.50±0.42 in overhead tank water respectively. The

pH was also measured in the experiment. It varied from 7.10±0.14 to 7.40±0.28 in pond water and 7.00±0.00 to 7.30±0.42 in overhead tank water, respectively. Water quality parameters in the study were recorded to find out their relationship with inducing breeding and suggest the best water quality parameters to hatchery owners to increase their production. After getting the result, they can overcome the water quality parameters problems to increase production as per their requirements.

Fertilization rate

Table 1: Summery of average value of three water quality parameters (Temperature, pH and DO) both in pond and overhead tank water.

Months	week	Mean Temperature and std. deviation		Mean dissolve oxygen and std. deviation		Mean pH and std. deviation	
		Pond	Overhead tank	Pond	Overhead tank	Pond	Overhead tank
April	W1	29.75±1.22	26.50±0.71	4.60±0.85	4.30±0.14	7.20±0.28	7.00±0.00
	W2	30.14±0.48	27.00±1.41	5.00±1.13	4.50±0.14	7.20±0.00	7.10±0.14
	W3	31.19±1.25	28.00±1.41	5.25±1.06	4.50±0.14	7.20±0.00	7.20±0.28
	W4	32.14±1.84	28.00±1.41	4.90±1.27	4.20±0.14	7.30±0.14	7.20±0.00
May	W5	31.81±0.75	28.00±1.41	5.25±1.06	4.50±0.28	7.20±0.00	7.20±0.00
	W6	33.57±0.45	27.00±1.41	5.00±0.70	4.70±0.42	7.40±0.28	7.00±0.00
	W7	33.94±0.18	27.00±1.41	5.20±1.41	4.60±0.14	7.30±0.14	7.30±0.14
	W8	32.00±1.07	28.00±1.41	4.95±1.48	5.00±0.14	7.20±0.00	7.00±0.00
June	W9	31.31±0.59	28.00±1.41	4.90±0.57	5.50±0.42	7.20±0.00	7.00±0.00
	W10	30.29±0.39	28.00±1.41	5.35±1.06	5.20±0.28	7.30±0.14	7.10±0.14
	W11	30.94±0.98	28.00±1.41	5.30±1.27	5.20±0.28	7.40±0.28	7.10±0.14
	W12	31.07± 0.19	28.00±1.41	5.15±0.92	3.80±0.14	7.30±0.14	7.10±0.14
July	W13	32.00±0.27	29.00±1.41	4.60±0.57	4.00±0.14	7.20±0.28	7.00±0.00
	W14	31.64±0.24	29.50±0.71	4.90±0.14	3.80±0.42	7.20±0.00	7.30±0.42
	W15	32.19±0.65	30.00±1.41	4.65±0.21	4.00±0.14	7.20±0.00	7.20±0.00
	W16	31.56±0.56	31.00±1.41	4.40±0.57	4.00±0.14	7.10±0.14	7.00±0.00

The fertilization rate in this experiment was calculated in total over 16 weeks. It varied from 54 to 80%. The lowest was 54% during the first week because the male Mystus tengara was weak, while the temperature was 29.75±1.22°C and 26.50±0.71°C, DO was 4.60 ±0.85 mg/l and 4.30 ±0.14 mg/l, and pH was 7.20±0.28 and 7.00±0.00, in the pond water and overhead tank, respectively. Fertilization was highest at weeks 7 and 8, when the temperature, DO, and pH were 33.94±0.18°C and 27.00±1.41°C, 5.20 ±1.41 mg/l and 4.60 ±0.14 mg/l, 7.30±0.14 and 7.30±0.14, in pond water and overhead tank, respectively. But the highest number of eggs was found in weeks 9 and 10 (Table 2).

Hatching rate

The hatching rate was an important part of this experiment, and it was calculated in total over 16 weeks. The highest hatching rate was recorded at week 9 and that was 81.29% due to high dissolve oxygen (5.50±0.42 mg/l) in overhead tank water, which showed a strong positive correlation with hatching rate (Table 4) (Figure 2). On the other hand, the lowest hatching rate was 49.36% and was recorded on the week of the 14th due to low dissolved oxygen (3.80±0.42 mg/l) in the overhead tank. A spawn number was also calculated in this experiment. The highest number of spawn was found in week 9 and the lowest in week 1 (Table 2).

Relationship of temperature with fertilization rate

Table 2: Amount of eggs, total number of eggs from ten fishes in every week, amount of spawn from fertilized and number of total spawn.

Treatment (T)	Weeks	Wt. of fish (gm)	No of Female	Total weight of female (gm)	Amount of eggs (gm)	Total Number of eggs	Amount of spawn (gm)	Total number of spawn
April	W1	50-100	10	750	50	30000	17	9250
	W2	50-100			70	42000	26	15080
	W3	50-100			100	60000	40	24000
	W4	50-100			120	72000	55	30800
May	W5	50-100			120	72000	62	34100

	W6	50-100			150	90000	85	46750
	W7	50-100			200	120000	120	67200
	W8	50-100			200	120000	122	68930
June	W9	50-100			220	132000	145	80475
	W10	50-100			220	132000	140	78400
	W11	50-100			200	120000	128	70400
	W12	50-100			200	120000	115	63250
July	W13	50-100			200	120000	95	52250
	W14	50-100			200	120000	70	38500
	W15	50-100			150	90000	57	34200
	W16	50-100			100	60000	33	19800

Table 3: Summery of average value of three water quality parameters (Temperature, pH and DO) both in pond and overhead tank water.

Months	**week**	**Fertilization Rate (%)**	**Hatching rate**
April	W1	54	58.77
	W2	60	59.84
	W3	63	63.49
	W4	64	66.84
May	W5	70	67.65
	W6	76	68.35
	W7	80	70.00
	W8	80	71.80
June	W9	75	81.28
	W10	78	76.15
	W11	78	75.21
	W12	75	70.28
July	W13	70	62.20
	W14	65	49.36
	W15	60	63.33
	W16	55	60.00

(%) and hatching rate (%)

The relationship between temperature, fertilization rate, and hatching rate was calculated using arithmetic and logarithmic formulas. A positive correlation was found among pond temperature, fertilization rate, and hatching rate, and a negative correlation was found among tank water temperature, fertilization rate, and hatching rate (Table 4). Fertilization started to increase with the increase in pond water temperature and continued up to week 8, then it started to decrease again (Figure 1). The lowest fertilization rate was recorded in the first and last weeks.

The temperature reached 33.94°C in the pond, but the fertilization rate was in stable condition (Figure 1). The fertilization rate fluctuated with the fluctuation of the pond water temperature. The best fertilization rate (70-80%) in this experiment was identified in the 31-34° C range of temperature (Figure 1) and a strong positive correlation was found between pond water temperature and fertilization rate (Table 4). On the other hand, the overhead tank water temperature showed a different scenario. There was a negative correlation between the overhead tank water temperature and the hatching rate. Overhead tank water temperature was considered for hatching rate because tank water has a direct impact on hatching rate in the hatchery.

The hatching rate was lower at the beginning of the experiment because of the low temperature. Hatching rates have started to increase with the increase in temperature. It was the highest at 28°C (Figure 2). But the hatching rate started to decline again with the temperature increase (Figure 2). There was found to be a strong negative correlation between overhead tank water and hatching rate (Table 4). So, 28°C was the best temperature to get the highest hatching rate (70-81%) in this experiment. Fertilization rate and hatching rate had a positive correlation (Table 4) with each other at a 0.01 level of significance.

Relationship of Dissolved oxygen (DO), fertilization rate,

Table 4: Mutual correlation among temperature in overhead tank, fertilization rate, hatching rate, DO in overhead tank, DO in pond water, temperature in pond water, pH in pond water and pH in tank water

Correlations									
		Temp. (Pond)	**Fertilization Rate**	**Hatching rate**	**DO (pond)**	**DO (tank)**	**Temp. (Tank)**	**pH (Pond)**	**pH (pond)**
Temp. (Pond	Pearson Correlation	1	.388	.084	.006	-.087	.074	.274	.281
Fertilization Rate	Pearson Correlation	.388	1	.729**	.647**	.581*	-.325	.621*	-.006
Hatching rate	Pearson Correlation	.084	.729**	1	.495	.789**	-.309	.466	-.277
DO (pond)	Pearson Correlation	.006	.647**	.495	1	.488	-.504*	.594*	.404
DO (tank)	Pearson Correlation	-.087	.581*	.789**	.488	1	-.431	.341	-.289
Temp. (Tank)	Pearson Correlation	.074	-.325	-.309	-.504*	-.431	1	-.507*	.058
pH (Pond)	Pearson Correlation	.274	.621*	.466	.594*	.341	-.507*	1	.085
pH (pond)	Pearson Correlation	.281	-.006	-.277	.404	-.289	.058	.085	1

***. Correlation is significant at the 0.01 level (2-tailed).*

**. Correlation is significant at the 0.05 level (2-tailed).*

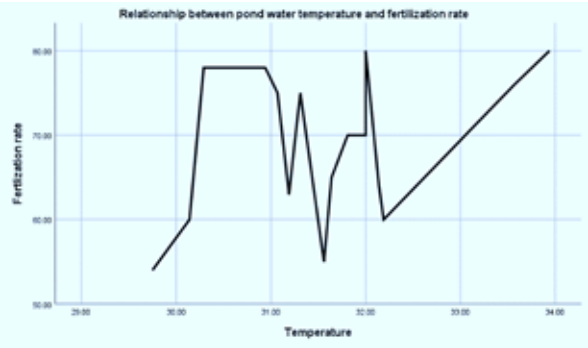

Figure 2: Relationship between temperature and Fertilization rate

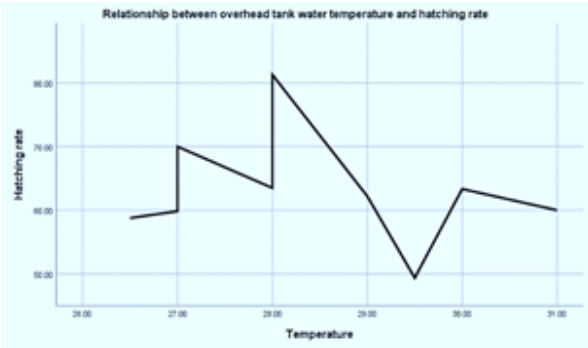

Figure 3: Relationship between temperature and Hatching rate.

and hatching rate

Dissolved oxygen is an important factor in inducing breeding. The data for the relationship among dissolved oxygen is in tables 01 and 03. Fertilization rate and hatching rate showed a strong positive correlation with dissolved oxygen. A strong positive correlation was found among pond water oxygen, tank water oxygen, and fertilization rate. This correlation of pond water dissolve oxygen with fertilization rate was significant at 0.01 level and 0.05 level. The fertilization rate was significant at the 0.05 level of significance, but the hatching rate was the highest on weeks 7 and 8, when the pond water oxygen level was around 5 mg/l, and the highest range of fertilization rate (70-80%) was recorded within 4-5.5 mg/l of dissolved oxygen in the pond. The fertilization rate was increased with the increase of dissolve oxygen (Figure 4), but it sometimes fluctuated with the fluctuation of water quality parameters because all the water quality parameters are mutually correlated. Dissolve oxygen from 4 mg/l to more than 5.5 mg/l was recorded as the optimum for the brood pond in this experiment. The relationship of hatching rate with dissolved oxygen in overhead tank water was clearly visible. The hatching rate started to increase with the increase of dissolved oxygen in tank water (Figure 5). The highest level of hatching rate (81.29%) was recorded in week 9 when the temperature and dissolve oxygen of overhead tank water for that week were 28°C and 5.5 mg/l. Although the temperature was optimal in week 14, the hatching rate was the lowest (49.36%) due to the lower amount of dissolve oxygen (3.8 mg/l) in that week. There was a strong correlation between hatching rate and dissolving oxygen (Table 4).

Relationship of pH, fertilization rate, and hatching rate

The pH of pond water showed a positive correlation with fertilization rate; on the other hand, the pH of tank water showed a negative correlation with hatching rate (Table 4). The fertilization rate was stable up to pH 7.20, and started to increase with the increase of pH. The

fertilization rate fluctuated with the increase of pH due to the fluctuation of water quality parameters (Figure 06). But the pH of tank water showed a different scenario. The hatching rate started to fall with an increase in pH (Figure 7). It was hard to understand the solo effect of pH on the induction of breeding of Mystus tengara, but it had a combined effect on the breeding system.

Relation of weeks and month in induced breeding

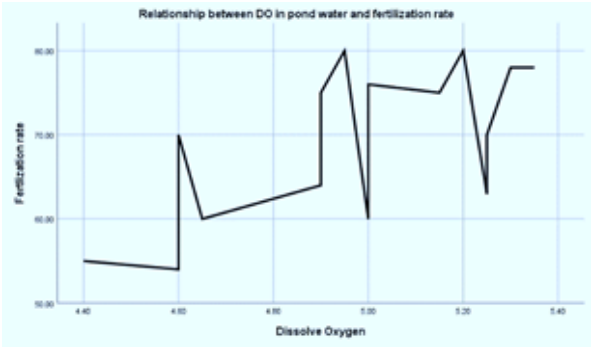

Figure 4: Relationship between DO in pond water and Fertilization rate

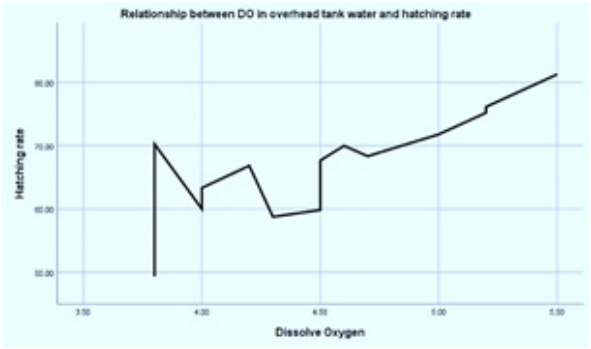

Figure 5: Relationship between DO in overhead tank water and Hatching rate.

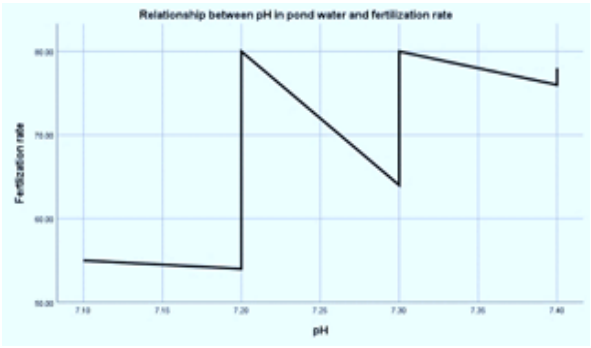

Figure 6: Relationship between pH in pond water and Fertilization rate

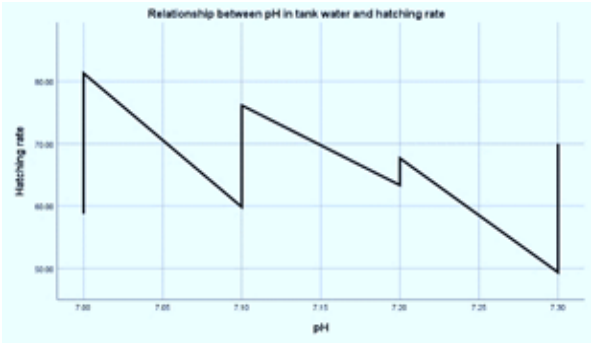

Figure 7: Relationship between pH in tank water and hatching rate

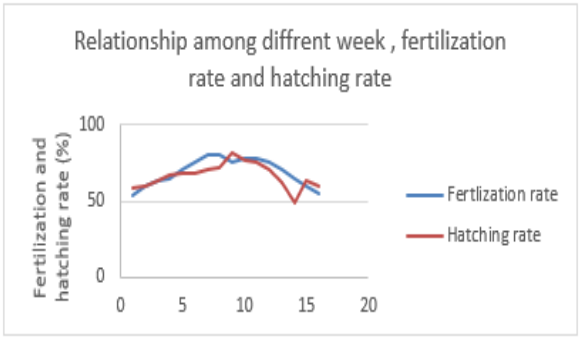

Figure 8: Relationship among week, fertilization rate and Hatching rate

and hatching rate, but May and June are the best times to induce breeding (Table 3, Figure 8).

DISCUSSION

There are few studies specifically on the effects of water quality parameters on induced breeding Mystus sp. Qasim & Qayyum (1962) recorded that June to September was the breeding season for Mystus cavasius. They also noted The hatching rate started to increase from the first week of April and continued up to the 9th week. The hatching rate started to fall after the 9th week, and it was good up to the 13th week. Considering the level of hatching rate in the middle of May to June, it was identified as the best time to get the productivity of Mystus tengara. However, April to July was identified as the breeding season of Mystus tengara based on their fertilization rate that July to August were spawning times for this species at Aligarh. A recent study recorded that mid-April to mid-July was the breeding time for Mystus tengara. On the other hand, Krishna Rao (2007) has identified June-July as spawning months for this fish species at Hemavathi reservoir, which is similar to the present study. In Bhadra reservoir, researchers found that the breeding period was February to July (Ashashree et al., 2013). According to Bhenila & Biswas (2014), the fertilization rate of Mystus Dibrugarensis was 34.83-77.54% at 27-29°C, while the fertilization rate of Mystus tengara was 56-80% at 26.5-31°C, which was mostly similar to the present findings. Water temperatures from 31 to 36°C (M. tengara), 30 to 32°C (M. cavasius), and 29.5 to 31°C (E. vacha) to get optimum spawning rate reported by Sarkar et al. (2019). The study denoted that 29-34°C temperature was identified as the optimum range for induced breeding. Ali et al. (2021) reported that the maximum fertilization rate was 83.66% and the hatching rate was 80.0 percent, which is mostly similar to this experiment where the fertilization rate was 80% and the hatching rate was recorded at 81%. This experiment was designed and performed to

generate some information on the effect of water quality parameters on the induced breeding of Mystus tengara. Salmon gonadotrophin releasing hormone was used in this experiment.

CONCLUSION

The results of the current research add to the understanding of how water quality conditions affect Mystus tengara's induced breeding. This investigation's list of water quality parameters will be useful to the hatchery's owner and technician. All of the metrics were recorded under outdoor circumstances. This experiment will clearly make the evident of water quality requirements for hatchery operations and brood management Mystus tengara.

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