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EFFECTS OF SPAWNING MONTH AND POND PROTECTION ON REPRODUCTIVE PERFORMANCE OF NILE TILAPIA, *OREOCHROMIS NILOTICUS*

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SUMMARY

The present experiment aimed to study the effect of spawning month (January and February for broodstock and February, March, April and May for fry production) and protection method (uncovered without heater tanks, cover without heater and cover with heater tanks) on reproductive performance of Nile tilapia, *Oreochromis niloticus* broodstock. The obtained results indicated that, average body weight and length of the spawning females did not significantly differ for the two groups uncovered without heater and covered without heater while the differences between each of these two groups and the third group (cover with heater) were significant. The average ovary weight for spawning females significantly affected by spawning month. Covered and uncovered tanks without water heating did not significantly affect ovary weight of spawning females *O. niloticus* while ovary weight of the third female group (cover with heater) significantly increased the ovary weight of spawning females.

Gonado Somatic Index (GSI) significantly varied from 0.85 (January) to 0.93 (February) and 1.41 (March). Uncovered tanks showed the lowest value (0.69) of GSI while covering of spawning tanks and supplying tanks with electrical heaters increased the GSI. Spawning month and protection method had a significant effect on GSI. Covering of spawning tanks increased absolute fecundity and supplying the covered spawning tanks by electrical heaters significantly increased absolute fecundity. Neither spawning month nor protection method had significant effect on relative fecundity.

During the second spawning month (March) there were no fry in the uncovered tanks while fry production/tank found to be 4475 in covered tanks and supplying covered tanks with electrical heaters increased fry production to 13215/tank and the same trend was also observed during the other spawning months (April and May).

Average fry weight found to be 0.0087, 0.0087, 0.0140 and 0.0150 g for the spawning months studied, February, March, April and May, respectively and the average fry weight found to be 0.0078, 0.0108 and 0.0165 g for the uncovered, covered and covered with heater groups, respectively and the differences in individual fry weight due to the effect of protection method were significant.

INTRODUCTION

Large variations within and between the strains of tilapia have been reported for age at first maturity, fecundity **(Rana, 1986)** and frequency of spawning (**Macintosh and Little, 1995)**. Various factors, namely, genetic **(Uraiwan, 1988)**, environmental (**Duponchelle *et al.,* 1997**) and management techniques **(Bevis, 1994)** affect the performance of Nile tilapia broodfish. **(Gunasekera *et al.,* 1996)** found that, in tanks with semi-purified isocaloric diets, *O. niloticus* females fed with 35% protein diet produced eggs with significantly higher protein than females fed with 10% and 20% protein diets and females fed 20% and 35% diets produced more number of eggs per spawning than those on 10% protein diet.

Wee and Tuan (1988) conducted a more elaborate study in concrete tanks with re-circulated water system. The protein levels used in the experiment were increased from 20% to 50% at increments of 7.5%. They reported that the optimum dietary protein level for spawning *O. niloticus* was 35%. Broodstock fed with the diet containing 20% protein, spawned only after 58 days, whereas other groups fed with diets containing medium and higher protein levels 27.5, 35, 42.5 and 50% spawned earlier <49 days. Moreover, the absolute and relative fecundities were found to be significantly higher in the fish fed the medium dietary protein (27.6 and 35%) than those fed with higher protein levels (42.6 and 50.1%), as high protein diets produced heavier and larger eggs at longer spawning intervals, i.e., lower spawning frequency.

O. niloticus and *O. mossambicus* can tolerate a wide range of temperatures: 8 - 42°C, but feed less below 20°C. They cease feeding below 16°C and death occurs below 12°C. Suitable temperatures for reproduction are above 20°C **(Popma and Lovshin, 1996)**. In *O. niloticus*, although short-term 6–24 h cool temperature treatment (22±1.5°C) induced spawning of 10–20% more females than in control treatments after 7 days, the same temperature held for longer periods resulted in complete re-absorption of oocytes **(Srisakultiew and Wee, 1988)**. **Popma and Lovshin (1996)** noticed that, no spawning was reported at 22°C in *O. mossambicus* and an increase in temperature from 25°C to 28 or 31°C increased seed production. However, reproduction in tilapia generally slows at 21– 24°C and increases in frequency above 25°C up to 30°C. Broodstock can be over-wintered at 15–17°C at high density i.e., 50 kg m^{-3}, to suppress spawning and aggressive behavior and this does not affect reproductive performance when the fish are re-stocked into ponds. In addition, this might be one of the suitable ways to improve spawning synchrony and to meet seasonal market demand for seed; however, maintenance of such a low temperature in tropical countries might not be cost effective. Reproductive performance at temperatures higher than 35°C, which can occur in the afternoon during the dry season in the tropics, has been found to be very poor **(Bevis, 1994)**. It seems that temperature and the exposure time to certain temperatures have significant relationships with broodfish productivity and the viability of eggs/fry.

MATERIALS AND METHODS

The practical work of the study was conducted at the hatchery unit at the experimental station of the WorldFish Center, Abbassa, Abou Hammad, Sharkia during the period from 1 January, 2005 until 31 May 2005. A total number of three hundred and eighty four (384) *O. niloticus* broodfish with an average body weight of 207 ± 23g were used in the experiment. Two hundreds and eighty eight (288) females and ninety six (96) males were used representing a sex ratio of three females for each male (3:1 ratio). Broodfish were distributed among twelve concrete tanks at the rate of 24 females and 8 males for each tank. All tanks were of equal surface area of 12 m^2 each and all tanks were filled with filtered canal water to maintain a water depth of seventy (70) cm and supplied compressed air through air diffusers to assure maintaining near optimum dissolved oxygen levels in the tank water.

Tanks were divided into three groups (four tanks each groups) representing one of three experimental treatments. The first group of tanks was just the ordinary tanks without any plastic cover or heating units and exposed to the ambient air temperature. The second group of tanks were covered with plastic sheets (2 mm thickness) extended over a metallic frame of arched iron bars similar to those used in agricultural greenhouses. The third group of tanks were also covered with plastic sheets (as the second group) but each of the four tanks in this group was supplied with a heating unit consisting of four heaters (1200 watts-each) fixed in an aluminum tray to keep them from sinking into the water. These heating units were set to maintain an average water temperature of 25±2°C by adjusting their thermostat controllers.

Fish in all groups were fed at the rate of 3% of their total body weight twice a day at 10:00 am and 2:00 pm six days a week. The experimental feed was formulated to contain 25% crude protein (Table 1) and manufactured at the feed manufacturing unit at the WorldFish Center facilities at Abbassa. During the experimental period continuous periodical monitoring and recording of the main water quality parameters such as ammonia, nitrate, nitrite and pH using Hack kits took place. Daily records of water temperatures were collected and recorded in all uncovered and covered tanks (Table 2).

Two broodfish from each tank were collected to check the fish general conditions and the developmental stage of their ovaries every month. Total weight and total body length were measured and recorded. Fish samples were also cut open and ovaries were removed and weighed to estimate the Gonadosomatic indices (GSI) for the different treatments and observe the developmental stage of their gonads through microscopic examination. These were done as follows:

1- Gonado Somatic Index (GSI) = [weight of ovary (g) / female body weight (g)] × 100

2- Developmental stage of the ovary from the egg diameter and determination of the dominant stage of ova through histological examination.

3- Number of eggs was estimated in one gram sample of the ovaries and used to calculate the absolute and relative fecundity according to **Bhujel (2000)** as Follow:

Absolute fecundity=Total weight of eggs per female (gm)×number of eggs in one (gm).

Relative fecundity = Absolute Fecundity / female body weight (g)

All tanks were checked daily to look for any presence of newly hatching tilapia fry and once any fry were seen in any of the tanks a collection process of the fry from the tanks was done by pulling a net through the tank from one end to the other. The net was made of soft materials and had a small mesh size that was small enough to collect all the fish and fry present in the tank. Once the fish were collected in the net, all broodfish were checked inside the tank for any eggs or fry being incubated in the mother's mouth and if any eggs or fry were present, those were collected and transferred to collection containers to be counted and recorded. Checked broodfish were held in a separate hapa until the fry collection process ended in the tank and the tank was completely cleaned of any sediments and wastes and refilled with clean water then broodfish were counted and returned back to their tank. This routine fry collection process took place once every two weeks even if no free swimming fry were observed in the tanks just to assure timely collection and recording of any spawning activity took place.

Table (1): Formulation and proximate analysis of the first experiment.

Ingredients	Experimental diets	
	25% crude protein	35% crude protein
Fish meal (72.0% CP)	6.0	13.0
Soy bean meal (48% CP)	26.0	49.0
Yellow corn	30	24
Wheat flour	5.0	5
Wheat bran	27.0	5
Vegetable oil	3.0	2
Cod liver oil	2.0	1
Dicalcium phosphate	0.87	0.87
[1]Vitamine and mineral mixture	0.10	0.10
Vitamine C	0.03	0.03
Sum	100	100
Proximate analysis (based on dry matter)		
Protein%	25.36	35.06
[2]ME (kcal/Kg)	2701.2	2771.4

P/E ratio (mg/kcal)	93.85	126.49

[1] Each Kg vitamin & mineral mixture premix contained Vitamin D_3, 0.8 million IU; A, 4.8 million IU; E, 4 g; K, 0.8 g; B_1, 0.4 g; Riboflavin, 1.6 g; B_6, 0.6 g, B_{12}, 4 mg; Pantothenic acid, 4 g; Nicotinic acid, 8 g; Folic acid, 0.4 g Biotin,20 mg , Mn, 22 g; Zn, 22 g; Fe, 12 g; Cu, 4 g; I, 0.4 g, Selenium, 0.4 g and Co, 4.8 mg,

[2] Estimated based on values of the diet ingredients (**NRC, 1993)**

Table (2): Water quality parameters in concrete tanks, covered and uncovered in the period from January to May 2005 (Second experiment)

Spawning month	Treatment	Water quality parameters			
		Temp.(°C)	pH	DO (Mg/l)	NH_3 (Mg/l)
January	T1	12.20	8.4	6.1	0.04
	T2	15.60	8.5	5.8	0.09
	T3	23.20	8.6	5.4	0.18
February	T1	15.80	8.1	8.9	0.04
	T2	20.70	8.2	5.8	0.08
	T3	27.60	8.4	5.6	0.14
March	T1	22.10	8.2	5.6	0.04
	T2	24.20	8.2	5.2	0.04
	T3	27.50	8.4	4.9	0.16
April	T1	24.10	8.4	5.8	0.08
	T2	24.60	8.6	5.4	0.16
	T3	27.80	8.6	4.8	0.22
May	T1	24.40	8.4	5.6	0.08
	T2	26.20	8.4	5.6	0.10
	T3	28.40	8.6	5.2	0.20

T1 Uncovered tanks, T2 Covered tanks without heaters and T3 Covered tanks with electrical heaters

Statistical analysis:

Statistical analysis of the obtained data was analyzed according to **SAS (1996).** Differences between means were tested for significance according to Duncan's multiple rang test as described by **Duncan (1955).** The following model was used to analyze the obtained data: $X_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + e_{ijk}$

Where X_{ijk}=The lth observation for the ith spawning month and jth protection regeme, μ=Overall mean, α_i=The effect of ith spawning month, β_j=The effect of jth protection regeme, $(\alpha\beta)_{ij}$=The effect of interaction between ith spawning month and jth protection regeme and e_{ijk}=random error assumed to be independently and randomly distributed (0, δ^2 e).

RESULTS AND DISCUSSION

1. Effect of Month, and tank protection on growth of Nile tilapia broodstock:

As described in table (3) the highest BW and BL were recorded for spawning females during March with significant (P<0.001) differences due to the effect of spawning month on BW and BL. The same table also indicated that, BW and BL of spawning females did not significantly differ for the two groups uncovered without heater and cover without heater while the differences between each of these two groups and the third group (cover with heater) were significant (P<0.01). The interaction between the two factors (month of spawning and protection method) indicated that the heavier and longest spawning females were recorded in March especially when electrical heaters were used for adjusting water temperature. However, the differences between BW and BL due to the interaction between these two factors were non-significant.

Size of female is more important than age in terms of fecundity and total number of eggs produced. Number of eggs produced is related to body length **(Rana, 1986)** while others have claimed that it is more related to the body weight of the female **(Rana, 1988)**. However, relative fecundity decreases with maternal age, weight and length. Nile tilapia females of larger size were found to produce more and bigger eggs and more fry per female, but smaller females spawn more frequently **(Guerrero and Guerrero, 1985)**.

Fath El-Bab (2006) indicated that absolute fecundity were found to be 1264.73, 1376.1 and 1299.84 and the averages relative fecundity were 4.14, 3.49 and 2.82 for the three females groups 300, 400 and 500g, respectively and the differences in absolute fecundity due to female body weight were significant. **Bhujel (2000)** indicated that, absolute fecundity is related to body weight, while **Estay *et al.,* (1997)** found that, the relative fecundity decreased with increasing of female body weight. On the other hand, **Bhujel (2000)** stated that, relative fecundity decreased with the decrease in age, body weight and body length of female Nile tilapia

2. Effect of Month, and tank protection on some reproductive traits of Nile tilapia:

2.1. Ovary weight (g):

Results of Table (4) indicated that the average ovary weight for spawning females as affected by spawning month were 2.13, 2.19 and 4.13 g for the three months studied, January, February and March, respectively. Analysis of variance showed that spawning month had a significant ($P<0.01$) effect on ovary weight of spawning Nile tilapia females. The highest average of ovary weight (4.13 g) was recorded for female in March compared that obtained during the other two months January (2.13 g) and February (2.19 g) and this may be due to the improvement in water temperature in March compared to the other two months (January and February). Results of Table (4) also indicated that, covered and uncovered tanks without water heating did not significantly affect ovary weight of spawning females *O. niloticus* while ovary weight of the third female group (cover with heater) significantly ($P<0.001$) increased the ovary weight of spawning females. The interaction between spawning month and protection method seemed to have a significant ($P<0.01$) effect on ovary weight of females where the heavier ovary weight was recorded for females spawned in cover+heater tanks during each of January (4.06 g) and March (5.28 g) and the lowest ovary weight was recorded for female group spawned in uncovered tank during the first month of spawning (January).

Abdel-Ghany (1995) reported that fish without feeding in winter lost significantly ($P<0.05$) body weight. Fish received feed at either 1% or 2% of body weight gained substantial weights. Fish demonstrated poor food conversion rates (FCR) reduced growth rates but with good survival rates. Fish producers addressing spring markets could increase weight gain and improve the FCR by adjusting over winter-feeding.

2.2. Gonado-Somatic Index (GSI):

In the present study GSI varied from 0.85 (January) to 0.93 (February) and 1.41 (March) and the differences in GSI due to the effect of spawning month were significant (Table 4). The cycle of maturation and monthly variation of GSI provides good indication of the extent of development of gonad with respect to the time of year. Gonad staging on a descriptive scale allows a rapid qualitative assessment of the breeding state and gonad weight gives a quantitative record of changes in the gonad condition (**Crossland, 1977**). **Hatikakoty and Biswas (2004)** reported that GSI of *O. mossambicus* varied from 0.22 (December) to 0.66 (July) and the GSI value showed four peaks in March, May, July and September.

GSI of spawned females in the uncovered tanks showed the lowest value (0.69) of GSI. On the other hand covering of spawning tanks and supplying tanks with electrical heaters increased the GSI to reach the highest value (1.66) and this may be due to the providing the optimal degree of water temperature for reproduction (Table 4).

The highest value of SGI was recorded for female reared on sheltered tanks (1.57, 1.22 and 175) because sheltering beside supplying tanks with heaters realize optimal water temperature required for fish spawning. Analysis of variance indicated that both spawning month and protection method had a significant effects (P<0.05 and P<0.001, respectively), while the interaction between the two factors did not reveal significant effect on GSI.

Table (3): Least square means and standard error for the effect of month, and protection method on some reproductive traits of Nile tilapia.

Variable	No.	Body weight (g)	Body length (cm)
Month (M)			
January (M1)	24	241.66±8.78 b	24.08±0.35 b
February (M2)	16	221.90±10.75 b	22.71±0.43 c
March (M3)	16	283.73±10.75 a	25.57±0.43 a
Protection method (C)			
Uncovered without heater (C1)	24	237.48±8.78 b	23.31±0.35 b
Cover without heater (C2)	16	231.54±10.75 b	24.09±0.43 b
Cover with heater (C3)	16	280.36±10.75 a	25.33±0.43 a
M × P			
M1 × C1	8	210.60±15.19 c	22.78±0.60 c
M1 × C2	8	248.03±15.19 abc	24.69±0.60 ab
M1 × C3	8	266.35±15.19 ab	24.76±0.60 ab
M2 × C1	8	228.75±15.19 bc	21.92±0.60 c
M2 × C2	8	215.05±15.19 c	23.50±0.60 bc
M3 × C1	8	273.09±15.19 ab	25.23±0.60 ab
M3 × C3	8	294.36±15.19 a	25.89±0.60 a

+ Means followed by the same letter in each column are not significantly different.

Table (4): Least square means and standard error for the effect of month, and protection method on some reproductive traits of Nile tilapia.

Variable	No.	Ovary weight (g)	GSI	Absolute fecundity	Relative fecundity
Month (M)					
January (M1)	24	2.13±0.37 b	0.85±0.12 b	981.0±61.38 b	504.4±79.0
February (M2)	16	2.19±0.46 b	0.93±0.15 b	819.7±92.07 b	494.9±96.7
March (M3)	16	4.13±0.46 a	1.41±0.15 a	2858.4±92.07 a	637.4±96.7
Protection method (C)					
Uncovered without heater (C1)	24	1.78±0.37 b	0.69±0.12 b	915.6±61.38 b	519.3±79.0
Cover without heater (C2)	16	2.17±0.46 b	0.91±0.15 b	982.8±61.38 b	538.3±96.7
Cover with heater (C3)	16	4.67±0.46 a	1.66±0.15 a	2793.4±92.07 a	571.2±96.7
M × P					
M1 × C1	8	0.83±0.64 d	0.39±0.21 d	352.1±184.1 b	338.3±136.8 b
M1 × C2	8	1.49±0.64 cd	0.60±0.21 cd	1258.4±184.1 b	795.1±136.8 a
M1 × C3	8	4.06±0.64 ab	1.57±0.21 ab	1332.5±184.1 b	378.8±136.8 ab
M2 × C1	8	1.53±0.64 cd	0.64±0.21 cd	932.3±184.1 b	642.5±136.8 ab
M2 × C2	8	2.85±0.64 bc	1.22±0.21 ab	707.2±184.1 b	347.3±136.8 b
M3 × C1	8	2.99±0.64 bc	1.06±0.21 bc	1462.6±184.1 b	577.1±136.8 ab
M3 × C3	8	5.28±0.64 a	1.75±0.21 a	4254.2±184.1 a	697.8±136.8 ab

+ Means followed by the same letter in each column are not significantly different.

2.3. Absolute and relative fecundity:

Results of table (4) showed that absolute fecundity were 981.0, 819.7 and 2858.4, for the three months January, February and March, respectively and spawning month had a significant effect on absolute fecundity where the greatest absolute fecundity was recorded in March compared to the other spawning months. Absolute fecundity found to be 915.6, 982.8 and 2793.4 for uncovered spawning tank, covered spawning tanks and the covered spawning tanks supplied by heaters, respectively and the differences were significant.

Covering of spawning tanks increased absolute fecundity and supplying the covered spawning tanks by electrical heaters significantly ($P<0.001$) increased absolute fecundity especially during March (4254.2) compared to January (1332.5). However, the differences between absolute fecundity, due to the interaction between spawning month and tank protection method were significant.

Water temperature, nutrition and photoperiod are considered to be the most important environmental factors that influence tilapia spawning and fecundity (**Brummett 1995**). **Ridha *et al*., (1985)** showed the possibility of extending the spawning season of *O. spilurus* by controlling temperature alone. Preliminary results obtained by **Ridha and Cruz (1998)** showed the possibility of extending the restricted spawning season of *O. Spilurus* in Kuwait to an entire year by controlling water temperature and photoperiod.

Relative fecundity for the three months January, February and March were found to be 504.4, 494.9 and 637.4, respectively. Analysis of variance indicated that neither spawning month nor protection method had significant effect on relative fecundity, i.e the number of eggs in gram of female body weight did not change from month to another during the spawning season. However, the differences between relative fecundity, due to the interaction between spawning month and tank protection method were significant ($P<0.01$).

2.4. Fry production/tank:

Average fry production/tank for the studied spawning months were found to be 6492, 5897, 11608 and 17106 for the four months studied, February, March, April and May, respectively (Taable 5) and spawning month had a significant ($P<0.001$) effect on fry production of spawning Nile tilapia females. The highest average fry number (17106/tank) was obtained during May and the lowest fry production was recorded for Nile tilapia females during March.

The spawning activity appeared to be influenced by water temperature. **Siddiqui *et al.*, (1998)** in Saudi Arabia found that, during the period of maximum spawning activity of Nile tilapia, *O. niloticus* the water temperature was more favourable and as it started decrease from the middle of September, the spawning activity also showed a decreasing trend. Results of Tables (5) also indicated that, fry number/tank of spawning females found to be 4929, 9063 and 16834 for the uncovered, covered and covered with heater groups, respectively. Analysis of variance indicated that, protection method of spawning tank had a significant effect ($P<0.001$) on fry production of Nile tilapia fry.

During the first spawning month (February) there were no any fry in covered and uncovered tans because water temperature (13.0-18.0 and 18.8-23.5°C, respectively) was not suitable for spawning and hatching while the supplying covered tanks with electrical heaters increased water temperature to the most suitable temperature for reproduction process of Nile tilapia (26.0-29.1°C). During the second spawning month (March) there were no any fry in the uncovered tanks because water temperature (15.0 - 20.0°C) was not suitable for spawning and embryo development. On the other hand, fry production/tank found to be 4475 in covered tanks and supplying covered tanks with electrical heaters increased fry production to 13215/tank and the same trend was also observed during the other months (April and May).

The gradual increase in seed production starting from March coincides with the gradual increase in water temperature (Table, 3). The interaction between spawning month and protection method had a significant (P<0.001) effect on fry production of Nile tilapia.

The obtained results are in agreement with those reported by **Ridha *et al.*, (1998)** who found that no seed of *Oreochromis spilurus* in February when water temperature was lowest (18.5ºC), and the sub-optimal temperature in March (24.1ºC) similarly resulted in a low seed production. This demonstrates the effect of low temperature in depressing spawning performance. **Maluwa and Costa-Pierce (1993)** found that temperature below 19.0ºC delayed reproduction, which ceased completely below 17.0ºC. **Eguia (1996)** obtained a positive correlation in seed production with temperature in different strains of tilapia.

Generally, results of Table (5) indicated that water temperature below 20°C was not suitable for spawning and embryonic development while tanks that protected and supplied with electrical heaters showed the higher fry production (19475, 13215, 17775 and 16873 fry/tank) because water temperature in these tanks (26.0-29.1, 27.0-29.0, 27.0-29.0 and 26-29°C, respectively) were very suitable for reproductive process in Nile tilapia because temperature is one of the most potent environmental factors influencing the developmental rate of fish eggs and fry (**Herzig and Winkler, 1986**).

The obtained results are in accordance with those obtained by **Rana (1990 a and b**) who found that incubation of fertilized eggs of Nile tilapia, *O. niloticus* in different incubation temperatures, 11, 17, 20, 24, 28, 30, 34.5 and 39.5°C affected embryonic survival and hatching success. At 17°C and below or at 34.5°C the proportion of embryos advancing from the cleavage stage to hatching decreased and the optimal development to hatching (>90%) occurred at 25-30°C compared with 23.5-32°C.

2.5. Average fry weight (g):

The average fry weight for the studied spawning months were found to be 0.0087, 0.0087, 0.0140 and 0.0150 g/fry for the four months studies, February, March, April and May, respectively and spawning month had a significant effect on fry weight of Nile tilapia. The highest average fry weight (0.015 g/fry) was obtained during May and the lowest fry weight (0.0087 g/fry) was recorded for Nile tilapia females during February and March. Also, the average fry weight found to be 0.0078, 0.0108 and 0.0165 g for the uncovered, covered and covered with heater groups, respectively and tank protection had a significant effect on the average weight of Nile tilapia fry (Table 5).

During the first spawning month (February) there were no fry in covered and uncovered tanks because water temperature (13.0-18.0 and 18.8-23.5°C, respectively) was not suitable for spawning and hatching while the supplying covered tanks with electrical heaters increased water temperature to the most suitable temperature for embryonic development of Nile tilapia, *O. niloticus* (26.0-29.1°C). During the second spawning month (March) there were no fry in the uncovered tanks. On the other hand, fry had the same weight (0.013 g) in covered tanks and covered tanks supplied with electrical heaters. Generally the interaction between spawning month and covering method had a significant (P<0.001) effect on the average fry weight of Nile tilapia.

3. Correlation coefficients between some reproductive traits of Nile tilapia:

Correlation coefficients between reproductive traits of Nile tilapia, *O. niloticus* are presented in Table (6). As shown in this table female body length is significantly and positively correlated with each of body weight (0.80), ovary weight (0.51) GSI (0.39) and number of egg/female (0.37). Also, the correlation coefficient between body weight was significantly and positively correlated with ovary weight (0.61), GSI (0.42) and absolute fecundity (0.50). On the other hand, **Cisse (1988)** found non significant correlation between body weight of *Sarotherodon* *melanotheron* and absolute fecundity. For black carp, **Graah (2001)** found that correlation coefficient between body weight and egg number per one gram was 0.33.

The obtained correlation coefficients between body weight and the different reproductive traits outlined above indicates that as the female body weight and length increased, ovary weight, GSI, relative fecundity and absolute fecundity increased. Similar results for black carp were obtained by **Graah (2001)** who found that as the female body weight increased, most of reproductive traits (egg weight per fish, egg weight/kg, absolute and relative fecundity, egg number for one gm egg, larvae number/fish larvae number/kg, and fry number /fish) significantly increased but the fry number/kg and fry viability (after 10 days from hatching) decreased.

Results of Table (6) also indicated that, ovary weight was positively and significantly correlated with GSI (0.97)) and absolute fecundity (0.66), and the same trend was also observed for correlation coefficient between each of GSI and absolute fecundity (0.58) and between absolute fecundity and relative (0.55). **Graah (2001)** found that, average number of eggs/gram egg was positive and significantly correlated with female body weight (0.34); relative fecundity did not significantly correlated with each of all the studied reproductive performance traits of black carp.

In conclusion, protection methods of spawning tanks with heater had a significant effect on weight of Nile tilapia fry. Also, a positive correlation between body weight and relative and absolute fecundity.

Table (5): Least square means and standard error for the effect of month, and protection method on fry production of Nile tilapia.

Variable	No.	Fry production/pond	Fry weight (g)/fry	Temperature (°C)
Month (M)				
February (M1)	24	6492±85 c	0.0087±0.00010 c	
March (M2)	24	5897±85 c	0.0087±0.00010 c	
April (M3)	24	11608±85 b	0.0140±0.00010 b	
May (M3)	24	17106±85 a	0.0150±0.00010 a	
Protection method (C)				
Uncovered without heater (C1)	32	4929±64 c	0.0078±0.00007 c	
Cover without heater (C2)	32	9063±64 b	0.0108±0.00007 b	
Cover with heater (C3)	32	16834±64 a	0.0165±0.00007 a	
M × C				
M1 × C1	8	0	0	13.0 – 18.0
M1 × C2	8	0	0	18.8 - 23.5
M1 × C3	8	19475±255 a	0.026±0.00030 a	26.0 – 29.1
M2 × C1	8	0	0	15.0 – 20.0
M2 × C2	8	4475±255 f	0.013±0.00030 e	23.0 – 25.0
M2 × C3	8	13215±255 de	0.013±0.00030 e	27.0 – 29.0
M3 × C1	8	4500±255 f	0.015±0.00030 c	19.0 – 25.0
M3 × C2	8	12550±255 e	0.014±0.00030 d	24.0 – 26.0
M3 × C3	8	17775±255 ab	0.014±0.00030 d	27.0 – 29.0
M4 × C1	8	15218±255 cd	0.016±0.00030 b	24.0 – 26.7
M4 × C2	8	19228±255 a	0.016±0.00030 b	25.0 – 27.0
M4 × C3	8	16873±255 bc	0.013±0.00030 e	26.0 – 29.0

\+ Means followed by the same letter in each column are not significantly different.

Table (6): Correlation coefficient between body weight, body length and some reproductive traits of Nile tilapia.

	Body length	Body weight	Ovary weight	GSI	Relative fecundity
Body weight	0.80 ***				
Ovary weight	0.51 ***	0.61 ***			
GSI	0.39 **	0.42 ***	0.97 ***		
Relative fecundity	0.02	0.11	0.01	- 0.04	
Absolute fecundity	0.37 **	0.50 ***	0.66 ***	0.58 ***	0.55 ***

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الملخص العربى

أجريت هذه الدراسة فى المركز الدولى للأسماك بالعباسة بمحافظة الشرقية وقد أجريت التجربة بهدف دراسة تأثير بعض شهور التفريخ (فبراير، مارس، أبريل، مايو) وكذلك طرق حماية أحواض التفريخ من البرودة (تغطية الأحواض، تغطية الأحواض مع إمدادها بسخانات كهربائية أو ترك أحواض التفريخ بدون تغطية وبدون سخانات) ودراسة تأثير ذلك على بعض الصفات التناسلية فى أسماك البلطى وكان من أهم النتائج المتحصل عليها مايلى:

- أدت حماية الأحواض بالبلاستيك إلى زيادة معنوية فى متوسط وزن وطول الجسم بالنسبة للأمهات مقارنة بالأحواض التى لم يتم حمياتها من البرودة. و قد تأثر متوسط وزن المبيض معنوياً بشهور التفريخ موضع الدراسة. كما وجد أن الأحواض التى تم تغطيتها بالبلاستيك وزودت بالسخانات قد أعطت أكبر قيم لوزن المبيض مقارنة بالأحواض المكشوفة والأحواض المغطاه بدون سخانات. وقد وجد أن التداخل بين شهر التفريخ وطرق حماية الأحواض من البرودة كانت ذات تأثير معنوى على وزن المبيض فى الأمهات.
- وجد أن دليل المناسل قد وصل إلى ٨٥ر٠، ٩٣ر٠، ٤١ر١% وذلك خلال شهور التفريخ يناير، فبراير، مارس وكانت الفروق بين هذه المتوسطات معنوية. وقد أعطت الأحواض المكشوفة اقل قيماً لدليل المناسل (٦٩ر٠) فى حين أن الأحواض المغطاه والمزودة بالسخانات فقد أعطت أكبر مقياس لدليل المناسل (٦٦ر١). وكان تأثير كلاً من شهور التفريخ وطرق حماية أحواض أمهات التفريخ على دليل المناسل معنوياً فى حين أن تأثير التداخل بين هذين العاملين لم يكن معنوياً.
- أدت تغطية أحواض أمهات التفريخ إلى زيادة فى عدد البيض الناتج من الأم كما أدى تزويد الأحواض المغطاة بالسخانات الكهربية إلى تحسن معنوى فى عدد البيض الناتج من الأم. ومن النتائج المتحصل عليها أيضاً وجد أن متوسط عدد البيض/جرام من وزن جسم السمكة لم يتاثر معنوياً بأشهر التفريخ وكذلك طرق حماية أحواض التفريخ.
- أظهرت النتائج كذلك أن عدد الزريعة الناتجة لكل حوض وكذلك متوسط وزن الزريعة الناتجة الناتجة قد تأثر معنوياً بشهور التفريخ ووسيلة حماية الأحواض من البرودة والتفاعل بين هذين العاملين.