Effect of spawning month, dietary protein and pond protection on fry production of the Nile tilapia, *Oreochromis niloticus*

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ABSTRACT

The practical work of the present experiments was carried out at the World Fish Center, Abbassa, Abou Hammad, Sharkia, Egypt. The experiment aimed to investigate the effect of spawning month (April and May), dietary protein level (25 or 35%) and protection of spawning tanks (covering or uncovering of the spawning tanks) on fry production and average fry weight of the Nile tilapia. The obtained results can be summarized as follow:

- Fry production/tank were found to be 6462 and 19082/tank during the two months April and May, 10719 and 14824/tank for the two dietary protein levels, 25 and 35% and 16428 and 9115 fry/tank for the covered and uncovered tanks, respectively and the differences in fry production due to the effect of spawning month, dietary protein content and tank protection were significant.
- Averages of individual fry weight as affected by month, dietary protein levels and pond protection were found to be 0.025 and 0.016 g during the two months April and May, 0.021 and 0.019 g for the two dietary protein levels, 25 and 35% and 0.018 and 0.023 g for the covered and uncovered tanks, respectively. Spawning month and tank protection significantly affected individual fry weight while dietary protein levels had no significant effect on fry weight.
- The interaction between the studied factors affected individual fry weight of the Nile tilapia indicated that the highest average individual fry weight was recorded for fish group raised in covered tanks and received the lower protein content during April. On the other hand, the lowest average individual fry weight was recorded for broodfish raised in an uncovered tanks and received the higher protein level (35%) in May.

Keywords: Nile tilapia, *Oreochromis niloticus,* spawning, protein, protection

INTRODUCTION

Low egg production per spawning and lack of spawning synchrony among tilapia females constrains the management of mass seed production (Little *et al.,* 1993) and this impacts upon the tilapia industry as a whole. As large numbers of parental stock are required in order to meet the demand for seed (Little *et al.,* 1997), a hatchery operator has to maximize seed output by exploiting the reproductive potential of his/her broodstock (Macintosh and Little, 1995).

Large variations within and between the strains of tilapia have been reported for age at first maturity (Macintosh and Little, 1995), fecundity (DeSilva, 1986 and 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.

Reproductive output is maintained at the expense of somatic growth. However, supply of inadequate protein for long periods results in slow ovarian recrudescence (Gunasekera and Lam, 1997), prolonged intervals between spawnings (Gunasekera *et al.,* 1996 a) and a complete halt to reproduction. Broodfish should, therefore, be provided with optimum levels of protein in the diet from a young age up to the egg producing stage. Gunasekera *et al.,* (1996 a) indicated that, the amount of protein in oocytes of Nile tilapia, *O. niloticus* females maintained on the 10% protein diet was significantly lower than the other dietary protein levels (20 or 35%). However, the gonadosomatic index of females and the diameter, mean weight and moisture content of oocytes were not affected significantly by the dietary protein levels.

In a study by Gunasekera *et al.* (1995), Nile tilapia fingerlings fed a low protein diet <17% did not show oocyte maturation, females fed 25% protein showed slow oocyte growth, whereas females fed >32% protein level had early oocyte growth and maturation. As there was no significant difference in oocyte growth and final maturation between 32% and 40% protein diets groups, 32% protein seems to be adequate for tilapia broodfish. Moreover, the protein level required for the normal growth of Nile tilapia seems to be sufficient for broodstock maturation too.

Dietary protein supply affects protein content of eggs, number of eggs per spawning and the spawning interval in *O. niloticus*. In tanks with semi-purified isocaloric diets, *O. niloticus* females fed 35% protein diet produced eggs with significantly higher protein than females fed 10% or 20% protein diets (Gunasekera *et al.,* 1996 a). In the same study, females fed 20% and 35% diets produced more number of eggs per spawning than those on 10% protein diet.

O. niloticus and *O. mossambicus* can tolerate a wide range of temperatures: 8 - 42°C (Philippart and Ruwet, 1982), but feed less below 20°C. They cease feeding below 16°C and death occurs below 12°C (Chervinski, 1982). 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). No spawning was reported at 22°C in *O. mossambicus* and an increase in temperature from 25°C to 28–31°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 (Popma and Lovshin, 1996). 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 (Srisakultiew and Wee, 1988) 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. High temperature stress may be reduced by using deep ponds, pond shading, water sprinkling and circulating during day time and through nutrition vitamin E. However, no research has been done so far on the effectiveness and the applicability of these techniques. The aim of the present work was to study the effect of spawning month (April and May), dietary protein level (25 or 35%) and protection of spawning ponds (covering or uncovering of spawning ponds) on fry production and average fry weight of Nile tilapia, *O. niloticus* under the Egyptian conditions.

MATERIALS AND METHODS

The practical work of the present study was conducted at the hatchery unit at the experimental station of the WorldFish Center, Abbassa, Abou Hammad, Sharkia, Egypt during the period from first of January, 2005 until 31 May 2005. Nile tilapia, *Oreochromis niloticus* broodstock were brought from the same experimental station (WorldFish Center, Abbassa). Five hundred and twelve (512) *O. niloticus* broodfish were used in the experiment where three hundreds and eighty four (384) females and one hundred and twenty eight (128) males were used representing a sex ratio of three females for each male (3 : 1 ratio). Fish were exposed to various combinations of different crude protein levels in diet and water temperature control regime. Reproductive performance of Nile tilapia broodfish was evaluated during two months (April and May). Two levels of crude protein in isocaloric (2700 Kcal ME/ kg diet) test diets (25% and 35%) and two water temperature control regimes were used (covered and uncovered tanks). Diet composition is shown in Table (1).

Each of the experimental diets was tested under each temperature control regime comprising the four experimental treatments of this study. The eight treatments were as following:

1- Treatment1 (T1): 25% protein diet and covered tanks (25°C) in April.
2- Treatment2 (T2): 25% protein diet and covered tanks (25°C) in May.
3- Treatment3 (T3): 25% protein diet and uncovered tanks (25°C) in April.
4- Treatment4 (T4): 25% protein diet and uncovered tanks (25°C) in May.
5- Treatment5 (T5): 35% protein diet and covered tanks (35°C) in April.
6- Treatment6 (T6): 35% protein diet and covered tanks (35°C) in May.
7- Treatment7 (T7): 35% protein diet and uncovered tanks (35°C) in April.
8- Treatment8 (T8): 35% protein diet and uncovered tanks (35°C) in May.

Table 1: Formulation and proximate analysis of the experimental diets.

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)

The experiment was conducted in 16 concrete tanks of 12 m^2 for each and all tanks were filled with filtered canal water to maintain a water depth of 70 cm so the water volume in each tank was 8.4 m^3 and each tank was supplied with compressed air through air diffusers to assure maintaining near optimum dissolved oxygen levels in the tank water. Eight (8) of the sixteen 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. Each tank was stocked with twenty four (24) sexually mature *O. niloticus* females with average weight of 175 ± 25 g and eight (8) *O. niloticus* males with total body weight average of 190 ± 30 g. Groups of four tanks were randomly assigned to each one of the experimental treatments. Each treatment group received one of the experimental diets. Fish in each tank were fed the designated diet 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 experiment lasted nine weeks (12 April to 27 May 2004) and 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 recorded in all uncovered and covered tanks (Table 2). All tanks were checked on daily basis 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.All treatment were performed in replicates.

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 mothers' 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 2: Averages of water quality parameters in the experimental concrete tanks.

Spawning month	Dietary protein level	Protection method	Water quality parameters			
			Temp. (°C)	pH	DO Mg/l	NH_3 Mg/l
April	25% CP	Covered	27.39	8.8	5.1	0.12
		Uncovered	21.89	8.4	6.5	0.08
	35% CP	Covered	27.39	9.2	5.7	0.24
		Uncovered	21.89	9.0	6.7	0.11
May	25% CP	Covered	26.95	8.9	5.2	0.13
		Uncovered	23.75	8.4	6.1	0.07
	35% CP	Covered	26.95	9.0	5.5	0.23
		Uncovered	23.75	8.8	5.3	0.10

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: $X_{ijkl} = \mu + \alpha_i + \beta_j + \gamma_k + (\alpha\beta)_{ij} + (\alpha\gamma)_{ik} + (\beta\gamma)_{jk} + (\alpha\beta\gamma)_{ijk} + e_{ijkl}$

Where: X_{ijkl}=The observation for the i^{th} month and j^{th} protein level and k^{th} protection regeme, μ= Overall mean, α_i=The effect of i^{th} spawning month, β_j=The effect of j^{th} protein level, γ_k=the effect of k^{th} protection regeme, $(\alpha\beta)_{ij}$=The effect of interaction between i^{th} spawning month and j^{th} protein level, $(\alpha\gamma)_{ik}$=The effect of interaction between i^{th} spawning month and k^{th} protection regeme, $(\beta\gamma)_{jk}$=The effect of the interaction between j^{th} protein level and k^{th} protection method, $(\alpha\beta\gamma)_{ijk}$=The effect of the interaction between i^{th} spawning month, j^{th} protein level and l^{th} protection regeme and e_{ijkl}=random error assumed to be independently and randomly distributed (0, δ^2 e).

RESULTS AND DISCUSSION

1- Effect of spawning month, dietary protein level and tank protection on fry number/tank:

Averages of fry number produced per tank as affected by month, dietary protein level and tank protection method were found to be 6462 and 19082 during the two months April and May, 10719 and 14824 for the two dietary protein levels, 25 and 35% and 16428 and 9115 fry/tank for the covered and uncovered tanks, respectively (Table 3). Analysis of variance indicated that, spawning month, dietary protein content and tank protection significantly (P<0.001) affected the fry number produced per tank.

As shown in Table (3) fry number produced/tank during May was significantly higher than that produced in April and this may be due to increase in water temperature during May compared to water temperature in April. Similarly, tank protection during the two months (April and May) increased significantly fry production and this may be due to the suitability of water temperature by covering fish tanks (27.39 and 26.95ºC). Sidiqui *et al*. (1998) found that, in Saudi Arabia, the maximum spawning activity of Nile tilapia, *O. niloticus* was recorded between May and August and thereafter, the spawning frequency gradually decreased with very low activity in November.

Water temperature is one of the most potent environmental factors influencing the developmental rate of fish eggs and fry (Herzig and Winkler, 1986). Generally, low rearing temperatures retard and high temperatures accelerate development of egg and fry. The habitat temperature and the temperature range over which eggs will develop and hatch normally varies between species, each specie having an optimal range for maximal developmental success depending on its ecology and life history.

Under hatchery conditions, however, it may be possible to control and maintain water temperatures within a narrow thermal range for optimal embryonic and fry development. This would be of considerable importance since the various stages of embryonic development may have different thermal tolerance ranges and optimal temperature requirements.

With respect to the effect of dietary protein content on fry production of the Nile tilapia, *Oreochromis niloticus*, results of Table (3) indicated that fry number/tank was increased from 10719 to 14824 as dietary protein content increased from 25 to 35%, respectively.

Nutrition of broodstock fish is usually reflect in their reproduction efficiency. The interaction between nutrition and reproduction of tilapia has attracted the attention of investigators (DeSilva and Radampola, 1990; El-Sayed *et al.,* 2003), who have studied the relationship between dietary protein and spawning efficiency.

Dietary protein has been found to influence seed production in tilapia. An increase in egg production with an increase in dietary protein levels has been reported for Nile tilapia, *O. niloticus* (Santiago *et al.,* 1985) and Taiwanese red tilapia (Chang *et al.,* 1988).

Table 3: Least square means and standard error for the effect of month, dietary protein level and protection method on fry production of Nile tilapia.

Variable	No.	Fry production/pond	Temperature (°C)
Month (M)			
April (M1)	16	6462±662 b	
May (M2)	16	19082±662 a	
Protein level (P)			
25% (P1)	16	10719±662 b	
35% (P2)	16	14824±662 a	
Protection method (C)			
Covered (C1)	16	16428±662 a	
Uncovered (C2)	16	9115±662 b	
M × P			
M1 × P1	8	6917±936 c	
M1 × P2	8	6007±936 c	
M2 × P1	8	14522±936 b	
M2 × P2	8	23642±936 a	
M × C			
M1 × C1	8	9657±936 c	
M1 × C2	8	3267±936 d	
M2 × C1	8	23200±936 a	
M2 × C2	8	14963±936 b	
P × C			
P1 × C1	8	13200±936 b	
P1 × C2	8	8238±936 d	
P2 × C1	8	19657±936 a	
P2 × C2	8	9992±936 c	
M × P × C			
M1 × P1 × C1	4	10834±792 d	27.39
M1 × P1 × C2	4	3000±792 f	21.89
M1 × P2 × C1	4	8480±792 e	27.39
M1 × P2 × C2	4	3533±792 f	21.89
M2 × P1 × C1	4	15567±792 bc	26.95
M2 × P1 × C2	4	13476±792 c	23.75
M2 × P2 × C1	4	30833±792 a	26.95
M2 × P2 × C2	4	16450±792 b	23.75

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

Santiago *et al.* (1985) reported that the best growth of *O. niloticus* breeders and the highest fry production were obtained at 40% dietary protein level, while lower protein levels resulted in reduced fry production. Chang *et al.* (1988) found that a diet containing 44% protein (eel diet) produced the highest number of fry, while tilapia feed (24% protein) and trash fish flesh (22% protein) resulted in significantly lower fry production. Gunasekera *et al.* (1995) concluded that 32% protein seems to be adequate for tilapia broodfish. In another study, Gunasekera *et al*. (1996 b) investigated the effect of different dietary protein levels (10, 20 or 35%) on reproductive performance of Nile tilapia *O. niloticus* and they found that females fed the 10% CP diet did not produced fertilized eggs while fertilization rate of eggs spawned by females fed the 35% CP diet was generally higher than that from females maintained on the 20% CP diet, also they found that, hatchability of eggs from females fed the 35% CP diet was significantly higher than those from females fed the 20% CP diet. In another study, Gunasekera *et al.*

(1996 a) found that Nile tilapia females fed 20 or 35% protein diets produced higher number of eggs per spawn than those fed 10% but relative fecundity and egg size did not differ significantly (P<0.05) between treatments (10, 20 and 35% CP diets).

In the study of Siddiqui *et al*. (1998), Nile tilapia fed experimental diets contained increasing levels of dietary protein (25, 30, 35, 40 and 45%) showed that, fish received 45% dietary protein spawned more frequently than fish received 25% dietary protein and the total number of eggs produced per female was significantly higher for females fed 45% protein feed than females received 25% and 30% protein levels while relative fecundity had non clear trend and they concluded that the use of a 30% protein diet, based on both fish meal and other protein sources, is cost-effective for tilapia seed production under local environmental conditions.

El-Sayed *et al.* (2003) studied the effect of increasing dietary protein levels (25, 30, 35 and 40%) on reproductive performance of Nile tilapia. They found that, the total number of spawnings per female and absolute fecundity were better in fish fed 40% protein and egg hatchability was linearly increased with increasing dietary protein level. The former studies recommended that high-protein diets must be given to tilapia breeders. On the contrary, DeSilva and Radampola (1990) found that the number of spawning by females *O. niloticus* increased with increasing dietary protein level from 20 to 30%, then decreased with a further increase in protein level. In addition, the number of spawning repetition per female and the number of eggs per spawning decreased significantly with increasing dietary protein level.

Generally, reproductive output is maintained at the expense of somatic growth. However, supply of inadequate protein for long periods results in slow ovarian recrudescence (Gunasekera and Lam, 1997), prolonged intervals between spawnings (Gunasekera *et al.,* 1996 a). Broodfish should, therefore, be provided with optimum levels of protein in the diet from young age up to the egg producing stage.

The investigations of the dietary protein requirements of tilapia for maximum reproductive performance have produced variable results and no clear picture has emerged. The differences in results may be caused by variations in the experimental design with respect to the size of culture units, environmental conditions, hygiene, size and age of the fish, duration of the study and the quality of the feed. Manipulation of both dietary protein level and source of protein have affected egg production and egg quality (Gunasekera *et al.,* 1996 a).

The interaction between the former factors (spawning month, dietary protein content and tank protection) on fry production/tank (Table 3) indicated that during the second month of the experiment (May) covering broodstock tank and increasing the dietary protein content (from 25 to 35%) significantly (P<0.001) produced the highest (30833 fry/tank) of Nile tilapia and this may be due to improving in temperature conditions (26.95°C) required for producing the healthy fry of tilapia while the lowest fry production/tank (3533) was recorded for broodfish reared in uncovered tanks which received the higher dietary protein level in April.

2. Effect of spawning month, dietary protein and tank protection on fry weight:

Averages of individual fry weight as affected by spawning month, dietary protein content and tank protection were found to be 0.025 and 0.016 g during the two months April and May, 0.021 and 0.019 g for the two dietary protein levels, 25 and 35% and 0.018 and 0.023 g for the covered and uncovered tanks, respectively (Table 4). Analysis of variance indicated that, spawning month and tank protection significantly (P<0.001 and P<0.01, respectively) affected individual fry weight produced while dietary protein content of the diets had no significant effect on fry weight.

The interaction between the studied factors affecting individual fry weight of Nile tilapia (Table 4) indicated that the highest average individual fry weight (0.036 g/fry) was recorded for fish group raised in covered tanks and received the lower protein content during April. On the other hand, the lowest average individual fry weight (0.014 g/fry) was recorded for broodfish raised in an uncovered tanks and received the higher protein level (35%) in May and this may be due to the negative correlation between the two traits, fry weight and fry number.

Table 4: Least square means and standard error for the effect of month, dietary protein level and protection method on fry weight of Nile tilapia.

Variable	No.	Fry weight (g)	Temperature (°C)
Month (M)			
April (M1)	16	0.025±0.0013 a	
May (M2)	16	0.016±0.0013 b	
Protein level (P)			
25% (P1)	16	0.021±0.0013	
35% (P2)	16	0.019±0.0013	
Protection method (C)			
Covered (C1)	16	0.018±0.0013 b	
Uncovered (C2)	16	0.023±0.0013 a	
M × P			
M1 × P1	8	0.027±0.0019 a	
M1 × P2	8	0.022±0.0019 ab	
M2 × P1	8	0.015±0.0019 b	
M2 × P2	8	0.016±0.0019 b	
M × C			
M1 × C1	8	0.018±0.0019 b	
M1 × C2	8	0.031±0.0019 a	
M2 × C1	8	0.017±0.0019 b	
M2 × C2	8	0.015±0.0019 b	
P × C			
P1 × C1	8	0.017±0.0019 b	
P1 × C2	8	0.026±0.0019 a	
P2 × C1	8	0.019±0.0019 b	
P2 × C2	8	0.020±0.0019 b	
M × P × C			
M1 × P1 × C1	4	0.018±0.0027 bc	27.39
M1 × P1 × C2	4	0.036±0.0027 a	21.89
M1 × P2 × C1	4	0.018±0.0027 bc	27.39
M1 × P2 × C2	4	0.026±0.0027 b	21.89
M2 × P1 × C1	4	0.015±0.0027 c	26.95
M2 × P1 × C2	4	0.016±0.0027 c	23.75
M2 × P2 × C1	4	0.019±0.0027 bc	26.95
M2 × P2 × C2	4	0.014±0.0027 c	23.75

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

In a study carried out by Abdelhamid *et al.* (2004) Nile tilapia broodfish fed experimental diets contained graded levels of dietary protein (25, 30 and 35%) they found that, the best body weight, daily gain and total gain of weight and body depth at different months of fry obtained by feeding their broodstock fish on a diet contained 30% CP at a rate of 1% of the body weight mass daily, particularly for the fry produced from the 1st spawning.

In comparison with other fish species in aquaculture, the nutritional requirements of female tilapias are greatly affected by their unique mode of reproduction. Mouth-brooders deprive themselves of food throughout each period of oral incubation. Since female *Oreochromis* can produce several broods in succession, they may ingest food for only 4-5 days between non-feeding short feeding periods each lasting 10-13 days (Macintosh, 1985). In the often short feeding periods between broods, female tilapias have to feed voraciously to regain body condition lost during incubation and to obtain energy to support further reproductive activity. Studies with tagged fish have shown that body weight loss is well correlated to the duration of incubation (Little, 1989).

While commercial pelleted diets are now routinely manufactured for tilapias, little is known about the underlying nutrition of tilapia broodstock. This is especially true with respect to their lipid, essential fatty acid, vitamin and mineral requirements (reviewed by Luquet, 1991). The optimum level of dietary protein for growth of fry and adult tilapias seems to be about 27-35% and 25%, respectively (Wee and Tuan, 1988 and Luquet, 1991).

A dietary level of 35% crude protein resulted in optimum growth and spawning by *O. niloticus* broodstock held in clear-water tanks (Wee and Tuan 1988). In the same study, higher protein levels in the diet (42 or 50% crude protein) stimulated earlier maturation and resulted in larger eggs and slightly higher hatching rates, but had a negative effect on spawning frequency and fecundity. DeSilva and Radampola (1990) found that spawning frequency decreased with protein level, whereas, Santiago *et al.,* (1985) reported that higher dietary protein levels (40 and 50%) increased spawning frequency in *O. niloticus*.

In conclusion, the interaction between the studied factors (spawning month, dietary protein level and tank protection) on fry production per tank indicated that the highest fry production per tank was recorded for broodfish reared in covered tanks and received the higher dietary protein level during May.While the highest average individual fry weight was recorded for fish group raised in covered tanks and received the lower protein content during April.

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ARABIC SUMMARY

تاثير شهور التفريخ ومحتوى العليقة من البروتين وحماية الاحواض على انتاج الزريعة فى البلطى النيلى

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1- كلية الزراعة بمشتهر – جامعة بنها
2- كلية الطب البيطرى بمشتهر – جامعة بنها
3- المعمل المركزى لبحوث الثروة السمكية بالعباسة – أبو حماد شرقية – مركز البحوث الزراعية

أجريت هذه التجربة بالمركز الدولى للأسماك – العباسة – مركز ابوحماد – محافظة الشرقية وقد أجريت هذه التجربة بهدف دراسة تأثير بعض شهور موسم التفريخ (أبريل ومايو) ومحتوى العليقة من البروتين (25 ، 35%) وكذلك تغطية أحواض التفريخ وذلك على عدد ومتوسط وزن الزريعة الناتجة من كل حوض من أحواض تفريخ اسماك البلطى النيلى. وكان من أهم النتائج المتحصل عليها مايلى:

– أظهرت نتائج التجربة أن عدد الزريعة الناتجة قد وصل إلى 6462 ، 19082 لكل حوض وذلك خلال شهرى أبريل ومايو و 10719، 14824 لنوعى العلف المستخدمين فى التجربة (25 ، 35% بروتين خام) كما وصل عدد الزريعة الناتجة إلى 16428 ، 9115 لكل حوض من الأحواض المغطاة والمكشوفة على التوالى.
– كما أظهرت النتائج أيضاً أن متوسط وزن الزريعة قد وصل إلى 0.025 ، 0.016 جم للزريعة الناتجة خلال شهرى أبريل ومايو 0.021 ، 0.019 جم لنوعى العلف المستخدمين فى التجربة (25 ، 35% بروتين خام) كما وصل متوسط وزن الزريعة الناتجة إلى 0.018 ، 0.023 جرام لكل من الأحواض المغطاة والمكشوفة على التوالى.
– كان للتداخل بين العوامل التى تمت دراستها تأثيراً معنوياً على كل من عدد ومتوسط وزن الزريعة حيث كان أعلى متوسط للزيعة قد تم الحصول عليه من مجموعة الأمهات التى وضعت فى الأحواض المغطاه والتى تمت تغذيتها على العلف ذو المحتوى المنخفض من البروتين وذلك فى فصل إبريل كما أعطت المعاملة التى ربيت فيها الأمهات فى الأحواض المكشوفة والتى تغذت على العلف ذوالمحتوى المرتفع من البروتين (35%) أعطت أقل متوسط لوزن الجسم وذلك خلال شهر مايو.