

EFFECT OF REST SYSTEMS DURING SPAWNING SEASON ON THE SPAWNING EFFICIENCY OF NILE TILAPIA IN COMMERCIAL HATCHERIES

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SUMMARY

This experiment was conducted to compare the effect of two resting system for 15 days of broodstock (rest in hapas and rest in ponds) versus no-resting control treatment on 6 months larvae production and spawning synchrony of Nile tilapia *Oreochromis niloticus* stocked in 12 hapa with a water volume of 25 m³/hapa suspended in earthen pond, four hapa/treatment. Adult males and females with mean body weights of 140 g and 125.4 g, were stocked at a rate of 120 fish/hapa with a male to female sex ratio of 1:3. Water temperature at 29 ± 1.0 °C and salinity 2.4 ppt were maintained throughout the experiment.

The results showed that broodstock in the rest system had higher seed production and spawning synchrony compared with those in no rest. The resting system resulted in an increase from 20.6 to 31.7% in larvae/female. The different spawning parameters of broodstock in the rest in hapa and rest in pond were higher than in the no rest (control).

Results suggested that broodstock resting strategy had a long-term improvement effect on larvae production and spawning synchrony, and resting all breeders in ponds was more profitable but faced a problem, its needed two pond more than hatchery pond which is not available in most hatcheries.

Keywords: Nile tilapia, spawning performance, economic efficiency, broodstock resting

INTRODUCTION

Tilapia hatcheries were widespread throughout Egypt, especially in the presence of fish farms, almost each large farm had a hatchery either commercial or produced fry needed (GAFRD, 2012). Fish production from aquaculture activities contributed 74% of the total fish production which amounted 1.305 million metric tons, and tilapia constituting 63.48 % of them. The fisheries sector contributed 8.5% in national agriculture income. The exploited area in Fish farms in Fayoum Governorate was 2750 feddans besides 12 fish hatcheries (GAFRA, 2012).

Most use hapa-based production systems in earthen ponds using the methods developed in South East Asia for commercial production of Nile tilapia fry and fingerlings (Bhujel *et al.*, 2001, 2007; Escover *et al.*, 1987; Little and Hulata, 2000 and Little *et al.*, 1995). Hapas in ponds are cheap to construct and more convenient to manage in commercial tilapia hatcheries (Bhujel, 2000).

Only a limited number of studies have highlighted the technical characteristics and economic performance of different commercial tilapia hatchery systems in Egypt (Abou-Zied and Ali, 2007; Eldokla *et al.*, 2011 and Naiel *et al.*, 2011).

Like other production, seed production stages gradually increased until it reached the highest level and then decreased until the season ends, which is estimated at around six months in Egypt for that, it is preferred to rest the broodstock during this period to restore its activity.

Conditioning of tilapia brood-stock requires maintaining males and females separately in different units, for a period of rest between spawning, at a high stocking density 2.5 kg/m² with good feeding regimes (Ambali, 1990). Exchange of both male and female brood-stock conditioned for 21 days resulted in a 16% increase in egg and fry production over a 105 days pawning period as compared to either no broodstock exchange or female only exchange (Lovshin and Ibrahim, 1988). Conditioning of females has been found to improve spawning synchrony and seed output. However, conditioning for more than 10 days had no advantage over shorter periods (Little *et al.*, 1993). Moreover, conditioning for 20 days resulted in 18% decrease in seed output per unit area per day (Little *et al.*, 1993). This is possibly due to the reabsorption of well-developed ova in the ovary which starts after about a week if females do not spawn (Peters, 1983). Moreover, it has been found that conditioned females with conditioned males produce more eggs as well as spawning more frequently than only conditioned females and no conditioning males (Ambali, 1990 and Little *et al.*, 1993). This is possibly due to the active roles of rested males in courtship. Moreover, fertilizing capacity of sperm sharply decreased from about 90% to 20% with increase in mating frequency (Rana, 1986) probably because of the production of immature spermatozoa. However, resting of males for long periods might have negative effects on sperm quality as spermatozoa are continuously produced and released into the lumen of the testis and the sperm quality declined with time after release. It

seems that a short period 5-10 days of resting males, like females, might be optimum (Purdom, 1993).

Since broodstock exchanged faced a problem in implementation thus this research aimed to resting broodstock for 15 days once in spawning season to increase larvae production.

MATERIALS AND METHODS

This study was conducted in a commercial hatchery at Shakshouk province, Fayoum Governorate, Egypt, to evaluate the resting systems for Nile tilapia applied in other commercial hatcheries on the spawning efficiency. The experiment extended during the period from 20 April, 2014 to 16 October, 2014.

One thousand four hundred and forty brood-stock were equally divided on twelve hapa located in broodstock earthen pond. Each hapa has an area of 5×7 m with a water depth of 70 cm. Three resting systems (treatments) were tested. Each system represented by four hapa (as replicates) as follows: System 1: broodstock continuous larvae production without stopping (no rest, control). System 2: broodstock rested in hapa for males alone and others for females at density of 20 fish/m³ for 15 days. System 3: broodstock rested in pond for males and females each other's alone at density of 20 fish/m³ for 15 days.

Nile tilapia, *Oreochromis niloticus*, male and female with mean body weights of 140g (110–170 g) and 125.4 g (110–145 g), respectively, were stocked at a density of 5 fish/m² and at a sex ratio of 1:3 male to female (each hapa contains 120 broodstock, 90 females + 30 males).

Broodstock in hapa were hand-fed with 3.0-mm sinking pellets (30% crude protein) at a rate of 2.0% of fish body weight (Bhujel *et al.*, 2007) two meals

per day except the days of collecting of larvae, but during the resting period fed at a rate of 3% of body weight twice daily for 15 days. Larvae were collected from hapa every 5 days and were individually counted.

Diets used during the experiment were analyzed for their proximate composition in triplicates following the methods described by AOAC (1999). Water temperature, pH, dissolved oxygen (DO₂), ammonia (NH₃-N), nitrate and salinity throughout the experimental period were periodically measured in the morning and at noon by using centigrade thermometer, Orion digital pH meter model 201, oxygen meter, Cole Parmer model 5946, HACH test kit ammonia mid-range 0-3 mg/L model NI-8, HACH test kit Nitrate/Nitrite model NI-12 and TDS apparatus, respectively.

Statistical Analysis:

Data were statistically analyzed using a one-way analysis of variance using SPSS (2007) version 16. Mean of treatments were compared by Duncan multiple range test when the differences were significant (Duncan, 1955).

RESULTS AND DISCUSSIONS

Water quality:

Table (1) showed the water quality parameters measured during the study in fish hapas. Mean values of water quality parameters were recorded as follows: DO 6.08±0.37 mg/L, pH 8.0±0.20, temperature 29±0.75 °C, NH₃-N 0.2±0.10 mg/L and salinity 1.4±0.08 ‰ respectively. These values were within the safe ranges and acceptable for the spawning and growth of tilapia as reported by Magid and Babiker (1975), Ross (2000), El-Sayed (2006) and El-Sherif and El-Feky (2008).

Table 1. Mean water quality parameters measured during the study

Item	DO ₂ , mg/L	pH	Temp., °C	NH ₃ -N, mg/L	NO ₃ , mg/L	Salinity,
First month	6.23±0.25	8.0±0.21	28±0.80	0.2	0	1.3±0.11
Second month	6.10±0.36	8.00.20	29±0.80	0.2	0	1.5±0.11
Third month	6.05±0.24	8.00.20	30±0.81	0.2	0	1.4±0.11
Forth month	6.38±0.38	8.00.21	29±0.81	0.2	0	1.5±0.13
Fifth month	5.70±0.48	8.00.20	29±0.81	0.2	0	1.5±0.10
Sixth month	6.05±0.31	8.00.21	28±0.82	0.2	0	1.4±0.11
Mean ± S.E	6.08±0.37	8.0±0.20	29±0.75	0.2±0.10	0	1.4±0.08

Spawning efficiency before resting:

Spawning performance of Nile tilapia *O. niloticus* under different broodstock resting schedules are presented in Table 2. The rest in hapa and in pond treatments had insignificant differences and the mean values were nearly equal for total larvae production per hapa (261000 and 268200, respectively) and

without rest was 260550 larvae. Larvae number/females (2900 and 2980, respectively) and without rest being 2895; spawning interval (19.55 and 19.03, respectively) and was 19.59 for control.

These results were obtained because all treatments received the same conditions thus it is nearly similar in spawning parameters values.

Table 2. Spawning efficiency of Nile tilapia brood before resting system (mean \pm S.E.)

	Resting system		
	Without	In hapa	In pond
Number of days	105	105	105
Total larvae weight/hapa, g	2895 \pm 146.15	2900 \pm 148.61	2980 \pm 85.54
Total larvae number/hapa	260550 \pm 13153	261000 \pm 13374	268200 \pm 7698
Larvae weight, g/hapa/month	827 \pm 41.75	829 \pm 42.46	851 \pm 24.44
Larvae number/hapa/month	74,443 \pm 3758	74,571 \pm 3821	76,629 \pm 2200
Larvae weight/female	32.17 \pm 1.62	32.22 \pm 1.65	33.11 \pm 0.950
Larvae number/female	2,895 \pm 146	2,900 \pm 149	2,980 \pm 86
Spawning intervals, day	19.59 \pm 1.05	19.55 \pm 1.07	19.03 \pm 0.56
Frequency spawning/female	5.36 \pm 0.27	5.37 \pm 0.28	5.52 \pm 0.16

Values in the same row with different superscripts are significantly different ($P \leq 0.05$)

Average larvae weight/female approximately 6 g and average larvae number/g = 90 larva

Spawning efficiency after resting:

Spawning performance of *O. niloticus* under different broodstock after resting schedules are presented in Table 3. Resting system in pond had the highest larvae weight/hapa, larvae number/hapa, larvae weight/hapa/month, larvae number/hapa/month, larvae weight/female, larvae number/female and frequency spawning/female being 1400, 126000, 700, 63000, 15.56, 1400 and 2.59, respectively and the best spawning intervals whereas the control (without) had the lowest estimates values. The rest in hapa and in pond treatments had significant differences and the mean values for total larvae production per hapa were increased by (258 and 325%, respectively) than control (without

resting). Larvae number/females; frequency of spawning had the same trend. In all parameters, resting broodstock in ponds were improved more than broodstock without rest (control) by approximately three times and quarter and broodstock rested in hapa improved by about two and half times than control.

The results appeared significantly improved for spawning performance with larvae collected from brood resting in pond and hapa than that collected directly from hapas without resting. This may be due to the active roles of rested males in courtship. It seems that a short period of 15 days of resting males, like females, might be optimum.

Table 3. Spawning efficiency of Nile tilapia brood after resting system (mean \pm S.E.)

	Resting system		
	Without	In hapa	In pond
Number of days	60	60	60
Total larvae weight/hapa, g	430 ^c \pm 12.25	1110 ^b \pm 57.70	1400 ^a \pm 102.55
Total larvae number/hapa	38700 ^c \pm 1103	99900 ^b \pm 5193	126000 ^a \pm 9230
Larvae weight, g/hapa/month	215 ^c \pm 6.13	555 ^b \pm 28.85	700 ^a \pm 51.28
Larvae number/hapa/month	19350 ^c \pm 551	49950 ^b \pm 2596	63000 ^a \pm 4615
Larvae weight/female	4.78 ^c \pm 0.14	12.33 ^b \pm 0.64	15.56 ^a \pm 1.14
Larvae number/female	430 ^c \pm 12.25	1,110 ^b \pm 57.70	1,400 ^a \pm 102.55
Spawning intervals, day	94.40 ^a \pm 2.73	29.44 ^b \pm 1.62	23.53 ^b \pm 1.78
Frequency spawning/female	0.80 ^c \pm 0.02	2.06 ^b \pm 0.11	2.59 ^a \pm 0.19

Values in the same row with different superscripts are significantly different ($P \leq 0.05$)

Average larvae weight/female approximately 6 g and average larvae number/g = 90 larva

Spawning efficiency in all season:

Reproductive performance, as indicated by larvae output per hapa or per female was enhanced in broodstock resting in hapa or pond. Mean larvae production for females rested in hapa and pond was increased by 21% and 32% than values of control in all spawning parameters as indicated in Table 4. There was a significant difference in all parameters for the benefit of brood-stock rested than control. The results showed significantly improved spawning

performance with larvae collected from brood resting in pond and hapa than that collected directly from hapas without resting. This may be due to the active roles of rested males in courtship and females restore vitality, strength and production more quantity of egg. These results are in agreement with the results obtained by Lovshin and Ibrahim (1988), Ambali (1990), Little *et al.* (1993) and Ridha and Cruz (2003).

Table 4. Effect of resting systems on pawning efficiency of Nile tilapia brood (mean \pm S.E.)

	Resting system		
	Without	In hapa	In pond
Number of days	180	180	180
Total larvae weight/hapa, g	3,325 ^b \pm 136.17	4,010 ^a \pm 103.06	4,380 ^a \pm 99.58
Total larvae number/hapa	299250 ^b \pm 12255	360900 ^a \pm 9275	394200 ^a \pm 8965
Larvae weight, g/hapa/month	554.17 ^b \pm 27.23	668.33 ^a \pm 20.61	730 ^a \pm 19.92
Larvae number/hapa/month	49875 ^b \pm 2451	60150 ^a \pm 1855	65700 ^a \pm 1792
Larvae weight/female	36.94 ^b \pm 1.51	44.56 ^a \pm 1.15	48.67 ^a \pm 1.11
Larvae number/female	3325 ^b \pm 136.17	4010 ^a \pm 103.06	4380 ^a \pm 99.58
Spawning intervals, day	29.39 ^a \pm 1.16	24.29 ^b \pm 0.59	22.23 ^b \pm 0.49
Frequency spawning/female	6.16 ^b \pm 0.25	7.43 ^a \pm 0.19	8.11 ^a \pm 0.18

Values in the same row with different superscripts are significantly different ($P \leq 0.05$)

Average larvae weight/female approximately 6 g and average larvae number/g = 90 larva

The lower spawning parameters observed in the control treatment compared with two resting systems was probably caused by exhaustion of broodstock (Ridha and Cruz 1998 and Ridha *et al.* 1998) and by the establishment of a stronger social hierarchical structure with time in control (without resting) treatment according to Little *et al.* (1993) and Ridha and Cruz (2000).

Economic efficiency:

The economic efficiency of the tilapia hatcheries that applying these systems and containing 30 hapas of broodstock (2700 female + 900 male) is presented in Table 5. The net returns from each hatchery was higher with brood-stock rested in ponds followed by brood-stock rested in hapas and the last is the control.

This study showed that if larvae collected from brood-fish rested in ponds every 5 days in a hatchery contained 3600 broodstock (30 hapa) produced about 9.460 million followed by broodstock rested in hapa 8.66 million and control 7.18 million fry after sex reversal in a spawning season. Net returns in L.E per hatchery were 115868; 97886 and 66595 for the larvae collected from broodstock rest in ponds, in hapa and control, respectively. Percentages of net return to total cost were 119.45; 100.9 and 70.1% for brood-stock rest in ponds, in hapa and control, respectively. The results indicate that the highest net return was obtained with the larval collecting from brood-stock rest in ponds.

Table 5. Economic efficiency of tilapia hatchery (30 hapa) under different resting systems

Item	Resting system		
	Without	In hapa	In pond
Hatchery costs, L.E.			
Brood	20000	20000	20000
Feed	25000	27000	27000
Equipment and apparatus	25000	25000	25000
Other (land, labors)	25000	25000	25000
Total costs	95000	97000	97000
Selling fry, L.E.			
Mono sex fry	8079750	9744300	10643400
Total sales	161595	194886	212868
Net returns/hatchery, L.E	66595	97886	115868
Net returns/total costs %	70.10	100.91	119.45

Price of 1000 fry was 20 L.E

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تأثير نظم الراحة اثناء موسم التفريخ على كفاءة تفريخ البلطي النيلي في المفرخات التجارية

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اجريت هذه التجربة لمقارنة تأثير نظامين لراحة الامهات لمدة 15 يوم (في هابيات و الاحواض) مقابل الكنترول (بدون راحة) لمدة 6 اشهر لانتاج يرقات وتفريخ البلطي النيلي الموجودة في 12 هابة بكل منها 25 م³ ماء ومثبتة في حوض ترابي. مثلت كل معاملة بأربع معاملات. وزعت ذكور واناث الاسماك الناضجة بمتوسط وزن 140 جم و 125.4 جم بمعدل 120/هابة بنسبة جنسية 1: 3 (ذكور: اناث). كان متوسط درجة الحرارة 29 درجة والملوحة 2.4 جزء في الالف خلال التجربة. اوضحت النتائج ان الامهات في نظم الراحة اعطت اعلى انتاج لليرقات ومظاهر التفريخ بالمقارنة بالتي لم يتم راحتها. نظم الراحة انتجت زيادة 20.6 و 31.7% في انتاج اليرقات/ ام وكل مظاهر التفريخ كانت اعلى في الامهات التي ريححت في الهابيات او الاحواض عن التي لم يتم راحتها. وتشير النتائج الى ان استراتيجية راحة الامهات تحسن صفات التفريخ ونظام الراحة في الاحواض يفضل ولكنه يواجه عدة مشكلات في التطبيق من حيث حاجته لوجود عدد اكثر من الاحواض في المفرخ وهذه لا تتوفر في معظم المفرخات.