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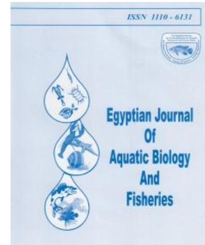

Improved technological innovation and management aspects in the Nile tilapia, *Oreochromis niloticus*, seed production

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ABSTRACT

The Nile tilapia, *Oreochromis niloticus*, is the queen of the fish; not only in Egypt but also in Africa because it is the food of the poor and the rich. The present work aimed to shed light on how to enhance Nile tilapia seed production through the study of some technological innovation and management aspects in Egypt by introduced Automated Monitoring and Control System (AMCS) to control water quality in El-Serow Hatchery, Dakahlia Governorate, Egypt. The results showed that from technological innovation viewpoint AMCS has led to positive results: rationalization of water and electricity use; increased the number of fertilized eggs by 23.8 %; increased production of tilapia seed by 20.2 % and improve growth and feed conversion ratio of the newly hatched larvae during nursing period by 23.6% and 14.6%, respectively. Under Automated Monitoring and Control water quality System, in order to obtain the much higher quantity and quality of Nile tilapia seeds, it is recommended to use broodstock at moderate stocking densities: 4.5 and 6.0 fish.m^{-3} with six ratios 3♀:1♂ during the spawning season in hatcheries.

INTRODUCTION

Tilapia is one of the most important cultured fish in the world. However, the gap between seed supplies and farmers demand is one of the serious limitations for tilapia culturists. The growth of aquaculture lies in the ability of the hatcheries to be able to produce and supply fish seeds for stocking production ponds on a sustainable basis (Coward and Bromage 2000; Ronald, 2010 and Essa *et al.*, 2016). The steadily growing importance of fish farming has compelled improvements in the technologies necessary for securing the initial and basic requirements for productive aquaculture; namely the production of fish seed for stocking.

Nile tilapia, *Oreochromis niloticus*, is the queen of the fish, not only in Egypt but also in Africa because it is the food of the poor and the rich. It constitute a major and important fish in the Egyptian aquaculture، with tilapia production reaching 967301 tons in 2017 representing about 66.63% of total aquaculture production (GAFRD, 2018).

Improved technologies for enhanced Nile tilapia seeds production in Egyptian hatcheries is a must. This is despite that the production of tilapia hatcheries arrived 102 million unit (GAFRD, 2016), but the needs of farms has increased by 60% in the last ten years to shift many of the tilapia farms from semi-intensive to intensive system (Essa *et al.*, 2016). Determination of brood density and appropriate size or weight was considered a positive tool for the management of Nile tilapia hatcheries because it may have consequences for reproductive efficiency (Salama and Essa, 1995; Ridha and Cruz,1999; Mashaii *et al.*, 2016). Also, increased knowledge of the factors that regulate brood productivity are of great importance for the further development of tilapia culture especially the overall environmental approach, age or weight, storage density, sex ratio and nutrition (Tahoun *et al.*,2008; Orlando *et al.*,2017; Suloma *et al.*,2017; Helal *et.al* 2017 ; Mashaii *et.al.*2019). These researchers have recommended further research to determine whether the weight, number or age of the brood should be the basis for maternal storage.

Therefore, the present work aimed to shed light on how to enhance Nile tilapia, *Oreochromis niloticus*, seed production through study some hatchery technological innovation and management aspects in Egypt.

MATERIAL AND METHODS

This work is a part of the African Union project outputs, "Improved management and technological innovation in African tilapia farms and hatcheries (ITACA)", funded by a grant from the European Union to the African Union 2012 (Agreement No REG/FED/2009/021/-575).

The present study was demonstrated at El-Serow Hatchery, National Institute of Oceanography and Fisheries (NIOF), Dakahlia Governorate, Egypt during 2014 to 2015.

3- El-Serow Experimental Research Hatchery

The total volume of water was1500 m^3 divided into four spawning greenhouses with an area of 440 m^2 greenhouse each (8 × 55 m). Each greenhouse was contain 17 spawning concrete rectangle concrete basins (16 m^3, 8 × 2 × 1 m) (Fig. 1).

The spawning and rearing basins was supply by a constant flow of water. The basins were illuminated using 60 cm fluorescent tubes fixed above the basins which emitted a light intensity of 2500 Lux, and the light duration was set at 18 h day^{-1}. A central air blower with a continua flow was used for aeration.

Fig. 1: Four spawning greenhouses and spawning concrete basins in El-Serow Hatchery, NIOF, Egypt

2- Automated Monitoring and Control System (AMCS)

In order to study the possibility of improvement the production of Nile tilapia seed (fry) in El- Serow hatchery, Water Quality Automated Monitoring and Control System-AMCS as a new technology has been designed for the first time in Egypt (Fig. 2). AMCS was having entailed the following major steps:

i. Installation of the electrical cabinet containing the controller, the data logger and other auxiliary items.
ii. The DO and temperature probes as well as the pH probes and their respective display devices were installed in the hatchery ponds and conveniently connected to the AMCS controller.
iii. Wiring in order to enable the activation of the systems by the controller (fresh water valves, hot water vales and air blowers).
iv. Communication test, verification of sensor readings and final tuning of the control algorithms and parameters set points.
v. Training to the end-users on the AMCS, focused on two main areas: (1) the maintenance of the installed equipment, including cleaning operations as well as preventive maintenance, sensors' calibration operations and basic troubleshooting; and (2) use of the AMCS including how to modify the established set points, how to display and download the data recorded by the data logger of the AMCS, etc.

Water quality Automated Monitoring and Control System (AMCS) In El-Serow Hatchery during the present trial.

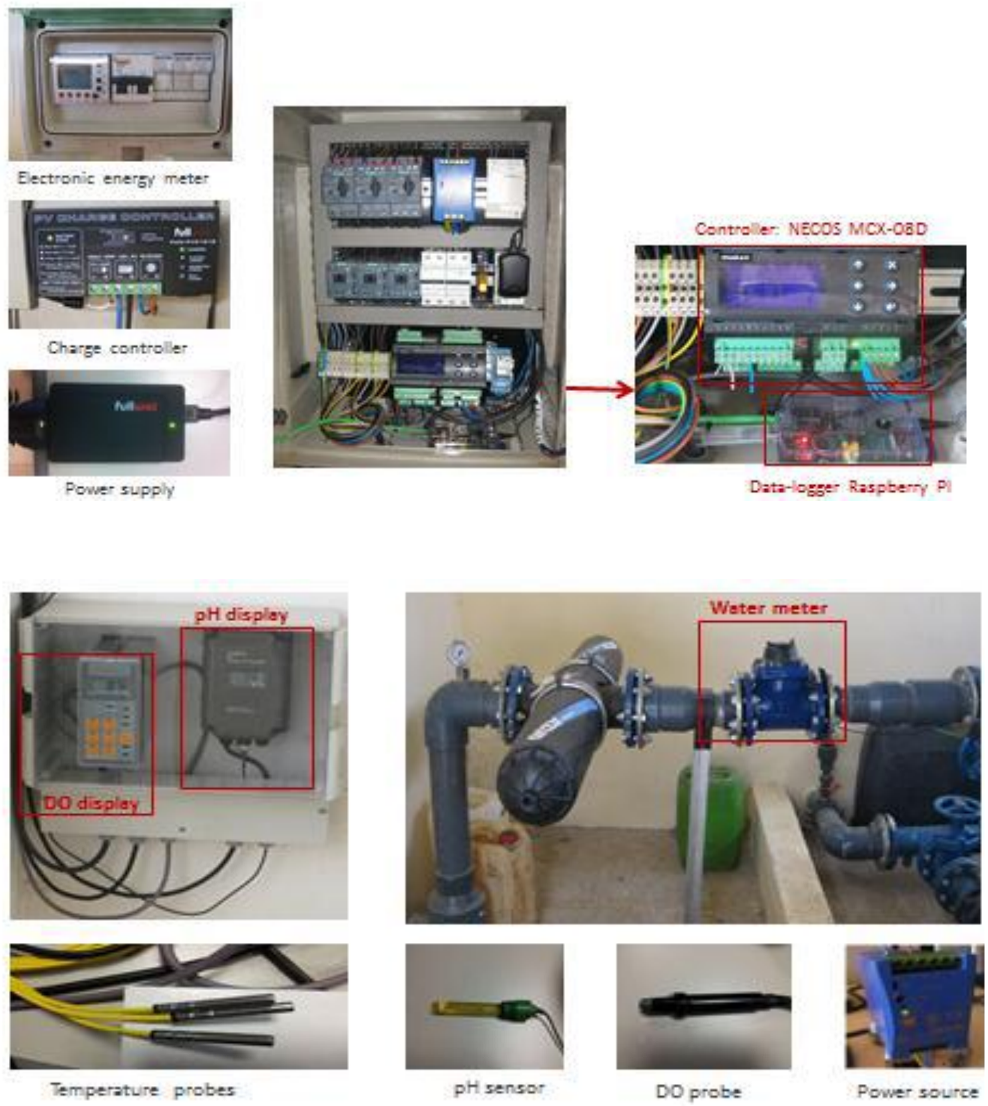

Fig. 2: Water Quality Automated Monitoring and Control System (AMCS) in El-Serow Hatchery. NIOF, Egypt.

3- Experimental treatments

3.1 Experiment I

The present study was conducted to investigate the effect of using the Automated Monitoring and Control System (AMCS) to controlling the water quality in El-Serow Hatchery on the reproductive efficiency and seed production parameters of Nile tilapia, *Oreochromis niloticus*, spawners for 4 months.

Six rectangle concrete basins (16 m^3, each) were used for two experimental treatments (three replicates per treatment). While the first treatment was carried out without AMCS system and consider as control in one greenhouse under normal conditions. The other three concrete basins was carried out with AMCS system.

In the two treatments, a total number of 480 Nile tilapia broodstock (120 male + 360 female) were selected and randomly stocking at sex ratio of 1:3 (20 male + 60 female, 5 fish.m^{-3}) to each six basins. The average body weights for both male and female was ranged from 223 to 238 g (Essa, 1993).

Table 1: Composition and proximate analysis of Nile tilapia broodstock diet during the present work.

Ingredient	**%**
Fish meal	23.0
Soybean meal	25.0
Corn grain	23.0
Wheat bran	23.0
Soybean oil	3.0
Vitamin and mineral premix*	2.0
Carboxy-methyl cellulose	0.5
NaCl	0.5
Total	100
Analyzed composition (dry matter basis)	
Dry matter (%)	92.46
Crude protein (%)	38.50
Lipid (%)	10.50
NFE (%)	34.20
Ash (%)	9.26
Gross energy (kcal Kg-1)	4644.08

***** Vitamins and minerals mixture each 3 Kg of mixture contains: 10,000,000 I.U. Vitamin A; 2,500,000 IU Vitamin D3; 10,000 mg Vitamin E; 1000 mg Vitamin K; 1000 mg Vitamin B1; 5000 mg Vitamin B2; 1500 mg Vitamin B6; 10 mg Vitamin B12; 30,000 mg Niacin; 10,000 mg Pantothenic acid; 1000 mg Folic acid; 50 mg Biotin; 300 mg Iodine; 30 000 mg Iron; 60,000 mg Manganese; 4000 mg Copper; 100 mg Cobalt; 100 mg Selenium; 50,000 mg Zinc; 3000 g Calcium Carbonate**.**

3.2.Experiment II

The effects of different broodfish densities on the reproductive performance and seed production of Nile tilapia, *O. niloticus*, spawners was investigated for 126 days using AMCS in El-Serow hatchery, NIOF, Egypt.

The broodstocks were separated by sex and maintained for two weeks in concrete basins as showed in Fig.1.

Nine rectangle concrete basins (16 m^3, each) was used for three experimental treatments (three replicates per treatment) using AMCS system.

A total number of 640 Nile tilapia broodstock (180 male + 480 female) were selected and randomly stocking at three stocking densities 4.5, 6.0 and 7.5 fish.m-3 at sex ratio of 1:3 (20 male + 60 female) to each nine basins. The average body weights was ranged from 153 and 159 g for males and105 – 109 g for females.

The following reproductive and seed production parameters were determined according to Mair *et al.* (2004), Tahoun *et al.* (2008) and Mashaii *et al.* (2019):

The weights of the males and females broodstock were measured using a digital precision scale (0.01 g). Every 2 weeks, seeds were collected from the spawning basins. Gonadosomatic index (GSI), Spawning rate (%), total egg number per kg female, egg diameter (mm), spawning intervals(day), seed production per female and g female, seed production / female/ day, seed production / basin 16 m^3/ m^3 water/ day as well as average weight of newly hatched larvae (g) were obtained.

3.3.Water quality

Water quality was maintained throughout the experiment at temperature (25.8 ± 1.6 °C), pH (7.7 ± 0.4), NH_3 (0.002 ± 0.00) and dissolved oxygen (6.75 ± 0.59) under AMCS hatchery system which was suitable and recommended for the survival and reproduction of Nile tilapia breeding (Little and Hulata, 2000). Furthermore the technical validation of the technologies implemented has been conducted. Growth Performance Parameters of Nile tilapia newly hatched larvae during nursing period (28 days) were determined as a result of introducing water quality

3.4. Experimental diets

Broodstock was fed a diet containing 38.50 % CP and 4644.08 Kcal ME. Kg^{-1} (Table 1) at a feeding rate of 1.5 % of total biomass in each experimental basin (six days/ week) for 4 months. Feed was introduced at 10:00 and 15:00 h. The feed amounts was adjusted depending on the increased of body weight of Broodstock each 15 days.

The newly hatched larvae was starting fed from the fourth day age on a powdered diet containing 35 % CP and 3312 Kcal ME (Sherbeen Factory for Fish, Animal and Poultry Feed - Dakahlia Governorate, Egypt) at a rate ranged from 10 – 20 % of total fry biomass/ day during nursing period (28 days).

4. Reproductive Performance and seed production parameters

The following reproductive and seed production parameters were determined according to Mair *et al.* (2004), Tahoun *et al.* (2008) and Mashaii *et al.* (2019) as a following:

- The weights of the males and females broodstock were measured using a digital precision scale (0.01 g).
- Every 2 weeks, seeds were collected from the spawning basins.
- Gonadosomatic index (GSI), spawning rate(%), total egg number per kg female, egg diameter (mm), spawning intervals(day), seed production per female and g female,

seed production / female/ day, seed production / basin 16 m^3/ m^3 water/ day as well as average weight of newly hatched larvae(g) were obtained.

5. Performance parameters of the newly hatched Nile tilapia

The average weight gain (g), percent gain in weight (%) specific growth weight ($\%.day^{-1}.fish^{-1}$), survival percentage and feed conversion ratio were determined according to Tahoun *et al.* (2008):

6. Water quality parameters

Temperature, unionized ammonia NH_3 ($mg.l^{-1}$), pH, salinity and dissolved oxygen ($mg.l^{-1}$) were regularly estimated in experimental basins according to Boyd (1990), little and Hulata (2000).

***7.* Statistical analysis**

Statistical analysis of each experiment was subjected to a one-way analysis of variance (ANOVA) and Duncan's new multiple range test at a 5% level of significance using the SPSS program (SPSS 1996).

RESULTS AND DISCUSSION

1. Enhanced Nile tilapia seed production through improved technological innovation:

Water quality control and forecasting play an important role in the modern management of fish hatchery and fish seed production. Fish and other organisms with aquaculture potential live in water, thus, it is no surprise that professional fish culturists state that "Water quality determines to a great extent the success or failure of a fish cultural operation" (Piper *et al.* 1982). Therefore, the present trial was conducted to investigate the effect of using the water quality Automated Monitoring and Control System (AMCS) in El-Serow Hatchery on the reproductive efficiency and seed production parameters of Nile tilapia, *Oreochromis niloticus*, broodstock. The introduction of this technology has produced positive results, which can be illustrated as follows:

1) Rationalization of normal water use.

2) Rationalization of electricity use

3) There was a significant improvement in the parameters of reproductive efficiency and the production of Nile tilapia seeds. Reproductive performance of female Nile tilapia broodstock was reported in Table (2). As the results of using of water quality Automated Monitoring and Control System (AMCS) in El-Serow Hatchery showed a significant increase in ovarian weight, Gonad somatic index and egg diameter than the treatment 2 (Green house without AMCS) by 16.35%, 21.13% and 7.64%, respectively. Also, the highest values for egg number Kg $female^{-1}$ (4114 egg), seed production $female^{-1}$ (1249.55 seeds), seed production g female-1 (5.61 seeds) was recorded for treatment (1) with AMCS system, while the lowest values (2423.00, 1039.75 and 4.62, respectively) were recorded for the second treatment (without AMCS system) (Table 3). This may be due to

the fact that under the conditions of the water quality Automated Monitoring and Control System (AMCS), best water quality is always maintained, as the parameters are at an appropriate levels for spawning. In the current trial, temperature (25.8 ± 1.6 °C), dissolved oxygen in the water was not less than 6.0 mg $.l^{-1}$, ammonia did not exceed 0.002 mg $.l^{-1}$and the pH values has always been on the alkaline side (Behrends and Smitherman, 1983, Boyd, 1990, Little and Hulata, 2000, Devi *et al.*, 2017).
Reproductive performance of female Nile tilapia broodstock is shown in Table (2). Nile tilapia females showed a significant increase in ovarian weight, gonad somatic index and egg diameter as the results of the using of AMCS compared the treatment without AMCS by 16.35%, 21.13% and 7.64%, respectively. The highest values for egg number kg $female^{-1}$ (4114 egg), seed production $female^{-1}$ (1249.55 seeds), seed production g $female^{-1}$ (5.61 seeds) were recorded for treatment with AMCS system, while the lowest values (2423.00, 1039.75 and 4.62, respectively) were recorded for the treatment without AMCS system (Table 3). This may be due to the fact that under the conditions of the water quality Automated Monitoring and Control System (AMCS), best water quality is always maintained, as the parameters are at an appropriate level for spawning. In the current trial, temperature (25.8 ± 1.6 °C), dissolved oxygen in the water was not less than 6.0 mg l^{-1}, ammonia did not exceed 0.002 mg $.l^{-1}$ and the pH values has always been on the alkaline side (Behrends and Smitherman, 1983, Boyd, 1990, Little and Hulata, 2000, Devi *et al.*, 2017).

Maintaining the integrity and quality of the aquatic environment on fish farms and hatcheries has been well documented as an important factor affecting fish health and fish growth performance (Piper *et al.*, 1982, Yoo and Boyd, 1993 and Devi *et al.*, 2017). Our results clearly demonstrated that the water quality Automated Monitoring and Control System (AMCS) in El-Serow Hatchery had a positive impact on Nile tilapia larvae growth performance and feed utilization parameters as well as survival rate evaluated. The present results recorded the improvement in the growth, feed utilization and survival (%) of newly hatched Nile tilapia larvae nursed for 28 days under conditions of AMCS compared to the treatment without the AMCS system. Final live body weight, gain in body weight, daily growth, feed conversion ratio and survival (%) of *O. niloticus* larvae, is given in Table 4. The results revealed that the treatment with AMCS system achieved the best values for average weight gain, average daily weight gain, percent gain in weight, specific growth rate, feed conversion ratio and survival (%) (4.25 g, 0.15 $g.fish^{-1}.day^{-1}$, 3035.0%, 1.50%/day, 1.51 and 95.11% , respectively) compared to the treatment without AMCS system (3.18 g, 0.11 $g.fish^{-1}.day^{-1}$, 2650.0%, 1.21%,1.73 and 91.73%, respectively). Mean differences between treatments were found to be significant ($P < 0.05$).

Table 2: Average ± SE female reproductive parameters of Nile tilapia broodstock as affected by introducing water quality Automated Monitoring and Control System (AMCS) In El-Serow Hatchery, Egypt*.

Mean female body weight (g)	Mean (male) body weight (g)	Ovary weight g female^{-1}	Egg diameter (mm)	GSI** (%)
Treatment 1 :Green house with AMCS system				
227.00 ± 22.10	238.00 ± 16.11	9.25^{a} ± 1.75	1.55^{a} ± 0.12	4.07^{a}± 0.38
Treatment 2 :Green house without AMCS				
223.50 ± 4.96	231.60 ± 4.96	7.95^{b} ± 2.50	1.44^{b} ± 0.00	3.36^{b}± .53

*In each row, means followed by different superscript letters are significantly different (P<0.05).
** GSI : Gonadosomatic Index.

Table 3 : Eggs and Seed production parameters of Nile tilapia broodstock as affected by introducing water quality Automated Monitoring and Control System (AMCS) In El-Serow Hatchery, Egypt*

Egg number Kg female^{-1}	Seed production g female^{-1}	Seed production female^{-1}
Treatment 1: Under Water Quality AMCS System Conditions:		
4114^{a} ± 360.10	5.61^{a} ± 0.46	1249.55^{a} ± 48.92
Treatment 2: Without Water Quality AMCS System Conditions:		
2423^{b} ± 163.70	4.62^{b} ± 0.16	1039.75^{b} ± 33.07

*In each row, means followed by different superscript letters are significantly different (P<0.05).

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Table 4: Growth Performance Parameters of Nile tilapia newly hatched larvae during nursing period (28 days) as affected by introducing water quality Automated Monitoring and Control System (AMCS) In El-Serow Hatchery, Egypt*.

Parameters	T1: with AMCS system	T2: without AMCS system
Initial weight (g.fish^{-1})	0.14± 0.01	0.12 ± 0.00
Final weight (g.fish^{-1})	4.39^{a} ± 0.55	3.30^{b} ± 0.021
WG (g.fish^{-1})	4.25^{a} ± 0.51	3.18^{b} ± 0.19
Average daily gain(ADG)g.fish^{-1}.day^{-1}	0.15 ± 0.00	0.11 ± 0.02
Percent gain in weight (%)	3035^{a}	2650^{b}
Specific growth weight (%.day^{-1}.fish^{-1})	1.5	1.21
Feed conversion ratio	1.51± 0.08	1.73±0.10
Survival (%)	95.11^{a}± 1.16	91.73^{b} ± 1.75

*In each row, means followed by different superscript letters are significantly different (P<0.05).

2- Enhanced Nile tilapia fry production through scientific management aspects:

Efficiency of the hatchery is affected by the management and would increase if optimum levels of the management are used. Thereby the present experiment aimed to investigate the effects of different broodfish stocking densities , 4.5, 6.0 and 7.5 fish.m^{-3} with a sex ratio 1:3 (Male: Female)(Delong *et al*., 2009) on the reproductive performance and seed production of Nile tilapia, *O. niloticus*, spawners under the water quality Automated Monitoring and Control System (AMCS) management conditions in El-Serow Hatchery.

The results in Tables 5 and 6 indicated that:

- The water quality parameters in the experimental basins were appropriate for tilapia propagation throughout the study period where temperature (24.0 to 27.9 °C), dissolved oxygen in the water was not less than 7.10 mg.l^{-1}, ammonia (NH_3) did not exceed 0.021 mg .l^{-1} and the pH values has always been on the alkaline side (Table 5) (Behrends and Smitherman, 1983, Boyd, 1990, Little and Hulata, 2000). However increased density rates in tilapia broodstock significantly ($P \leq 0.05$) reduced the reproductive performance and seed production parameters. The lower stocking density had the best spawning rate, mean spawning intervals, seed production / female, seed production / g female, seed production / female/ day, seed production / m^3 water basin/ day and average weight of newly hatched larvae were found in fry group spawned by broodstock, held at the 4.5 fish.m^{-3}stocking density followed by 6.0 fish.m^{-3} and finally 7.5 fish.m^{-3} (Table 6), and the differences were significant ($P<0.05$). However, the differences in average weight of newly hatched larvae were insignificant. One of the physiological mechanisms associated with these shifts in behavior is the suppression of serum sex steroid levels in the females; levels rise rapidly when fish are transferred to less crowded conditions, usually concurrent with a renewal of spawning activity (Coward *and Bromage*, 2000). The results of this study are also consistent with the corresponding results from Reda and Cruz (1999), Zimmerman *et al*. (2000), Tahoun *et al*. (2008) and Machaii *et al*. (2019) that the reproductive efficiency in Nile tilapia broodstock can decrease in the rate of egg and fish seed production under conditions of high stocking density. This of course is due to at high densities, there is a competition for space which increases social interaction and in turn, causes social stress may be responsible for low utilization of food and poor growth leading to low fecundity and possibly thereby affecting reproductive efficiency. Also, in the present study, although the treatment 7.5 fish.m^{-3}achieved the least results, it surpassed the results of other trials as a result of the use of the AMCS system that preserved the water environment in the concrete hatchery basins suitable for Nile tilapia spawning throughout the study period. The average of spawning rate and seed production/ female/ day in the current study were 77.70 % and 5.71 seeds at a density 7.5 fish.m^{-3}, which were 3.5 and 2,5 times higher than the counterpart at a density 8 fish.m^{-3} (22,30 % and 2.30 seeds, respectively) by Ridha and Cruz (1999) under hatchery water recycling conditions.

Therefore, under the management conditions of Water Quality Automated Monitoring and Control System (AMCS) of Nile tilapia (*O. niloticus*) hatchery, in order to obtain much higher quantity and quality of Nile tilapia seeds, it is recommended to use broodstock at a moderate stocking densities: 4.5 and 6.0 fish.$m^{-3}$with six ratio 3♀:1♂ during the spawning season in hatcheries.

Table 5: Water quality criteria in spawning concrete basins stocked at three broodstock densities under water quality Automated Monitoring and Control System (AMCS) conditions In El-Serow Hatchery, Egypt*.

Parameter	The range
Water temperature (°C)	24.00 – 27.90
Unionized ammonia (NH3) (mg l^{-1})	0.004 – 0.021
pH	7.21 – 7.73
Salinity (½)	1.40 – 1.52
Dissolved Oxygen (mg l^{-1})	7.10 – 7.80

Table 6: Average spawning efficiency parameters of Nile tilapia broodstock stocked at three stocking densities and sex ratio 1 : 3 (male : female) under water AMCS hatchery system conditions. The data are the means ± SE of three replicates. *

Parameters	**Stocking density (broodstocks .m^3)**		
	4.5	6.0	7.5
Mean male weight (g)	159.00 ± 6.10	154.20 ± 5.30	153.00 ± 5.10
Mean female weight (g)	108.40 ± 3.30	109.00± 3.10	105.60 ± 2.90
Total fish biomass (g basin^{-1})	8715.0^c	11548.8^b	14094.0^a
Spawning rate (%)	98.33^a ± 1.08	86.00^b ± 2.77	77.70^c ± 4.16
Mean spawning intervals (day)	17.50^c ± 3.90	19.55^b ± 4.65	22.20^a ± 4.90
Seed production / female	98.52^a±23.80	894.36^b ±72.10	719.10^c± 55.15
Seed production g female^{-1}	6.28^a ± 1.02	5.80^b ± 1.40	4.70^c ± 1.20
Seed production female^{-1} day^{-1}	7.92^a ± 1.22	7.10a ± 1.21	5.71b ± 1.49
TSP basin^{-1} m^3 water^{-1} day^{-1}**	29.72^a ± 5.0	26.62^b ± 4.6	21.40^c ± 7.80
AWNL***	0.15 ± 0.00	0.15 ± 0.00	0.14 ± 0.01

*In each row, means followed by different superscript letters are significantly different (P<0.05).

** TSP: Total seed production.

*** AWNL: Av. weight of newly hatched larvae (g).

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Arabic Summary

تحسين جوانب الابتكار التكنولوجي والإدارة في إنتاج زريعة البلطي النيلي

عمرو منير هلال ، باسم سعد عبد العاطى ، محمد على شحاتة العقبى ونيفين محمود ابوشبانة، محمد عبد الرازق عيسى
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البلطي النيلي، ، هو ملكة الأسماك، ليس فقط في مصر ولكن أيضا في أفريقيا لأنه غذاء الفقراء والأغنياء. يهدف العمل الحالي إلى تسليط الضوء على كيفية تعزيز إنتاج زريعة البلطي النيلي من خلال دراسة بعض الابتكارات التكنولوجية وادارة مفرخات البلطى . تم ادخال نظام الرصد والتحكم الآلي لجودة المياه في مفرخ السرو التابع للمعهد القومى لعلوم البحار والمصايد بمحافظة الدقهلية ، مصر. وأظهرت النتائج أنه من وجهة نظر الابتكار التكنولوجي قد أدى ذلك إلى نتائج إيجابية نوجزها فى : ترشيد استخدام المياه والكهرباء - زيادة عدد البيض المخصب بنسبة ٢٣.٨ ٪ - زيادة إنتاج يرقات البلطي بنسبة ٢٠.٢ ٪ - تحسين معدل النمو ومعدل التحويل الغذائى فى يرقات البلطى الحديثة الفقس خلال فترة التحضين بنسبة ٢٣.٦ ٪ و ١٤.٦ ٪ على التوالي. كما اتضح ايضا من نتائج الدراسة تحت نظام الرصد والتحكم الألى لجودة المياه انه من أجل الحصول على كمية ونوعية أعلى بكثير من يرقات البلطي النيلي يوصى باستخدام أمهات بلطى نيلى بكثافة تخزين معتدلة: ٤.٥ - ٦.٠ سمكة / م ٣ مع نسبة جنسية ٣ ♀: ١♂ خلال موسم التفريخ في المفرخات.