REPRODUCTIVE PERFORMANCE OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*) AT DIFFERENT LEVELS OF WATER TEMPERATURE AND REARING OF FRY AT DIFFERENT STOCKING DENSITIES

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Abstract

The present study includes natural spawning of Nile tilapia (*Oreochromis niloticus*) under different levels of water temperature and rearing of fry at different stocking densities of Nile tilapia (*Oreochromis niloticus*).

The study indicated that there are significant differences between different levels of water temperature 22 °C – 25 °C , 26 – 31 °C and 34 – 37 °C for number of fry per female and number of fry per (gm) of female body weight of *Oreochromis niloticus*. Also, the results indicated that there were a significant difference in rearing of fry at different stocking rates 300 fry / m^3, 150 fry / m^3 and 75 fry / m^3, for growth parameters. The survival rate showed no significant differences between stocking rates 300 fry / m^3 and 150 fry / m^3, while, there was a significant differenc between them and stocking density 75 fry / m^3.

It was concluded that the water temperature 26 – 31°C is the best for reproductive performance and growth. Also, stocking density 75 fry / m^3 was the best result for growth of Nile tilapia than other stocking density.

INTRODUCTION

Tilapia only show secondary sexual characteristics and spawn at temperature above 20 – 23 °C. Thus, in equatorial regions the fish will spawn all year round, but in subtropical and in high-altitude tropical areas, reproduction will be restricted during the cold months. Furthermore, prolonged exposure of *O. niloticus* to temperatures below 20 °C has been reported to result in a failure of immature, to mature and, in mature fish, gonad reabsorption took place (Mishrigi and Kubo, 1978). High temperatures have been shown to stimulate an increase spawning under laboratory conditions. Ray (1978) reported the temperature control alone to be successful factor in increasing reproduction during the winter months, even though, the photoperiod was shorter. Lowering temperature from 25 to 18 °C for two weeks, and then raising it back again, has been possible to induce over 50 per cent of female *O. niloticus* to spawn. Rothbard (1979) reported that the optimal temperature range for spawning for most species is 26 to 29 °C.

The environment plays an important role in initiating at least the reproductive cycle in *Oreochromis mossambicus*. An increase in photoperiod, rainfall and water temperature together with a decrease in water pH are causes for gonadal maturation (Cornish and Smit, 1995). Major environmental factors involved in causing reproductive activity are temperature and photoperiod (Balarin and Hatton, 1979). The photoperiod is generally accepted as the most important factor synchronizing sexual maturation and reproduction in fish (Bromage *et al.*, 2001). Use of photoperiod manipulation to alter the incidence of sexual maturation and the time of spawning has been reported for number of species (Duston *et al.*, 2003).

The number of eggs per spawn may differ among species, but, within species the number of eggs increased with increasing weight of female (Badawy, 1993).

The normal range of water temperature for tilapia is 19 to 30 °C (Wohlfarth and Hulata, 1981), and the optimum temperature for maximum growth is between 19 and 28°C (Balarin and Hatton, 1979). The use of high stocking density is considered a stress as previously mentioned by Vijayan and Leatherland (1988). However, it is still not clear how high stocking density influences the growth of fish.

The aim of this work is to investigate different levels of water temperature on reproductive performance and rearing of *Oreochromis niloticus* fry at different stoking densities.

MATERIALS AND METHODS

The experimental study was carried out in Experimental Station of Research of Freshwater Fish at Bechima El-Hamma - Gabes in South Tunisia.

The study includes spawning of *Oreochromis niloticus* under different water temperatures and rearing of fry at different stocking densities.

The work was a cooperation between Ministry of Agriculture of Egypt and Ministry of Agriculture of Tunisia.

Spawning of brood fish under different conditions. Fifty-four female and 18 males were randomly assigned to nine fiberglass tanks (2m X 1m X 1m) at sex ratio of one male to three females per cubic meter of fiberglass tank. The water used in the fiberglass tanks comes from giothermal water, which supplies the experimental station of freshwater fish at Bichima El-Hamma – Gabes in South Tunisia.

Water depth was maintained at 40 cm and water was completely changed every day. Fish were exposed to different water temperatures (22 – 25 °C, 26 – 31 °C and 34 – 37 °C) at natural photoperiod. Numbers and weights of (*Oreochromis niloticus*) broodfish of are presented in Table 1.

Table 1. Numbers and weights of (*Oreochromis niloticus*) Broodfish.

Treatments	Density	No.of Females	No of Males	Sex Ratio	Wt. of Female (g)	Wt. of Male (g)
22-25°C	4 / m	6	2	3 : 1	159±2.64	148.3±9.27
26-31°C	4 / m	6	2	3 : 1	171±3.05	167.6±14.5
34-37°C	4 / m	6	2	3 : 1	155±10	184.3±4.9

Feeding brood fish and fry. Brood fish were fed a pellated commercial fish diet containing 21.5 % of crude protein. The brood fish were fed 7 days per week at a rate of 3 % of their biomass two times / day. The fry were collected with dep net after drainage of wate, then transferred to fiberglass tanks and grown to fingerlings stage in nursery tanks.

Fish feeding was carried out in fiberglass tanks, filled with freshwater fish. Fry were fed commercial fish diet containing 25 % crude protein. The composition of artificial fish feed was: fish meal 9%, meat meal 9%, cotton seed 10%, Soya bean meal 10%, wheat bran 15%, yellow corn 30%, rice bran 15%, and mollase 2%, as recommended by Allen and Nelson (1910). Fry received the diet about four times per day, 7 days per week.

Rearing of *Oreochromis niloticus* fry at different stocking densities. Rearing of *Oreochromis niloticus* fry at different stocking densities was carried out in fiberglass tanks to investigate the effect of rearing fry under different levels of stocking densities on growth parameters. The stocking density was 300 fry / m^3 , 150 fry / m^3 and 75 fry / m^3. Water temperature was adjusted to be 28 °C – 31 °C. Dissolved oxygen concentrate was 6 ppm, salinity 2.8 ppt and pH 7.6 as determined daily. The area of fiberglass tank was $1m^3$.

Aeration was supplemental, provided by regenerative blower and stones submerged at the bottom of each fiberglass tank.

Source of water

Natural thiothermal water was obtained from under ground at 2500 meter depth. Water temperature was 53 °C. Three sediment ponds were used to store water as a reservoir and reduce the temperature. Each pond provided a group of fiberglass tanks.

Growth parameters

Weight gain (WG) was calculated as follows:

Weight gain = Fwt – Iwt

Where:

Fwt = Final weight, Iwt = initial weight

Daily weight gain (DWG) was calculated as follows:

Daily weight gain = (Fwt – Iwt)/t

Where:

Fwt = Final weight

Iwt = Initial weight

t = Time

Condition factor (K) was calculated according to Lagler (1959) by using the following formula:

Condition factor (K) =Weight (g) /Length $(cm)^3$*100

Statistical analysis

The data were analyzed by analysis of variance. Duncan's Multiple Range test was applied to number fry/female, number fry/g of female body weight, weight gain, daily weight gain and survival rate. All statistics were carried out using Statistical analysis systems (SAS, 2004).

RESULTS AND DISCUSSION

Spawning performance

Spawning rate of Nile tilapia (*Oreochromis.niloticus*) was affected by water temperature in fiberglass tanks. Generally, a temperature of 21- 23 °C is the minimum required for spawning (Huet, 1972). Temperature above 20 °C triggers the development of secondary sexual characteristics and nest building (Frer and Iles, 1972). In the present study, fry were produced at water temperature 22 – 25 °C as shown in Table 2, but, were not produced at temperature lower than 22 °C. This agrees with El-Naggar *et al.* (2000) who reported that Nile tilapia (*Oreochromis niloticus*) did not lay eggs when water temperature decreased below 19 °C. Also, David and Leslie (1983) observed that, in spawning of *Oreochromis niloticus* no seeds were recovered during the first harvest. Table 2 illustrated the average number of fry per female, number of fry per gram of body weight (512±27.15, 706.66±17 and 0.00) and (3.22±0.119, 4.13±0.052 and 0.00) for number of fry / female and numbers of fry / gram of female body weight at different water temperatures 22 – 25 °C, 26– 31 °C and 34 – 37 °C, respectively. Shmul and Yoel., (1975) illustrated that reproduction activity of tilapia begins at 22 °C and the optimal temperature range is 25 – 29 °C. In the present study, when water temperature reached above 34 °C fry did not produce as shown in Table 2. Analysis of variance for different water temperatures showed significant differences between 22 – 25 °C, 26 – 31 °C and 34 – 37 °C at ($P < 0.05$). The differences may be attributed to different levels of water temperature. The water temperature 26 – 31 °C was the highest value for number of fry / female and number of fry / gram of female body weight. These results were in agreement with Rothbard (1979) who found that the optimal temperature range for spawning for most species is 26 to 29 °C.

Table 2. Spawning of Nile tilapia (*Oreochromis niloticus*) at different water temperatures at natural photoperiod.

water temperature	weight of female	length of female	K factor	no. of fry / female	no. of fry / g of body weight
22-25°C	159±2.64	19.23±0.66	2.26±0.202a	512±27.15b	3.22±0.119 b
26-31°C	171±3.05	19.60±0.45	2.29±0.19a	706.66±17.63a	4.13±0.052 a
33-37°C	155±10	19.53±0.56	2.07±0.04a	0.00±0.00 c	0.00±0.00 c

Means with the same letter in the same column are not significant differences ($P < 0.205$).

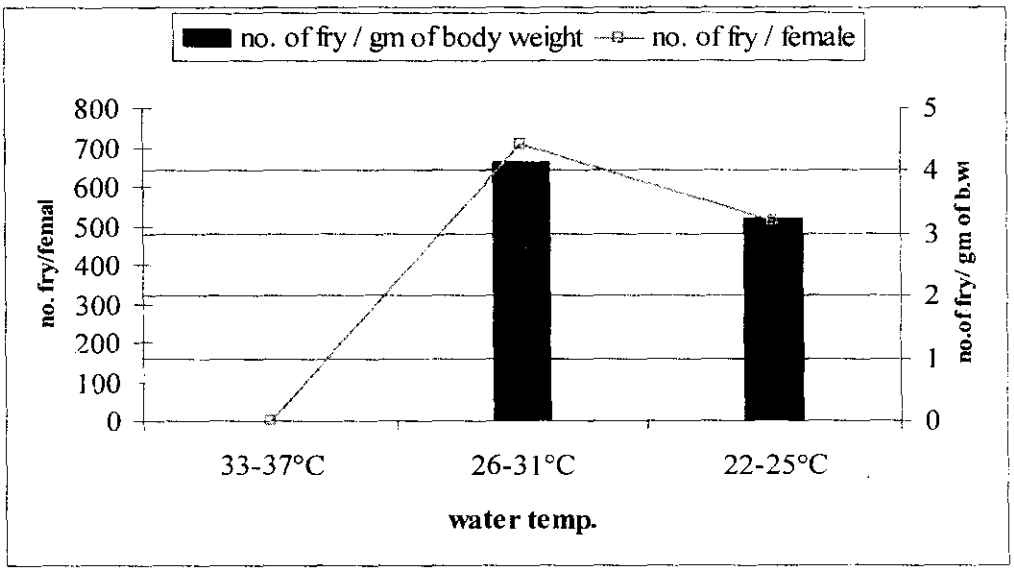

Fig. 1. Number of fry / female and number of fry / g of female body weight at different levels of water temperature

Rearing of fry at different stocking densities of Nile tilapia (*Oreochromis niloticus)*

Growth rate of Nile tilapia (*Oreochromisniloticus*) fry developing solely on their yolk reserves has been observed to accelerate at higher rearing temperatures (Rana, 1990). The growth rate was affected by three factors of stocking density as shown in Table 3. The highest value at stocking density 75 fry / m^3 (42.99±0.35, 0.477±0.003 g) was followed by decreased stocking density 150 fry / m^3 (27.99±0.305, 0.313±0.003 g) then stocking density 300 fry / m^3 (16.55±0.088, 0.183±0.003 g), respectively. Total weight production was 3.03 kg for stocking density 75 fry / m^3, 3.77 kg for stocking density 150 fry / m^3 and 4.36 kg for stocking density 300 fry / m^3. The results were in agreement with Tidwell *et al.* (1999) who reported that the high production can be increased by increasing stocking density; however, this decreases average individual fish size. Smith *et al.* (1978) observed negative impact production economics as the proportion of the crop that reaches marketable sizes is decreased. The survival rate was affected by different stocking densities as shown in Table 3. At stocking density 300 fry / m^3, the survival rate was 88 % while, at stocking density 75 fry / m^3, the survival rate was 94%.

It was concluded that the water temperature 26 – 31 °C was the optimum for reproductive performance and growth. Also, stocking density 75 fry / m^3 was the best results for growth of Nile tilapia than other stocking density.

Table 3. Rearing of fry at different stocking densities of Nile tilapia (*Oreochromis niloticus*) fry for 3 months.

Stocking rate	Initial Wt.(g)	Length mm	Final Wt. (g)	Length (cm)	Weight Gain (g)	Daily weight Gain (g)	K factor	Survival Rate	Total Weight production
300 fry / m^3	0.014	10	16.56	7.7	16.55±0.008c	0.18±0.003c	3.63±0.12a	88±1.0b	4.37
150 fry / m^3	0.014	10	28	11.77	27.99±0.31b	0.31±0.003b	1.72±0.06b	90±0.57b	3.78
75 fry / m^3	0.014	10	43	11.27	42.99±0.35a	0.47±0.003a	3.03±0.21a	94±0.57a	3.01

Means with the same letter in the same column are not significant differences ($P < 0.05$).

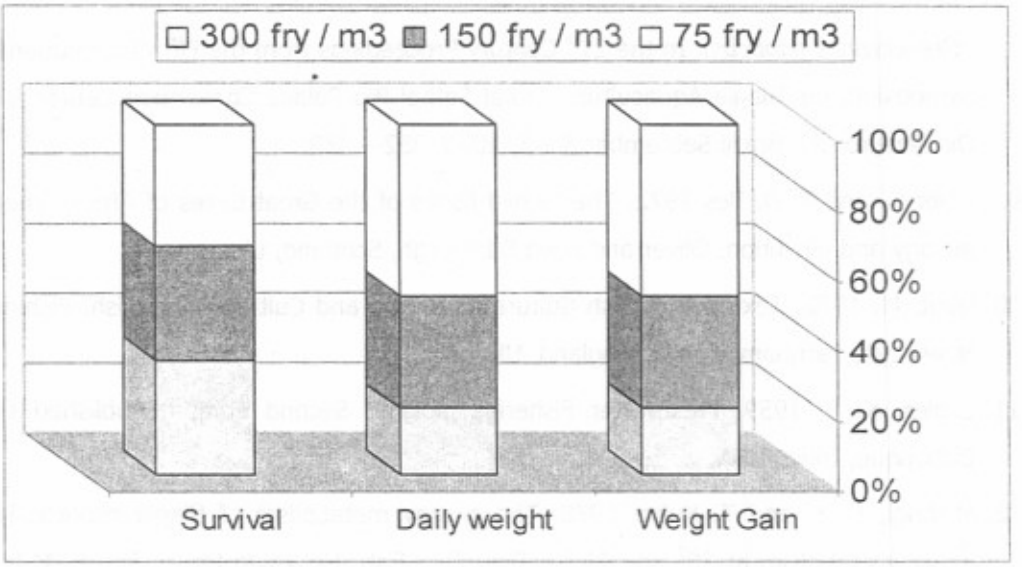

Fig. 2. Growth of Nile tilapia (*Oreochromis niloticus*) of different stocking densities

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أداء تكاثر أسماك البلطي النيلي عند مستويات مختلفة من درجة حرارة المياه ورعاية الزريعة عند كثافات تخزينية مختلفة

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أجريت هذه الدراسة في المحطة التجريبية لبحوث أسماك المياه العذبة ببشيمة – الحامة – قابس (جنوب تونس) – جمهورية تونس.

أجرى هذا العمل نتيجة تعاون مشترك بين المعمل المركزي لبحوث الثروة السمكية بالعباسة شرقية – مركز البحوث الزراعية – مصر ووزارة الفلاحة التونسية.

هذه الدراسة تشتمل على تفريخ أسماك البلطي النيلي عند مستويات مختلفة من درجة الحرارة ورعاية هذه الزريعة عند كثافات تخزينية مختلفة.

هذه النتائج تدل على أن هناك فروقا معنوية لكل من عدد الزريعة / أنثى وعدد الزريعة لكل جرام من وزن الأنثى عند مستويات مختلفة من درجة حرارة المياه ٢٢ – ٢٥ م ، ٢٦ – ٣١ م و٣٤ – ٣٧ م على التوالي.

دلت النتائج أيضا على وجود اختلافات معنوية لرعاية الزريعة عند معدلات تخزينية مختلفة ٣٠٠ زريعة / متر – ١٥٠ زريعة / متر – ٧٥ زريعة / متر بالنسبة لمقاييس النمو.

معدلات الإعاشة أظهرت عدم وجود فرق معنوي بين معدل التخزين ٣٠٠ / متر و١٥٠ زريعة / متر بينما كان هناك اختلاف معنوي بين هذين المعدلين ومعدل الكثافة ٧٥ زريعة / متر.

توصي هذه الدراسة أن درجة حرارة المياه المناسبة للتفريخ والنمو تتراوح بين ٢٦ – ٣١ م وأن أفضل نتيجة للنمو كانت عند كثافة تخزينية ٧٥ زريعة / متر عن معدلات التخزين الأخرى.