EFFECT OF DIFFERENT BROODSTOCK DENSITIES ON THE REPRODUCTIVE PERFORMANCE OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*) KEPT IN HAPAS SUSPENDED IN EARTHEN POND

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Abstract

The present study was conducted to evaluate the effect of different stocking densities on reproductive performance of Nile tilapia (*Oreochromis niloticus*) broodfish. Males: females with an average body weight of 140±7 gm and of 150±5 gm respectively, were stocked at three different stocking densities (3, 5 and 7 fish / m2) at a male: female ratio 1: 3 in hapas. The harvest number was five harvestings every interval 10 days, from 15 June to 8 August, 2007.

Average numbers of (eggs & fry / female) and (number of egg & fry / gm female body weight) of *Oreochromis niloticus* females increased from 1st, 2nd, 3rd, 4th till the 5th harvestings in density 3 fish / m2. The same trend was observed till the 4th harvesting then decreased in the 5th harvesting in densities 5 and 7 fish / m2 (at $P \leq 0.05$).

Analysis of variance for (number of eggs & fry / female) and (number of eggs & fry / gm of female body weight) at density of 3 fish / m2 was significantly higher than those in the other two densities (5 and 7 fish / m2).

However, stocking density 3 fish / m2 had the highest results than those in the other two densities 5 and 7 fish / m2 for (number of egg and fry / female) and (number of egg & fry / gm female body weight) of *Oreochromis niloticus* females at the different harvestings.

INTRODUCION

Maintaining the correct stocking density and sex ratio of farmed tilapia will certainly improve hatchery efficiency and mass production of tilapia seed. Suboptimal broodstock density will result in low seed production (Mires, 1982).

Also, high broodfish density often reduces seed production (Bevis, 1994), presumably due to aggression and fighting between males leading to reduction in courtship, egg fertilization and maternal care (incubation) (Behrends *et al.*, 1993; Ridha and Cruz, 1999).

Several stocking densities have been suggested for optimum seed production of tilapia, depending on tilapia species, broodstock size and condition, culture systems and water quality El-Sayed, (2006).

Results have been reported on the relationship between stocking density of broodstock and seed production. Hughes and Behrends (1983) suggested that 5 fish /m^2 for the optimum seed production of Nile tilapia in suspended net enclosures. On the other hand, only 29% of Nile tilapia females reared in hapas in ponds in Thailand spawned when broodstock density was 10 fish/m^2, compared to 39% and 42% at 5 and 2.5 fish / m^2 (Bevis, 1994). However, Ridha and Cruz, (1999) found that 4 fish/ m^2 had better seed production and spawning synchrony than 8 and 12 fish/ m^2. A sex ratio of 1: 3 appears optimum and is suggested especially when synchronized spawning is required. Hughes and Behrends (1983) found that in Nile tilapia a male: female ratio of 1: 2 produced more seed than a 1: 3 ratio. To the contrary, Mires (1982) reported that 1: 3 and 1: 2 sex ratios in tilapia hybrids were more productive than 1: 1 and 1: 2 ratios, presumably due to the effect of male pressure or the increase in spawning frequency of individual females.

The tilapia ovary regenerates immediately after spawning, very rapidly and previtellogenic stages are recruited into vitellogenic and late vitellogenic stages in as little as one week (Coward and Bromage, 2000). Siraj *et al.* (1983) found that first and second-year classes of Nile tilapia spawned at short intervals (7-12 days), while third-year class fish spawned at longer intervals (10-20 days).

Many studies stated that the removal of eggs and fry from female's mouths accelerates vitellogensis and shortens the intervals between successive spawning (Tacon *et al.*, 1996; Baroiller *et al.*, 1997).

Mair *et al.* (1993) found that the inter-spawning interval of Nile tilapia was 37.5% shorter when eggs were removed from females mouths at 4 day intervals, as compared to females allowed to incubate their eggs naturally.

In addition, the removal of Nile tilapia eggs and fry from the mouths of females increases seed production (Little *et al.* 1993; Macintosh and Little, 1995). Macintosh and Little, (1995) reported that removing eggs and fry of Nile tilapia at 5 and 10 day intervals resulted in a significant increase in seed production, compared to seeds produced under normal natural incubation. A 5 day cycle of seed removal from female's mouths is a common practice in commercial tilapia hatcheries in Thailand (Bhujel, 2000).

Khater, (2006) found that fry production ranged from 512 – 706.66 fry / female and 3.22 – 4.13 fry / gm of female body weight at stocking density of 4 fish / m^2 and a sex ratio of 1: 3 in fiberglass.

The aim of the present study to identify the most suitable stocking density of broodfish for improving the reproductive performance of Nile tilapia (*Oreochrmis niloticus*) in hapas suspended in earthen pond.

MATERIALS AND METHODS

The present study was conducted at Abou-sita Fish hatchery, Edko, El-Behera Governorate, Egypt. To identify the most suitable stocking density of broodfish for improving the reproductive performance of Nile tilapia (*Oreochrmis niloticus*) kept in hapas suspended in an earthen pond. The experimental period was from 15 June to 8 August 2007.

945♀ and 315♂ of Nile tilapia (*Oreochrmis niloticus*) broodfish were used in the present study for all stocking densities, with an average weight of 140±7 and 150±5 gm for male and female respectively. Nine hapas measuring (4 × 7 × 1.25 m), were assigned to produce seeds of Nile tilapia (*Oreochrmis niloticus*). The harvest number was five harvestings every interval 10 days.

Three broodstock densities 3, 5 and 7 fish / m^2 were tested. Each density was triplicate, the number of broodfish in hapa was 63 female to 21 male for the density 3 fish / m^2, 105 female to 35 male for the density 5 fish / m^2 and 147 female to 49 male for the density 7 fish / m^2 at a sex ratio 3: 1 female to male.

According to Ungsethaphan, (1995) who reported that *Oreochromis niloticus* fed twice a day at low feeding rates (0.5 and 1 % of body weight) produced more seed compared to those fed once a day.

The *Oreochromis niloticus* broodstock were fed on diet containing 34.85 % protein twice / daily at a rate of 1% of their body weight / day. The ingredient and the proximate analyses of the diet illustrated in table (1).

Table 1. Composition of the experimental diet for Nile tilapia (*Oreochromis niloticus*) broodfish stocked in hapas

Ingredients	%
Fish meal	30
Rice bran	21
Wheat bran	16
Yellow corn	14
molasses	2.75
Dicalcium phosphate	1
Vit. & min. premix	0.25
Total	100
Proximate analysis	%
Protein	34.85
Lipids	6.20
Ash	7.7
Fiber	6.13
NFE	45.12

Egg collection and incubation.

Fertilized eggs of *Oreochromis niloticus* were collected from female's mouths for each hapa every 10 days and incubated in jars at water temperature 27 °C – 29 °C for 4 to 5 days.

The number of eggs was calculated by determining their number in one gram and multiplying this value by total weight of eggs for each female. The eggs were transferred into the zuger jars (Horvath *et al.*, 2002).

Numbers of fry were calculated by counting the numbers of fry in one gram and multiplying this value by total weight of fry for each female.

Water quality is very important, and plays a significant part in the success or failure of a hatchery. Averages of water temperature were 28 ^oC, pH value was 7.8 and dissolved oxygen was 5 ppm, depth of water in hapa was 1m.

Statistical analysis

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

RESULTS AND DISCUSSION

Egg production

The results in tables (2 and 3) showed that the average of egg weights and numbers which were produced by a Nile tilapia (*Oreochromis niloticus*) broodfish was affected by different stocking densities 3, 5 and 7 fish /m^2.

Egg weights and numbers of *Oreochromis niloticus* increased gradually from the first harvest to 2nd, 3rd, 4th till the 5th harvest at stocking density 3 fish /m^2. The same trend was observed till the 4th harvesting then decreased in 5th harvesting in densities of 5 and 7 fish / m^2.

Results indicated that there were significant differences in eggs weights and numbers at different stocking densities in the first harvest at ($P \leq 0.05$). There was no significant difference between stocking densities 3 and 5 fish /m^2 in eggs weights and numbers at 1st, 2nd, 3rd, 4th till the 5th harvest, while, a significant difference was observed between density 7 fish /m^2 and the other two densities 3 and 5 fish / m^2 at ($P \leq 0.05$). Increased egg weights and numbers may be attributed to increase broodstock in one meter at density 7 fish /m^2 than the other densities 5 and 3 fish /m^2.

Broodstock density is one of the important biological factors that has considerable influence on seed production in tilapia (Obi and Shelton, 1988). The results were agreement with those reported by Obi and Shelton (1988) who found that seed production per unit area (m^2) in *O. hornorum* increased with the increase in broodstock density. On the other hand, Broussared *et al* (1983) found that increasing broodstock density, at a fixed male: female sex ratio of 1: 3 had a negative effect on fry production of Nile tilapia reared in ponds. The authors attributed that effect to increased competition between territorial male. In general, low broodstock densities gave better seed production than higher densities (Bautista et al. 1988).

Table 2. Averages of egg weight of Nile tilapia (*Oreochromis niloticus*) at different stocking densities for 5th harvest

Stocking density	Harvest number				
	1st	2nd	3rd	4th	5th
3 fish /m^2	133.33±4.41c	172.33±5.04b	175.00±8.66b	195.00±7.64b	200.00±2.89b
5 fish /m^2	163.33±7.26b	182.33±7.22b	193.33±7.26b	213.33±7.26b	208.33±6.01b
7 fish /m^2	190.00±8.66a	206.67±4.41a	226.67±7.26a	250.00±5.77a	245.00±2.89a

Means followed by the same letter in column are not significantly different at ($P \le 0.05$).

Table 3. Averages of egg number of Nile tilapia (*Oreochromis niloticus*) at different stocking densities for 5th harvest

Stocking density	Harvest number				
	1st	2nd	3rd	4th	5th
3 fish /m^2	21333.33± 705.53 c	27573.33± 807.08 b	28000.00± 1385.64 b	31200.00± 1222.02 b	32000.00± 461.88 b
5 fish /m^2	26133.33± 1162.37 b	29173.33± 1155.01 b	30933.33± 1162.37 b	34133.33± 1162.37 b	33333.33± 961.48 b
7 fish /m^2	30400.00± 1385.64 a	33066.67± 705.53 a	36266.67± 1162.37 a	40000.00± 923.76 a	39200.00± 461.88 a

Means followed by the same letter in column are not significantly different at ($P \leq 0.05$).

The averages number of eggs / female and number of eggs / gm of female body weight of *Oreochromis niloticus* females as illustrated in tables (4 and 5) increased at 1^{st}, 2^{nd}, 3^{rd}, 4^{th} till the 5^{th} harvest in density 3 fish /m^2. There was an increasing in number of eggs / female and number of eggs / gm of female body weight at 1^{st}, 2^{nd}, 3^{rd}, till 4^{th} harvest 4 and decrease in 5^{th} harvest for densities 5 and 7 fish / m^2.

The number of eggs / female and number of eggs / gm of female body weight at density 3 fish / m^2 was significantly higher than those in other tow densities (5 and 7 fish / m^2) at ($P \leq 0.05$). The lowest density (3 fish /m^2) had the highest mean number of eggs / female and number of eggs / gm of female body weight. The higher broodstock densities (5 and 7 fish / m^2) had significantly lower values for mean number of egg / female and number of egg / gm of female body weight at ($P \leq 0.05$).

These results are in agreement with those reported by Little, (1989) found that a high density such as (4.7 and 9.5 fish / m^2) produced the lowest seed production / female of *Oreochromis niloticus*. However, higher seed production could be obtained using lower stocking density Maluwa and Costa-Pierce, (1993).

In the present study, a general trend of declining seed production / female per unit area as the density increased was observed.

Table 4. Averages of egg number / female of Nile tilapia (*Oreochromis niloticus*) at different stocking densities for 5th harvest

Stocking density	Harvest number				
	1st	2nd	3rd	4th	5th
3 fish /m^2	338.63±11.20a	437.67±12.81a	444.44±21.99a	495.24±19.40a	507.94±7.33a
5 fish /m^2	248.89±11.07b	277.84±11.00b	294.60±11.07b	325.08±11.07b	317.46±9.16b
7 fish /m^2	206.80±9.43c	224.94±4.8c	246.71±7.91b	272.11±6.28c	266.67±3.14c

Means followed by the same letter in column are not significantly different at ($P \leq 0.05$).

Table 5. Averages of egg number / gm of female body weight of Nile tilapia (*Oreochromis niloticus*) at different stocking densities for 5th harvest

Stocking density	Harvest number				
	1st	2nd	3rd	4th	5th
3 fish / m^2	2.26±0.07a	2.92±0.09a	2.96±0.15a	3.30±0.13a	3.33±0.05a
5 fish / m^2	1.66±0.08b	1.85±0.07b	1.96±0.07b	2.17±0.08b	2.11±0.06b
7 fish / m^2	1.38±0.06c	1.50±0.03c	1.64±0.05b	1.81±0.04c	1.78±0.02c

Means followed by the same letter in column are not significantly different at ($P \leq 0.05$).

Fry production

The average of fry production at different stocking densities (3, 5 and 7 fish / m^2) at different harvest numbers of *Oreochromis niloticus* females are illustrate in table (6). The produced fry of *Oreochromis niloticus* increased from 1st, 2nd, 3rd, 4th till 5th harvest in density 3 fish / m^2. The same trend observed in densities (5 and 7 fish / m^2) at 1st, 2nd, 3rd till 4th harvest then decreased in the 5th harvest.

Statistical analysis showed that there were significant differences in total number of fry among densities (3, 5 and 7 fish / m^2) in the first harvest, while there were insignificant difference between densities (3 fish / m^2 and 5 fish / m^2) at 2nd, 3rd, 4th till 5th harvest at ($P \leq 0.05$). Increasing of total number of fry in density 7 fish /m^2, the increasing may be attributed to increasing number of broodfish in one meter. The present results are in agreement with those of Obi and Shelton, (1988) who found that fry production per unit area (m^2) in *O. hornorum* increased with the increase in broodstock density.

In ponds, the low production of tilapia fry has been attributed to suboptimal broodstock density (Mires, 1982). On the other hand, under intensive hatchery systems, broodstock are often stocked at high densities in small and confined breeding units such as aquaria, tanks and net enclosures (hapas), resulting in aggression and fighting between males and thus, affecting seed production (Behrends *et al.*, 1993).

Table 6. Averages of total number of fry Nile tilapia (*Oreochromis niloticus*) at different stocking densities for 5th harvest.

Stocking density	Harvest number				
	1st	2nd	3rd	4th	5th
3 fish / m^2	17493.33± 578.54 c	22610.13± 661.81 b	22960.00± 1136.23 b	25584.00± 1002.06 b	26240.00± 378.74 b
5fish / m^2	21429.33± 953.15 b	23922.13± 947.11 b	25365.33± 953.15 b	27989.33± 953.15 b	27333.33± 788.74 b
7fish / m^2	24928.00± 1136.23 a	27114.67± 578.54 a	29938.67± 953.15 a	32800.00± 757.48 a	32144.00± 378.74 a

Means followed by the same letter in column are not significantly different at ($P \leq 0.05$).

Number of fry / female and number of fry / gm of female body weight was affected by different stocking densities (3, 5 and 7 fish /m^2) as presented in tables (7 and 8). There were a significant difference among densities 3, 5 and 7 fish / m^2 at 1st, 2nd, 3rd, 4th till 5th harvest in number of fry / female and number of fry / gm of female body weight at ($P \leq 0.05$).

Stocking density 3 fish / m^2 had the best results followed in a decreasing order by those of the densities 5 fish /m^2 and 7 fish /m^2 at 1st, 2nd, 3rd, 4th till 5th harvest. Suboptimal broodstock density will result in low seed production (Mires, 1982). Also, high broodfish density often reduces seed production (Bevis, 1994), presumably due to aggression and fighting between males leading to reduction in courtship, egg fertilization and incubation (Behrends *et al.*, 1993; Ridha and Cruz, 1999). Results obtained by several workers have indicated that lower stocking densities (≤ 4 fish / m^2) gave better seed production (Ridha and Cruz, 1999).

The study concluded that the most suitable stocking density of Nile tilapia (*Oreochrmis niloticus*) broodfish was 3 fish / m^3 that had the highest results of eggs and fry production compared to other densities 5 and 7 fish /m^2 at different harvest.

Table 7. Averages number of fry / female of Nile tilapia (*Oreochromis niloticus*) at different stocking densities for 5th harvest.

Stocking density	Harvest number				
	1st	2nd	3rd	4th	5th
3fish / m^2	277.67±9.18a	358.89±10.50a	364.44±18.03a	406.10±15.90a	416.51±6.01a
5fish / m^2	204.09±9.08b	227.83±9.02b	2471.57±9.08b	266.56±9.08b	260.32±7.51b
7fish / m^2	169.58±7.73c	184.45±3.94c	202.30±6.48b	223.13±5.15c	218.67±2.58c

Means followed by the same letter in column are not significantly different at (P ≤ 0.05).

Table 8. Averages number of fry / gm of female body weight of Nile tilapia (*Oreochromis niloticus*) at different stocking densities for 5th harvest.

Stocking density	Harvest number				
	1st	2nd	3rd	4th	5th
3 fish / m^2	1.85±0.06a	2.39±0.07a	2.43±0.12a	2.71±0.11a	2.78±0.04a
5 fish/ m^2	1.36±0.06b	1.52±0.06b	1.61±0.06b	1.78±0.06b	1.74±0.05b
7 fish / m^2	1.13±0.05c	1.23±0.03c	1.35±0.04b	1.49±0.03c	1.46±0.02c

Means followed by the same letter in column are not significantly different at (P ≤ 0.05).

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تأثير كثافة التخزين المختلفة على الأداء التناسلي لأسماك البلطي النيلي المخزنة في هابات معلقه في الحوض الترابي

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أجريت الدراسة الحالية لتقييم تأثير كثافات تخزينية مختلفة على الأداء التناسلي لأمهات أسماك البلطي النيلي بمتوسط وزن ١٤٠ ± ٧ جم للذكور و١٥٠ ± ٥ جم للإناث ،الكثافات التخزينية المختلفة هى ٣ و ٥ و ٧ سمكات / متر^{٢}. النسبة الجنسية كانت ١: ٣ (ذكور: إناث) وذلك خلال خمسة حصادات تجرى كل فترة ١٠أيام بدءا من ١٥ يونيه الى ٨ أغسطس ٢٠٠٧.

دلت النتائج على وجود زيادة متتالية في عدد البيض والزريعة / أنثى وكذلك عدد البيض والزريعة / جم من وزن الأنثى بدءا من الحصاد الأول حتى الحصاد الخامس للكثافة ٣ سمكات / متر^{٢} ، أيضا شوهد نفس الاتجاه المتزايد في عدد البيض والزريعه المنتجة بدءا من الحصاد الأول حتى الحصاد الرابع ثم يقل عند الحصاد الخامس وذلك بالنسبة للكثافة ٥ و ٧ سمكات / متر^{٢}.

أظهر تحليل التباين وجود اختلافات معنوية بين الكثافات المختلفة (٣ و ٥ و ٧ سمكات / متر^{٢}) بالنسبة لعدد البيض والزريعة / أنثى وكذلك عدد البيض والزريعة / جم من وزن الأنثى. حيث لوحظ أن الكثافة ٣ سمكات / متر^{٢} سجلت أعلى المعدلات عن الكثافات الاخرى (٥ و ٧ سمكات / متر^{٢}) في عدد البيض والزريعة / أنثى عند الحصادات المختلفة لإنتاج البيض والزريعة.