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Short communication

Productivity of intra and inter-specific mating of two species of Tilapia *Oreochromis niloticus* and *O. aureus* reared in Morocco

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Abstract
The present research aimed to determine the reproductive performance of intra and inter-specific of tow tilapia species; Nile tilapia and Blue tilapia under different stocking densities and the same breeding parameters. Eight tanks with a volume of 1.8 m3 were used to accommodate two storage densities; 1:3 and 2:6 males and females of both species. The physicochemical parameters of the water were more or less stable in all tanks. The sizes and the survival rates of larvae 20 days post-hatching of various couplings were measured to determine the performance of their growths. The results obtained for the density 1:3 shows that the reproduction occurs early compared to the other density. Also, the intra-specific coupling was more fertile than the inter-specific one; latter showed that the crossing between the male blue tilapia and female Nile tilapia is more productive than the reciprocal crossing. The larvae of intra-specific crossing of Nile tilapia have the largest size in his age group.

Keywords: Reproductive performance, *Oreochromis niloticus, O. aureus*, inter-specific and intra-specific crossing.

Introduction

Tilapias (Cichlidae) constitute a group of native fishes from Africa. They are the second group of the most world aquaculture fish products after carp. Nile tilapia represents more than 70% of the world's tilapias production. For this, the Nile tilapia is among the 10 most produced aquaculture species in the world, he was introduced to more than 90 countries (Casal, 2006). For this, aquaculture has proven to be a primary vector for introduced species (Zambrano *et al.*, 2006; Leal-Florez *et al.*, 2008). Ease of production in different farming systems with rapid sexual maturation at 6 months and the quality of its white flesh has allowed them to be more appreciated by the farmers.

In Morocco, the Nile tilapia (*Oreochromis niloticus* Linnaeus, 1758) and the Blue tilapia (*Oreochromis aureus;* Steindachner, 1864) were introduced for the first time in 2004 by fish Company "Pisciculture du Nord" in Tangier (Northern Morocco) to initiate the development of national aquaculture. Their breeding has had great difficulty in principle with the natural conditions of the region.

The two species of tilapia have different sex determination; XX, XY for Nile tilapia and ZZ, ZW for Blue tilapia with the heterogametic genotype being male and female respectively (Verdegemet *et al.*, 1997; Penman & McAndrew, 2000). Hybridization between these two species, results in the production of predominantly male offspring (Hulata, 2001). The hybrid males have superior growth than pure parental species (Doudet *et al.*, 1991; Siddiqui *et al.*, 1997; El-Zaeem, 2011)

Inter-specific hybridization has long been practiced in various fish species to increase the growth rate, produce sterile animals, increasing disease resistance and tolerance to environmental conditions

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(Bartley *et al.,* 2001; Rahman *et al.,* 2005; Um-E-Kalsoom *et al.,* 2009).

The purpose of the present study was to estimate the productivity performance of Nile tilapia, *O. niloticus* and Blue tilapia, *O. aureus* and inter-specific cross under tow stocks densities; 1:3 and 2:6 males and females of both species that will serve as a pilot study for the development of tilapia breeding in Morocco.

Materials and methods

Test site

The experiment was conducted at the fish farm “Pisciculture du Nord” in Tangier (35°34'37.1"N 5°55'38.1"W, North of Morocco) in June 2014.

Experimental Protocol

The experimental device consists of male and female spawners of Nile tilapia and Blue tilapia with signs of reproduction (ventral side inflated) and free from deformity and injuries.

The rearing structures are cylindrical tanks in polyesters (1.50m x 1.20 m) of volume with renewal of water continuously. Breeding conditions were the same used in the farm (T° between 27 °C and 28 °C, pH between 8 and 9, and 4 to 5 ppm of O_2) these parameters were measured just before putting females using a multi-parameter analyzer probe.

Spawners were weighed after anesthesia by immersion in a water volume of 10L with 4ml of stock solution clove essential oil (1:10 alcohol 95 %) (Schlumberger & Girard, 2013).

The sexes of tilapia can be distinguished by the naked eye on examination the genital papillae under the belly of the fish. Sexing was twice realized for two technicians to avoid the error.

Females were first put in tanks for five days so that they adapt to the conditions of experience. After this period, the males are introduced to start mating with a total density which not more than 2 kg/m^3 (Campos-Mendoza *et al.,* 2004; Nobah *et al.,* 2008) (Table 1). A total of eight tanks with a volume of 1.8 m^3 each are used. The sex ratio of males and females used is 1:3 and 2:6. The density and distribution of individuals by tanks are shown in Table 1.

The fish have been fed with the same food used on the farm composed of 28 % protein, 8 % fat, 3 % fibers, 7 % ash, 15 kj/g of energy and a premix of vitamins and minerals (total phosphorus (0.8 %), vitamin A (8,000 IU/kg), vitamin D3 (1,400 IU/kg), vitamin E (160 mg/kg) and vitamin C (90 mg/kg). The food was distributed to the daily ration of 1 % of the biomass in three meals (10, 14 and 18 h). The period of the experiment lasted between 14 and 18 days, during this period, the fish were continuously monitored to detect signs of incubation and recover the eggs. These were recovered directly from the mouth of females and deposited in a cylindroconical incubation tank. Viable eggs floating in the water column and in the surface were recovered and placed in a beaker for counting subsequently. Nonviable eggs fall to the bottom and retrieved through the valve opening. Diameter of 40 eggs was measured using a dissecting scope with a graduated Petri dish.

After 20 days, 40 larvae were taken at random to measure their sizes (total length) with an ichtyometer 5 cm long. Dead larvae were collected from the bottom of the tank for counting survival rates.

Zootechnical parameters

- Fertility rates expressed as:

* Number of eggs per female = total number of eggs in the tank/total number of females.

* Number of eggs per Kg = total number of eggs in the tank/total weight of females.

- Hatching rate (%) = (total number of eggs - number of eggs lost/total number of eggs) x100.

- Larvae survival rate 20 days (%) = (total number of larvae - number of larvae lost/total number of larvae) x100.

Table 1. Experimental design: type of crossing, the number of individuals used, their weights and sizes and stocking density per m^3.

Tank 1	**2♂ Nile tilapia** (313.79g / 24.25cm)	**6♀ Blue tilapia** (235.51±10.70g / 24.17±0.82cm)	1.36 Kg/m^3
Tank 2	**1♂ Nile tilapia** (302.87g / 24.30cm)	**3♀ Blue tilapia** (251.33g / 24.50cm)	0.71 Kg/m^3
Tank 3	**2♂ Blue tilapia** (309.25g / 24.25cm)	**6♀ Nile tilapia** (218.93±10.55g / 23.58±1.11cm)	1.28 Kg/m^3
Tank 4	**1♂ Blue tilapia** (329.10g / 26.00cm)	**3 ♀ Nile tilapia** (205.48g / 23.73cm)	0.63 Kg/m^3
Tank 5	**2♂ Nile tilapia** (334.73g / 25.50cm)	**6♀ Nile tilapia** (244.34±17.37g / 24.17±0.68cm)	1.42 Kg/m^3
Tank 6	**1♂ Nile tilapia** (346.56g / 26cm)	**3♀ Nile tilapia** (224.45g / 24.33cm)	0.68 Kg/m^3
Tank 7	**2♂ Blue tilapia** (323.72g / 22.75cm)	**6♀ Blue tilapia** (234.99±18.95g / 23.80±1.42cm)	1.37 Kg/m^3
Tank 8	**1♂ Blue tilapia** (330.2g / 23cm)	**3♀ Blue tilapia** (253.81g / 24.33cm)	0.73 Kg/m^3

♂: male, ♀: female.

Results and Discussion

The physicochemical parameters of the breeding water are determinants key of physiological characteristics of fish in captivity (Ghabrial, 1999). Other parameters, such as maintenance of broodstock, the farming system and stress conditions from the storage density and changes in environmental parameters may influence hybridization success in a wide variety of freshwater and marine finfishes. (Izquierdo *et al.*, 2001; Rahman *et al.*, 2013).

Our results are closely linked with the experimental protocol used and the conditions for the breeding of the farm. The Table 2 shows the physicochemical parameters measured in each tank.

Table 2. Values of physicochemical parameters of the breeding water analyzed in the 8 tanks

	Tank 1	Tank 2	Tank 3	Tank 4	Tank 5	Tank 6	Tank 7	Tank 8
T° (°C)	27.6	27.2	27.8	27.1	27.7	27.3	27.8	27.2
pH	8.7	8.3	8.6	8.3	8.7	8.2	8.5	8.3
O_2 (ppm)	4.4	4.7	4.2	4.6	4.3	4.6	4.4	4.7

The food represents one of the most important indicators when incubation occurs, the quantity of food consumed decreases because the females cease feeding. All the females incubated eggs in their mouths; this indicates that all the females are reproduced.

The results obtained for the reproduction tanks that contain three females and one male show that reproduction occurs at an early stage in comparison with other tanks, as well as the incubation and subsequently the hatching. Tharwat (2007) report that at the lowest stocking density combined with the longest photoperiod resulted in earlier reproduction by the appearance of larvae with yolk-sac.

The results presented in Table 3 shows that the reproduction of individuals

Table 3. Zootechnical parameters analyzed in eight tanks of the experimental device.

Tank	Fertility rate		Diameters (mm)	Hatching rate (%)	Larvae survival rate 20 days (%)
	Number of eggs per female	Number of eggs per Kg			
1	363±27.8	1541	1.7 - 1.8	89	95
2	354±18.3	1397	1.7 - 1.8	89	95
3	1008±84.4	4125	1.5 - 1.7	86	94
4	847±32.5	3774	1.7 - 1.8	87	93
5	1167±102.5	5330	1.8 - 1.85	90	81
6	942±74.2	4584	1.8 - 1.9	90	86
7	1552±127.6	6604	1.5 - 1.6	90	95
8	1446±108.4	5697	1.5 - 1.6	90	94

of the same species (the tanks 5, 6, 7, and 8) is more productive in relation to the crossing between two different species.

Several studies of reproductive performance in tilapia used a storage density less than 2 kg/m^3 or 4 individuals by tank, while showing that these lower densities, the tilapia present its best reproduction rate (Ridha & Cruz, 1999; Campos-Mendoza *et al.,* 2004; Tsadik & Bart, 2007; Nobah *et al.,* 2008).

In addition, intra-specific breeding of Blue tilapia (tanks 7 and 8) is more fertile and with high larval survival rates than Nile tilapia (tanks 5 and 6).

The result of inter-specific mating showed that the crossing between male Blue tilapia and female Nile tilapia (tanks 3 and 4) is more productive than the reciprocal crossing (tanks 1 and 2).The sizes of the larvae of 20 days post hatching of different crossing reveal that the larvae of the intra-specific mating Nile tilapia have the largest sizes of the same age group (Table 4).

Table 4. Size (the smallest and the largest) of the larvae of 20 days post hatching among the different crossing.

	♀N.T x ♂B.T	♀B.T x ♂N.T	♀N.T x ♂N.T	♀B.T x ♂B.T
Size of larvae (cm)	1 - 1.7	1.2 - 1.8	1.2 - 2	1 - 1.7

N.T: Nile tilapia; B.T: Blue tilapia

Conclusion

Under these breeding conditions, the reproduction of Blue tilapia is more fertile than Nile tilapia. Also, inter-specific crossing between male Blue tilapia and female Nile tilapia is more productive than the reciprocal crossing. At the density 1:3, the reproduction occurs early. Nile tilapia larvae grow faster than larvae of Blue tilapia, but with a less survival rates.

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