International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

PRODUCTION OF *OREOCHROMIS NILOTICUS* JUVENILES IN FIBERGLASS TUBS IN SENEGAL

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ABSTRACT

The effect of loading density on the growth performance of *Oreochromis niloticus* in 1.2m³ fiberglass tubs was studied in the Fatick hatchery in Senegal. The purpose of this study is to contribute to the improvement of production by optimizing the stocking density. A total of 300 juveniles with an average weight of 42 g were distributed in three densities of 41 individuals / m³; 83 individuals / m³; 125 individuals / m³ named respectively D50; D100 and D150. Three days after filling with fertilized water, the tubs were fully ready to receive the subjects. Twenty-four hours after stocking, the fish began to feed on imported granulated feed. They were fed to satiety. The temperature was constant during our study and its value was 32 ± 2 °C. Growth control fishing were conducted every 10 days. At the end of the experiment (40 days later), the results obtained gave a final average weight of 110 g for D50, 95 g for D100, and 85 g for D150. The survival rates selected gave the following proportions: 100% for D50, 94% for D100 and 92% for D150. The average weight gains recorded gave 68 g for D50, 53 g for D100 and 43 g for D150. The D50 and D100 recorded the best growth performance and survival rate.

Keywords: Growth performance, survival, stocking density, *Oreochromis niloticus*, fiberglass tubs

1. INTRODUCTION

Fishing, fish processing and trade have been sources of food, employment and income for centuries for coastal communities and those living on the edge of inland waters. Fish makes a substantial contribution to the world's availability of animal protein (FAO, 2016) either directly or as a result of its use for livestock feed. Almost a third of fish catches are processed into flour and oil. Increasing incomes and increasing awareness of the dietary value of fish are stimulating fishing effort (FAO, 2016), resulting in increased fishing activity. In addition to the exploitation pressure, there is the degradation or destruction of aquatic ecosystems caused by pollution or

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competing uses (Conca 2006, Julien 2010). The oceans function as a weir for carbon dioxide, soils washed away by erosion, contaminants, fertilizers, human and industrial waste. Most urban and industrial activities, and indeed much of human life, are concentrated near coastal waters, streams and lakes. An answer to the growing demand for fish and the reduction of supplies has been the development of aquaculture.

In some countries, aquaculture has benefited from considerable support through fiscal and monetary incentives, which has improved the access of many households to food and strengthened its contribution to the achievement of the Millennium Development Goals (MDG). Major biotechnological innovations have had a major impact on the development of freshwater aquaculture: control of artificial reproduction of species such as *Oreochromis niloticus*, use of complementary or artificial feeds, genetic improvement and introduction of exotic species into many countries.

Senegal has important freshwater resources: the Senegal River, rivers, lakes and bodies of water. As a result, the potential in aquaculture is enormous, but there are still some technical difficulties to make the sector more efficient.

According to several authors (Hecht and Pienaar, 1993, Liu and Chang 1992, Rahman et al., 2017), stocking density is an important factor affecting fish growth, feed utilization, overall production of fish and economic profitability. As a result, production efficiency may be affected by incorrect density. In fact, the production time of fish of commercial size becomes longer as the costs increase. In addition, raising above ground in fiberglass tanks makes control easier compared to a cloudy pond environment where even the observation of young fry is almost impossible, hence its interest in the production of fish fry.

This experimental study aims to determine the optimal storage density of *Oreochromis niloticus* raised in fiberglass basins.

2. MATERIAL AND METHODS

The *Oreochromis niloticus* larvae collected in liner ponds were placed in rectangular ponds of 10 m^3 volume. They were followed up to the pre-enlargement stage (average weight equal to 42 g). This category of juveniles was used in the experimental study.

The feed has been imported. Its production date is 08/07/2016. The granular shape and its floating aspect make the feed more appreciated compared to the local one. It is thus composed: wheat; Fishmeal; concentrated soy protein; corn gluten; soybean cake; fish oil. Its nutrient content is summarized in Table 1.

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Table 1: The analytical content of the feed distributed

Elements	Percentage (%)
Raw protein materials	40
Raw fat	5
Raw cell	2.4
Crude ashes	7
Calcium	1.5
Sodium	0.4
Phosphorus	0.9
Food additives Micro nutriments and antioxidants	**Quantity per Kg of feed**
Vitamin A	7500 /I.U
Vitamin D3	1125/I.U
Iron (ferrous sulfate monohydrate)	62 mg
Iodine (anhydrous calcium iodate)	3.1 mg
Copper (cupric sulfate pentahydrate)	8 mg
Manganese (manganous sulfate monohydrate)	23 mg
Zinc (zinc sulfate monohydrate)	160 mg
Zinc (hydrated amino acid chelate)	30 mg
BHT (Butylhydroxytoluene)	75 mg
Etoxyquine	0 mg
Propyl gallate	0 mg

The study took place according to these different stages:

- ✓ Preparation of the three fertilized tubs

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The fiberglass tubs make it easy to handle the subjects and easy harvesting. That's why we have choose tubs of this kind. Three fiberglass tubs of 1.2 m^3 each were used for the experimental study. Five (5) days before the start of the experiment, the tubs were emptied of their contents, cleaned to remove any impurity and left dry for a few hours. A volume corresponding to 0.8 m^3 of water from the borehole and a volume of 0.4 m^3 of filtered and fertilized water were poured into each tub. It took us 24 hours for the phytoplankton to grow before proceeding with stocking.

- ✓ Loading of juveniles

The 300 juveniles were distributed after preparation and filling with water of the 3 fiberglass tubs at different densities. These individuals were of average weight 42 g. The charging was carried out with three different densities namely D50, D100 and D150 respectively corresponding to a biomass equal to 1750 g / m^3, 3500 g / m^3 and 5000 g / m^3. Juveniles came from selected broodstock and stored in liner ponds. So they all had very close genetic factors. The loading of the juveniles was carried out on Tuesday, August 15, 2017. The feeding (composition of the food, number of meals / day, size of the food particles, time of the first meal, diet ...) was done similarly for all three tubs.

- ✓ Water quality monitoring

Every two days two thirds (2/3) of the tubs water were renewed. The water temperature of the tubs was measured twice a day with a thermometer. Suspended matter, feces, dead fish and uneaten food were removed from the tubs after each observation. The effluents were decanted in an open pit before being discharged to the inlet.

- ✓ Growth and survival monitoring of juveniles

To monitor growth trends, control fishing was conducted every 10 days, i.e. 4 times throughout the experiment. This process consisted of weighing 10 individuals using a scale and determining the average weight for each tub. At the same time, a systematic count of all individuals has been carried out to evaluate the survival of juveniles. The average size of individuals was obtained by measuring the size of 5 individuals in each tub.

- ✓ Data processing

These collected data were used for the calculation of the survival and to assess the evolution of the size and the weight of the juveniles (the growth) during the follow-up.

- o Average daily weight gain (GMQ) in g/d : GMQ= Pmf-Pmi/t
- o Average weight gain (GP in g): GP(g)= ((Pmf-Pmi)

Pmf and Pmi are the final and initial average weights in g and t is the time in number of days.

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- Initial average weight (g): Pmi = Pti/ni

Pti: initial total weight; ni: initial number of individuals chosen as sample.

- Final average weight (g): Pmf = Pt/nf

Pt: total weight after the experiment; nf: final number of individuals chosen as sample.

- Survival rate (Ts) in %: Ts = (Ns / Ni) * 100

Ns: total number of individuals at end of the experiment; Ni: total number of individual at start of the experiment.

- Average size (Tm) in cm: Tm = (Tt / ni) * 100

Tt: sum of the sizes of the individuals sampled after each control fishing; ni: number of individuals taken as sample.

✓ Statistical analyzes

The data obtained and the calculated parameters were subjected to ANOVA analysis of variance. In all these statistical tests, the differences were considered significant at the 5% threshold. All these analyzes were carried out using software R. The graphs were made with Microsoft Office Excel 2013.

3. RESULTS

The physico-chemical parameters of the rearing environment (temperature, pH, dissolved oxygen, water transparency and salinity) did not vary much. This may be due to the regular frequency of emptying the tubs. Also it was noticed that tub with higher density showed a faster deterioration of water. The number of individuals explains the quantity of excreta released into the medium (water).

After 40 days of rearing the juveniles of *Oreochromis niloticus*, the survival rates (Ts) obtained did not have a large difference between the tanks. Survival rate (Ts) values were 100% for D50; 94% for D100; 92% for D150 (Figure 1).

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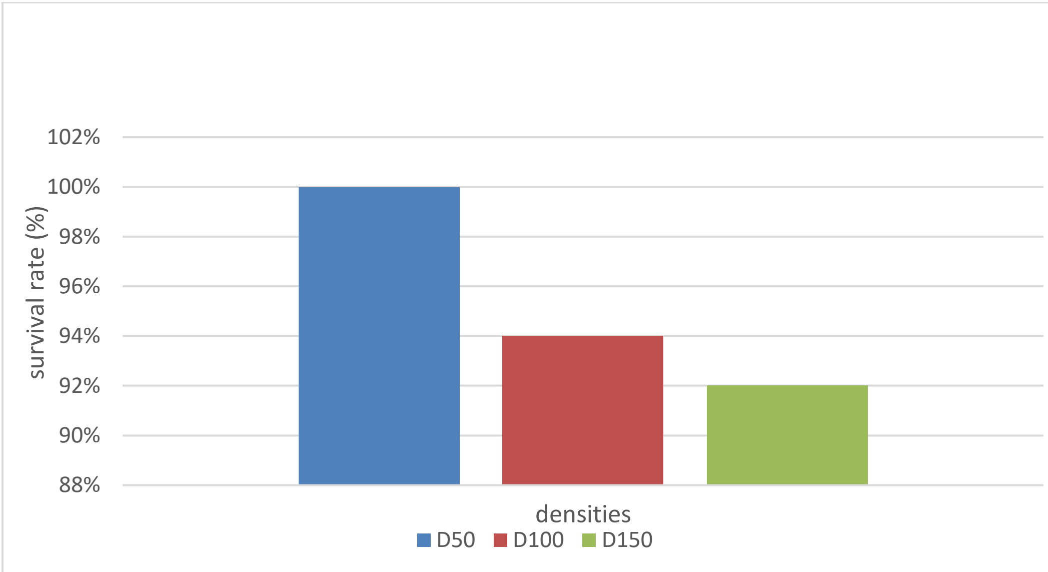

Figure 1: The effect of loading density on the survival rate

Throughout the experiment, the average weights were taken every 10 days. The values obtained for each tub were listed in Table 4. The results of the fourth control fishing showed that the final average weight difference between D50 and D100 is wider than that observed between D100 and D150. (Table 2).

Table 2: Average weights obtained after each control fishing

Period / density	Initial weight	0-10 jours	10-20 jours	20-30 jours	30-40 jours
D50	42± 0.60 g	55± 0.54 g	85± 0.34 g	90± 0.40 g	110± 3.27 g
D100	42±0.60 g	55± 0.72 g	60± 0.69 g	85± 0.81 g	95± 6.21 g
D150	42±0.60 g	50± 0.78 g	55± 1.36 g	60± 1.03 g	85± 7.45 g

The average weight gain is 68 g for D50; 53 g for D100 and 43 g for D150. The daily weight gain allowed us to appreciate the evolution of the daily weight during the 40 days of rearing. The values obtained were 1.7 g / day for D50; 1.3 g / day for D100; 1.07 g / day for D150.

Values collected after each control fishing for average size were recorded in Table 3.

Table 3: Average Size after each Control Fishing

Density / Control fishing	D50	D100	D150
1st control	15.26 ± 0.25 cm	14.98 ± 0.41 cm	13.64 ± 1.06 cm
2nd control	16.42 ± 0.18 cm	15.06 ± 0.54 cm	14.72 ± 0.71 cm
3rd control	16.94 ± 0.59 cm	16.46 ± 0.77 cm	14.98 ± 1.24 cm
4th control	17.3 ± 0.66 cm	16.74 ± 0.76 cm	15.36 ± 0.97 cm

4. DISCUSSION

The physico-chemical characteristics (temperature, pH, dissolved oxygen, transparency) recorded during this study are within the range required for tilapia culture. Under the effect of the rain, we sometimes noticed a slight change in temperature. The rearing water was also poor in dissolved oxygen since it came directly from the water of the borehole (water table). However, in order to use this water properly, it was necessary to fertilize it. As a result, under the influence of the sun, phytoplankton began to develop and photosynthesize. Then the water can be saturated with dissolved oxygen depending on the efficiency of the work of microorganisms. A behavior of swimming on the surface of water is often observed especially in the morning before sunrise. At this moment, the water becomes low in dissolved oxygen, which is due to a competition in the use of dissolved oxygen between algae and fish raised during the night. In the water, the oxygen reserve is far from inexhaustible. Tilapia can only use oxygen in the dissolved form, which has, on average, only about ten milligrams per liter of water (Audebert et al, 2014).

The comparative study between the 3 experimental tubs identified the best performing group for each parameter (survival rate, change in average weight and average size, daily weight gain, average weight gain).

- ✓ Regarding the survival rate, the results illustrated in Figure 1 showed significantly that D50 has a higher survival rate. A note from these results is that the lowest densities (D50 < D100< D150) have high survival rates. On this, we can say that the mortalities are also proportional to the rearing densities. The work of Vincke (1992) in a floating cage with a volume of 5 m^3 on juveniles of *O. niloticus* at a density of 24 males / m^3 had a survival rate of 82.2%. Comparing the results, we can say the raising in fiberglass tub allows to better minimize the mortalities. The dead subjects were well diagnosed before throwing them away. Their gills were normal and no morphological changes were noticed. Since

ISSN: 2455-6939

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they were not dead en masse, it was concluded that it was a natural death. Most often there were dead subjects early in the morning.

- ✓ The growth performance of juveniles of *O. niloticus* at different stocking densities shows that the final average weights, daily weight gains, changes in weight and size of D50 are greater compared to densities D100 and D150. Regarding the size of the individuals, a homogeneity is noted for D50 and a slight variability of size between the subjects of D100 as well as those of D150. The results suggest that fish raised at low densities make better use of the available food resources in the rearing environment, in opposition when they are raised at higher densities. An additional reason in this study was that D50 individuals had more appetite during feeding compared to those at other higher densities. Anabolism, which increases body weight over time by assimilating food requiring oxygen, seemed to be more interesting at the lower density when water volumes were equal. This phenomenon can be explained by the fact that the amount of oxygen was more available for D50 and that anabolism is proportional to respiration. This shows that the increase in dissolved oxygen has a positive influence on growth. The climate of the rearing environment had an influence on the growth performance of the individuals. There was sometimes a drop in the water temperature when the weather was cloudy or just after rain. As a result, the fish reduced their amount of food consumed. After the effects of the climate, we also had the manipulation that increased the stress. It is admitted that the manipulation was inevitable because it made it possible to determine the parameters of growth and survival during each control fishing. All of these factors slowed growth. On the other hand, imported feed appeared to be effective and appreciated by the fish by its granular form and ability to float for more than 1 hour. Its buoyancy had made it easy to remove uneaten food to prevent deterioration of farmed water. The food contained 40% protein and several components. It could supplement the nutritional needs of fish by acting positively on growth performance.
- ✓ The highest final average weight was recorded at density D50 (110 ± 3.27 g) followed by that at density D100 (95 ± 6.21 g) and lowest at density D150 (80 ± 7.45 g). ANOVA statistical analysis (variance analysis) showed that the final average weights were not significantly different ($P > 0.05$) after forty (40) days of rearing.
- ✓ The highest mean final size was recorded at density D50 (17.5 ± 0.66 cm), followed by density at D100 (16.74 ± 0.76 cm) and lowest at density D150 (15.36 ± 0.97 cm). The results obtained by Plaquette and Petel (1976) in *Oreochromis niloticus* juveniles reared for 35 days at different densities in a 4-ares pond indicate the effect of density on the growth performance of this species. Their results are similar to ours.
- ✓ In our study, the daily weight gain is higher for D50 (1.7 g) followed by D100 (1.3 g) and lower at D150 (1.07 g). The floating cage experimental study of juvenile male of

Oreochromis niloticus with a density of 1 male / m^3 of Azaza et al (2004), resulted in a daily weight gain equal to 2.02 g / d. The density in the floating cages was very low and they were breeding only males and it is known that the male of Nile tilapia has a better growth performance than the female. On the other hand fish feel more natural in a floating cage than in fiberglass tanks.

5. CONCLUSION

This study has shown that the stocking density of *O. niloticus* juveniles in fertilized fiberglass tanks is an important factor in fish production. According to the results obtained, an incorrect storage density has a negative impact on the growth performance and the survival of the subjects. The best growth performance was recorded with the lowest D50 density but the D100 also showed good result. These results offer a real boost in breeding *O. niloticus*. This experience we led, can highlight the use of fiberglass tubs in rearing juveniles under conditions where the ground is muddy and the water of ponds may be very trouble to monitor juveniles.

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