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GROWTH AND PRODUCTION OF MONOSEX TILAPIA (*Oreochromis niloticus* L.) UNDER DIFFERENT LEVELS OF STOCKING DENSITIES

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ABSTRACT

Monosex tilapia (*Oreochromis niloticus* L.) was evaluated in a freshwater pond for 100 days at Gokuleshwor, Baitadi, Nepal during the summer and rainy seasons of 2019. Fingerlings were supplied at stocking densities of 5, 10, 15, and 20 fish per m^3. At the time of stocking, the average fingerling weight was 8.5 grams. Each treatment had four replicates. Each of the treatments involved feeding the fish twice a day. The results revealed that the specific growth rate and survival rates decreased with increasing levels of stocking density. As stocking density increased, the growth performance of tilapia dropped. Fish growth was the highest at a stocking density of 5 fish per m^3, but the production was the highest at a stocking density of 20 fish per m^3. According to the findings of this study, farmers should use higher stocking densities to maximize production.

Keywords: Monosex tilapia, Stocking densities, Growth.

INTRODUCTION

The Nile tilapia (*Oreochromis niloticus* L.) is a highly adaptable fish that feeds on macrophages and grows quickly, making it ideal for low-tech aquaculture in impoverished countries. This fish is a robust fish that can survive in shallow and muddy water and is a good organic matter converter into high-quality protein (Stickney et al., 1979). Tilapias have a strong ability to take natural feed from ponds, a high interest in supplementary feed, a high ability to survive in bad weather, and high disease resistance power (Pullin, McConnell, 1982). They can withstand

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temperatures of 10 to 11 degrees Celsius. In 1985, two tilapia species, *Oreochromis niloticus*, and *O. mossambicus*, were introduced into Nepal for the first time from Thailand (Shrestha, 1994). Tilapia has long been considered a low-value trash fish. Tilapia can be cultured in a variety of aquaculture systems, ranging from ponds with a low density to high-intensity commercial farms, pens, cages, and raceways (Yadav, 2006). Tilapias have a wide range of aquaculture characteristics. They grow well even on low protein diets, whether in natural aquatic production or as supplementary food. They can withstand a wide range of environmental conditions, are disease resistant, and can be handled and kept in captivity (Yadav, 2006).

Tilapia development is normally determined by several parameters, including stocking density, physiological status of the fish, reproductive status of the fish, food quality, energy content of the diet, and environmental drivers such as dissolved oxygen, pH, temperature, and so on (Lovell, 1989; Gibtan et al., 2008). Among these factors, fish stocking density is important in profitable aquaculture (Kunda et al., 2021). Stocking density is also important for lowering input and maintenance expenses. As a result, both under-stocking and over-stocking are less commercially viable in commercial culture systems (Marma et al., 2017). The ideal stocking density enables long-term aquaculture by ensuring proper feed use, maximum productivity, a healthy habitat, and good health. In comparison to low stocking density, high stocking density has a number of negative consequences, including competition for food and shelter, as well as the quick spread of disease if it occurs. As a result, optimizing the stocking density for the target species in aquaculture is critical for achieving the necessary level of production (Reza et al., 2015). In terms of quality fingerling production, optimum stocking density and feed quality dictate its growth, survival, and economic viability (Timalsina et al., 2017). The information regarding the stocking density of tilapia in Nepal is not sufficient. Therefore, this study was carried out to find the optimal stocking density of tilapia in Gokuleshwor, Baitadi, Nepal.

MATERIALS AND METHODS

Study area

The experiment was conducted for 100 days in a single pond at the Gokuleshwor Agriculture and Animal Science College (GAASC), Baitadi, Nepal, from July 5, 2019 to October 17, 2019 at a latitude of 80°34"E and a longitude of 29°40" N. It is located in Baitadi District's Dilasaini rural municipality, which is part of the Far Western Development Region (Province No.7) Mahakali Zone. The research area is located at an elevation of approximately 886 meters above sea level.

Experiment design and setup

The experimental setup included sixteen net-hapas (1 m × 1 m × 1 m). A completely randomized design (CRD) was used to allocate four treatments replicated four times at four levels of stocking density. The stocking density of *Oreochromis niloticus* L. is given in Table 1.

Table 1: Different levels of stocking density used in the experiment

Treatment	Treatment details (Stocking density i.e., no. of fish per m^3)
T1	5
T2	10
T3	15
T4	20

Pond management

The pond's water was drained and dried in the sun for roughly 5 days. All water inlets and outputs have been inspected and repaired. Predators and vermin are kept out of the pond system by repairing it. Using lime (1 kg per 45 m^2), all aquatic weeds were eliminated from the pond and dike, as well as the total elimination of all undesired fish, insects, and other aquatic life. Temperature: 26-32ºC, dissolved oxygen: 5-8 mg L^{-1}, PH: 6.5-8.5, turbidity: 25-40 cm, and other normal water quality parameters were maintained during the research. Plankton concentration: moderate, water depth: 1.3 m, water color: mild green, 0.2 ppm ammonia and 20 ppm dissolved CO_2. Hapas are installed in the pond seven days after liming.

Collection and stocking

The fries of monosex tilapia were carried out from Agriculture and Forestry University, Rampur, Chitwan, Nepal. Those fry were brought to Dhangadhi (Geta), the experimental location, in oxygenated water in a polybag for the re-installation of oxygen in the polybag to reduce fry mortality. Fry were acclimatized in plastic bags with experimental pond water for one day before being released at 8:00 a.m. the next day in each experimental pond at a rate of 5 individuals per m^3 in Treatment T1, 10 individuals per m^3 in Treatment T2, 15 individuals per m^3 in Treatment T3, and 20 individuals per m^3 in Treatment T4. At the time of stocking of fry in hapa, the initial average weight of fry was about 8.5 g.

Feed preparation and feeding

During the experiment, a commercial floating pellet was employed. The feed included 30% crude protein, 5.6% crude fat, 14.23% crude ash, and 9.5% moisture in 1.8-2 mm pellets. Initially, the fry was given 10% of their body weight twice a day. Every ten days, the feeding is reduced by 2% of the feed weight. Feeding was roughly 3% of their body weight in the previous week.

Data recording

Fish were sampled monthly for growth determination. At least 10% of each species were netted and weighed. Daily weight gain, survival rate (%) and food conversion ratio (FCR) were estimated. The water quality parameters were recorded throughout the experimental period. Water samples were collected between 9:00-10:00 a.m. at fortnightly interval. The physico-chemical parameters like temperature (°C), dissolved oxygen (mg L^{-1}), transparency (cm), pH and water depth (cm) were determined monthly three times i.e. in the morning (6-7 am), afternoon (12-1 pm) and evening (5-6 pm).

Statistical analysis

The obtained data from the experiment were analyzed statistically by one-way ANOVA using statistical software GenStat (version 15.0, VSN International Ltd., England and Wales) was used to evaluate the collected data. The least significant difference (LSD) test was used to identify the significant differences between treatments at a 5% level of significance (Gomez, Gomez, 1984). MS-Excel 2016 software was used to create graphs and tables.

RESULTS AND DISCUSSION

Growth

The stocking density has a significant effect (p<0.01) on fish growth as measured by weight (Fig. 1). The growth rate of mono-sex male tilapia was measured at 10-day intervals under various stocking densities, and the results are reported in Table 2. This finding indicates that lower stocking densities resulted in a higher weight (g) growth rate, which was subsequently reduced as densities increased.

Table 2. Mean values of growth increment (g) of monosex male tilapia at different stocking densities

Stocking density (No. of fish per m^3)	Days								
	20	30	40	50	60	70	80	90	100
5	11.05a	14.25a	21.73a	33.08a	41.55a	57.43a	73.41a	93.23a	133.31a
10	10.18b	13.20b	20.60ab	31.65ab	41.20a	54.70b	70.05b	89.23ab	124.48b
15	9.95b	12.65bc	19.80b	30.38bc	38.59b	51.25c	66.35c	85.90bc	119.95b
20	9.55b	12.13c	19.60b	29.13c	38.15b	50.80c	63.55c	81.56c	110.25c
Mean	10.18	13.06	20.43	31.06	39.87	53.54	68.34	87.48	122.00
SE	0.19	0.32	0.57	0.54	0.53	0.89	1.30	1.42	2.70
LSD (0.05)	0.68	0.90	1.16	1.93	2.22	2.09	3.00	4.41	8.05
CV (%)	7.55	9.93	11.24	6.92	5.28	6.63	7.59	6.48	8.86
F test	**	**	**	**	**	**	**	**	**

SE = standard error; **-Significant difference at P < 0.01. In column, mean followed by the same letter (s) did not differ significantly at 0.01level.

The effect of stocking densities on the growth of fishes at different days was found to be significant (P<0.01) (Table 2). The increasing stocking densities reduced the growth of fishes (Table 2). These results are similar to those found by Ferdous et al. (2014) and Rayhan et al. (2018). The growth rates changed depending on stocking density, which was also reported by Begum (2009), Rubel (2008), and Masum (2011). Abaho et al. (2020) and Shamsuddin et al. (2022) found that the growth rate of Nile tilapia (*Oreochromis niloticus*) was affected by different stocking densities.

Specific growth rate

The effect of stocking densities on specific growth rates was found to be non-significant. The specific growth rate has decreased with an increasing level of stocking densities (Fig. 1). At the lowest stocking densities, the highest values of specific growth rates were attained by Islam (2007) and Alam (2009). The temperature variation across locations and the natural productivity of the ponds could explain the difference in SGR values of *Oreochromis niloticus* in the current study. The next cause could be the starting size difference of the *Oreochromis niloticus* employed in the studies (Mandal, 2019).

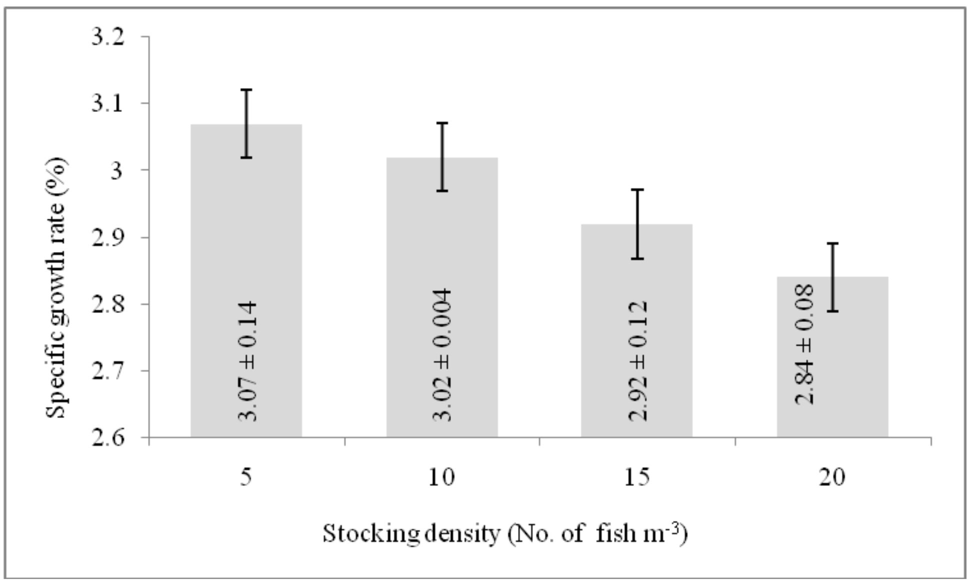

Figure 1. Specific growth rate of mono-sex male tilapia at different stocking densities. In graph, error bars denote standard deviation.

Food conversion ratio

The effect of stocking densities on feed conservation ratio was found significant ($p<0.05$). The feed conversion ratio has increased with increasing levels of stocking densities (Fig. 2).

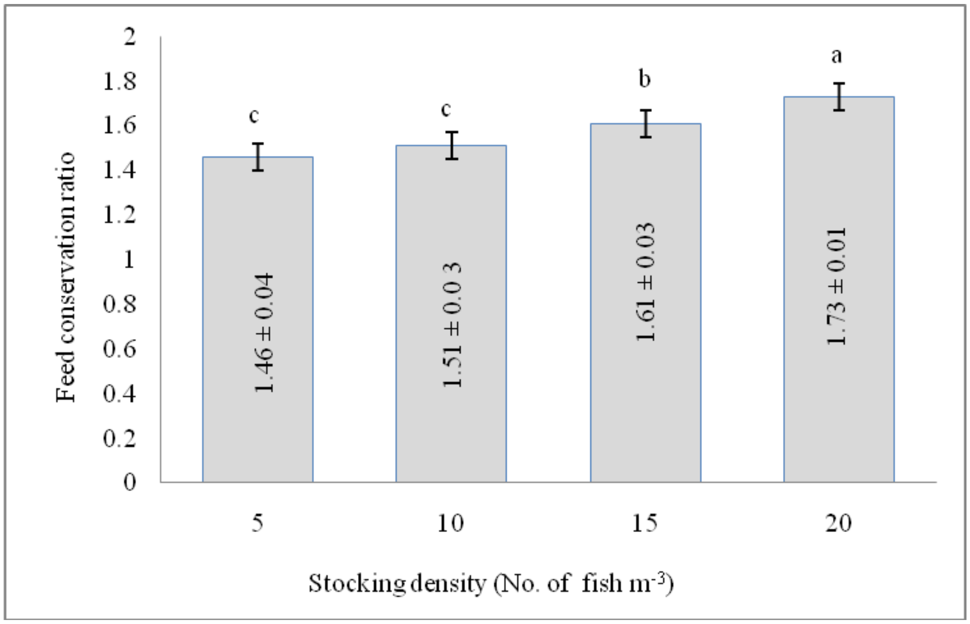

Figure 2. Food conversion ratio (FCR) of mono-sex male tilapia at different stocking densities. In graph, error bars denote standard deviation. Different lowercase letters on error bars indicate statistically significant differences between treatments ($p \leq 0.05$), as performed by the least significant difference (Fisher's LSD) test.

Begum (2009) reported food conversion ratio (FCR) values ranging from 1.03 to 1.2, which were in agreement with the current findings. Tilapia are omnivorous fish that eat phytoplankton, zooplankton, and decomposing suspended organic matter, so the decreased FCR score could be attributed to this. Uneaten feed and metabolic waste created nutrient enrichment in the ponds where feeding was done, which increased plankton production. The FCR rose when stocking density increased in this study, which could be due to the amount of feed provided in each treatment, as Al-Harbi and Siddiqui (2000), and Ani et al. (2021) noted. The effect of stocking density on the feed conservation ratio of Nile tilapia (*Oreochromis niloticus*) was studied by Kunda et al. (2021).

Survival rates

The effect of stocking densities on survival rates was found to be significant ($p<0.05$). The survival rates have decreased with increasing levels of stocking densities (Fig. 3).

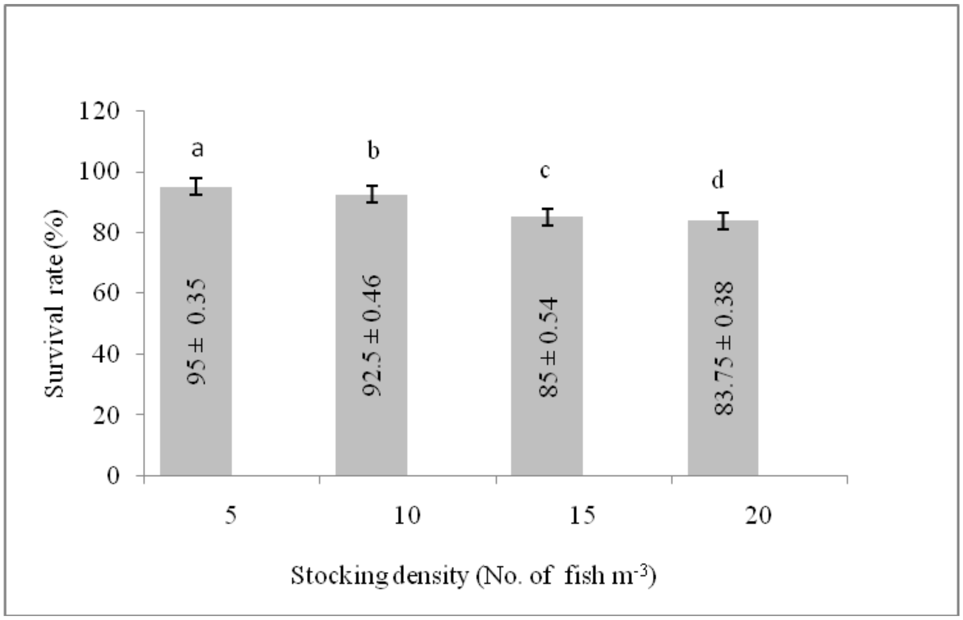

Figure 3. Survival rate (%) of mono-sex male tilapia at different stocking densities Different lowercase letters on error bars indicate statistically significant differences between treatments ($p \leq 0.05$), as performed by the least significant difference (Fisher's LSD) test.

Hassan (2007) and Masum (2011) found similar survival rates, with survival rates ranging from 79.44 to 89.83% and 84 to 92%, respectively. Different stocking densities were discovered to have a negative impact on the survival rate. Low stocking density provides the best chances of survival. This is due to less ammonia production and less competition for food and space among the fish. The survival rate decreased as the stocking density increased. Despite the fact that the fish were fed until they were satisfied, this could be due to the crowded conditions created by higher densities and the resulting competition. Gibtan et al. (2008) and Suresh and Lin (1992) both found similar results. Ani et al. (2022) and Das et al. (2019) studied the effect of stocking density on the survival rate of monosex Nile Tilapia (*Oreochromis niloticus*).

Production

The effect of stocking densities on production was found to be significant ($p<0.05$). Fish production has increased with the increasing levels of stocking densities (Fig. 4). The current research backs up the findings of Hasan (2007) and Begum (2009), who found that higher stocking densities yielded better results than lower ones. Our findings were similar to the findings of Gibtan et al. (2008), who reported a positive relationship between the stocking density and the Nile tilapia production. The higher yields as stocking densities increased were also found by El Nouman et al. (2021).

The effect of stocking density on production of Nile tilapia (*Oreochromis niloticus*) was studied by Abaho et al. (2020) and Shamsuddin et al. (2022).

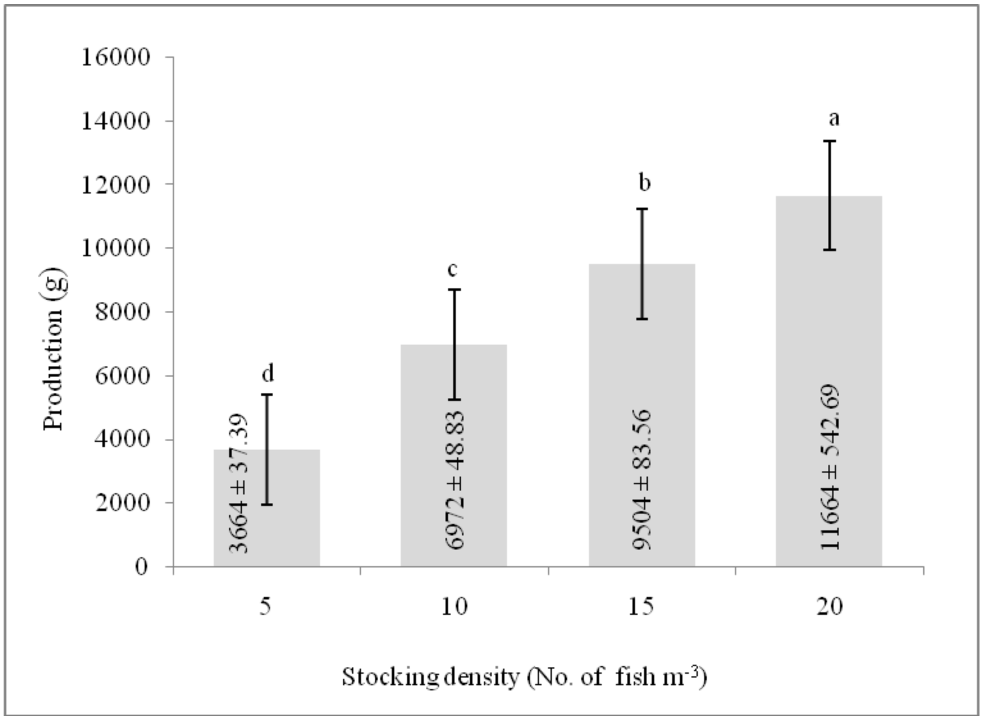

Figure 4. Production of mono-sex male tilapia at different stocking densities. Different lowercase letters on error bars indicate statistically significant differences between treatments ($p \leq 0.05$), as performed by the least significant difference (Fisher's LSD) test.

CONCLUSION

Stocking density is an important parameter in fish culture as it has a direct effect on the growth and production of fish. With the increasing levels of stocking densities, growth rates and survival rates decreased. However, the stocking density of 20 fish per m^3 gave the highest production (11664 g). Therefore, it can be suggested that farmers should use a stocking density of 20 fish per m^3 for mono-sex tilapia.

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