Journal of Fisheries & Livestock Production

Sanudi et al., J Fisheries Livest Prod 2015, 3:4
DOI: 10.4172/2332-2608.1000148

Review Article Open Access

Effect of Stocking Density and Feed on Growth of Improved (F5) Mono-Sex Oreochromis Shiranus Reared in Tanks

Sanudi F[1]*, Jere B[1], Mzengereza K[1] and Chirwa BB[2]

[1]Department of Fisheries, Mzuzu University, Luwinga, Mzuzu, Malawi
[2]Department of Fisheries, Ministry of Agriculture, Domasi, Malawi

Abstract

A study was undertaken to determine the effects of stocking density and type of feed on growth of mono-sex culture of improved strain of Oreochromis shiranus reared in tanks. The fish stocked at 3 fish/m^2 and 5 fish/m^2 replicated three times were randomly assigned to Malawi Gold Standard (MGS) and maize bran (MB) diets. The fish were cultured for 42 days. Results showed that the mean weight gain and gain in standard length were inversely proportional with stocking density. Treatments fed MGS and a stocking density of 3 fish/m^2 had higher mean body weight gain (4.37 ± 0.284 g) and standard length gain (3.07 ± 0.111 cm) compared to 2.60 g and (2.25 ± 0.120 cm) for weigh gain and gain in length for treatments fed MB at 5 fish/m^2 respectively. There were significant differences (P<0.001) between treatments fed MGS and MB in terms of mean weight gain and standard body length. The study also determined the rate of survival in the different treatments. The highest survival rate was in MGS and 3 fish/m^2 (94.7%) while the least was in MB and 5 fish/m^2 (87.1%). This study shows that stocking density and feed affect growth of mono-sex culture of improved strains of O. shiranus reared in tanks. MGS and stocking density of 3 fish/m^2 gave the best results. However, for resource limited farmers a recommendation of 3 fish/m^2 and MB can be made to achieve 2.59 cm gain in length and 2.78 g gain in weight instead.

Keywords: Improved strain; Stocking density; Feed; Monosex; MGS; Maize bran

Introduction

Fish contributes about 72% of animal protein in people's diets [1] and the fish industry employs more than 600,000 people. Fish is thus of paramount importance to food and economic security of Malawian citizenry. However, fish catches have declined in the natural water bodies, consequently there has been a decrease in the per capita fish consumption from 14.9 kg to about 5.6 kg between 1970s and 2011. The decrease in the per capita fish protein supply is dangerous to the health and economic security of Malawians. Aquaculture is therefore considered a remedy to counteract the decreasing fish catches from the wild water bodies. Aquaculture production is dependent on a number of factors such as stocking density, quality of feeds, good husbandry practice and the fish stock.

In Malawi, the most cultured fish species are tilapias as they have excellent aquaculture potential owing to their herbivorous and omnivorous feeding habits, high tolerance to diseases and parasites [2]. Tilapias are the easiest fish to culture and ideal for small farmers as well as industrial scale aquaculture [3]. Two tilapia genera cultured in Malawi are Tilapia species which are macrophagous and substrate spawners and Oreochromis species which are microphagous and mouth brooders.

Russell et al. (2008) pointed out that Oreochromis shiranus is one of the currently farmed species in both smallholder and commercial aquaculture. Being one of the commercially important species, this study focused on this species which is cultured by over 90% of the fish farmers in Malawi. In 2007 Maluwa and Gjerde improved the species by mass selection (MAS) [4]. The selection achieved 37% increase in growth after two generations. The growth performance of mono-sex culture of this improved strain kept at different densities given different kinds of feed was studied to recommend the optimum stocking density using a particular feed (Malawi Gold Standard or maize bran).

Tilapia grows and reproduces in a wide range of environmental conditions and tolerates stress induced by handling [5]. This allows easy and rapid propagation of the fish in various environmental conditions, but can as well be a source of problem within a limited environment. Uncontrolled multiplication of the fish not only reduces genetic diversity of the system but also produces dwarf fish population of poor market value.

Problems common for many tilapia culture systems are the reduction of growth rates at the onset of sexual maturity and precocious and excessive reproduction [6]. There are a number of ways to control reproduction in mixed-sex populations, one of which is the culture of all male tilapia. The mono-sex culture of male populations of tilapia is desirable as reported by Pillay (1993) because of its ability to increase production potential and lower management requirements [7].

The mono-sex culture of sexually reversed O. shiranus combined with the appropriate stocking density and feed can lead to increased production in the different culture systems and hence act as a stable source of fish protein to supplement the declining catches in the wild water bodies.

This study therefore established the appropriate stocking densities of O. shiranus given Malawi Gold Standard (MGS) and maize bran as feed in different treatments.

Methods and Materials

The sexually reversed fry were collected from the National Aquaculture Centre where the study was conducted. The fry were sexually reversed using 17α-methyltestosterone months prior to the experiment.

***Corresponding author:** Sanudi F, Department of Fisheries, Mzuzu University, Luwinga, Mzuzu, Malawi, Tel: +265 (0)1 320 722/575; E-mail: kumbumzenge@gmail.com

Received October 17, 2015; **Accepted** November 19, 2015; **Published** December 02, 2015

Citation: Sanudi F, Jere B, Mzengereza K, Chirwa BB (2015) Effect of Stocking Density and Feed on Growth of Improved (F5) Mono-Sex Oreochromis Shiranus Reared in Tanks. J Fisheries Livest Prod 3: 148. doi:10.4172/2332-2608.1000148

A total of 300 fry were collected for stocking and were weighed and length recorded before stocking at a density of 3 fish/m^2 and 5 fish/m^2 in different treatments with stocking density of 3 fish/m^2 given Malawi Gold standard as feed, stocking density of 3 fish/m^2 given maize bran as feed, stocking density of 5 fish/m^2 given Malawi Gold standard as feed and stocking density of 5 fish/m^2 given Malawi maize bran as feed

Malawi Gold Standard and Maize bran were prepared as feed for the fry after stocking. The MGS and maize bran were provided as feed in different treatments to assess growth performance of fish given different feeds.

Experimental design

The factorial experiment was set in 12 tanks using completely randomized design (CRD) whereby it was assumed that the environmental conditions were constant in all treatments. Each treatment was replicated three times to reduce errors. The study had 4 treatments namely; 3 fish/m^2 fed MGS, 3 fish/m^2 fed MB, 5 fish/m^2 fed MGS and 5 fish/m^2 fed MB.

Data collection

After every two weeks sampling was conducted with 16 fingering collected from each tank. Body weight (BW) was recorded for individual fish using Tanita KB 200 electronic balance – Thailand. Total and standard length was measured from the tip of the snout to the caudal fin and tale respectively using the measuring board.

Water parameters

Water quality parameters that were measured were water temperature, dissolved oxygen, and ph. These parameters were measured in the morning around 8.00 a.m. and late in the afternoon around 4.00 p.m.

Data analysis

Data was entered on a Microsoft Excel at the end of each sampling. Body weight and length were compared using univariate analysis of variance using Statistical Package for Social Scientists (version 16.0).

The growth parameters of fish in different treatments in terms of mean weight gain, mean length gain, percentage length gain, Feed Conversion Ratio (FCR) and survival were calculated as follows:

$$\text{Mean weight gain}=\frac{\text{Final weight(g)-Initial weight(g)}}{\text{Initial weight(g)}}\times 100$$

Specific Growth Rate (SGR% day^{-1}) = 100 [(lnWt-lnWo) t^{-1}];

Where:

W_o is initial weight(g)

W_t is final live weight (g)

t is culture period in days

L_n is the natural log

$$\text{Food conversion ratio (FCR)}=\frac{\text{Total weight of food consumed(g)}}{\text{Total weight gain by fish(g)}}$$

$$\text{Mean length gain}=\frac{\text{Final length(mm)-Initial length(mm)}}{\text{Initial length(mm)}}\times 100$$

$$\text{Survival rate}=\frac{\text{total number of fish counted}}{\text{total number of fish stocked}}\times 100$$

The hypothesis of no significant difference between mean of four treatments was accepted or rejected using 95% significance interval. After that, Post hoc analysis using Duncan test was used to separate means.

Results

Stocking density of 3 fish/m^2 and Malawi Gold Standard feed (MGS)

The fish stocked at a stocking density of 3 fish per square metre and fed MGS registered the highest gain in body weight and standard length (Table 1).

This level of growth was attained because there was a small number of fish in the tank hence making feed available. The mean body weight for the treatment was 6.34 ± 3.94 (Table 1). The standard length for the treatment was 5.46 ± 0.111 (Table 1).

Stocking density of 3 fish/m^2 and maize bran as feed

In this treatment, the mean body weight for the treatment was 4.60 ± 2.81, a mean which was below that observed in a treatment with stocking density of 3 fish/m^2 (Table 1). The treatment also had a standard length below that observed in the treatment with stocking density of 3 fish/m^2 fed MGS

Stocking density of 5 fish/m^2 and malawi gold standard feed

The fish stocked at 5 fish/m^2 and given Malawi Gold Standard as feed attained a mean body weight and standard length of 5.45 ± 2.95 and 5.18 ± 0.122 respectively (Table 1). The growth was reduced as compared to the treatment given the same feed but stocked at a stocking density of 3 fish/m^2. The mean weight gain in this treatment was close to that observed using maize bran as feed at a stocking density of 3 fish/m^2 (Table 1).

Stocking density of 5 fish/m^2 and maize bran as feed

In this treatment the least growth was observed as compared to all the other treatments. The treatment had a mean body weight of 4.53 ± 2.47 (Table 1), a mean which is least among all the treatments and it also had the least standard length.

Comparison of treatments with same stocking density

The different treatments registered different growth rates with treatments with low density having quick growth as compared to treatments with high density. The same trend was observed in treatments with Malawi Gold Standard as feed compared to those treatments in which Maize bran was used as feed.

Comparison of all treatments

The study also established that there were significant differences in

Parameter	3MGS	3MB	5MGS	P-value
IBW	1.97 ± 0.21	1.82 ± 0.20	2.02 ± 0.19	0.001
MBW	6.34 ± 0 .284^a	4.60 ± 0.203^c	5.45 ± 0.213^b	0.001
AWG	4.37^a	2.78^c	3.43^b	0.001
SL	5.46 ± 0.111^a	4.49 ± 0 .115^c	5.18 ± 0.122^b	0.001

Figures with different superscripts within a row are significantly different ($p<0.05$)

3MGS=3 Fish/m^2 with MGS feed, 3MB=3 Fish/m^2 with MB feed, 5MGS= 5 Fish/m^2 with MGS feed, 5MBS=5 Fish/m^2 with MB feed

Values are presented as Mean ± SE at α=0.05

Table 1: Initial body weight, mean growth weight, average weight gain and standard length by treatment of Oreochromis shiranus.

terms of growth among the different treatments. There was correlation between feed and stocking density with respect to growth of the fish in the different treatments (Table 2). The study also established that stocking density and type of feed affect the growth performance of the improved strain of Oreochromis shiranus in monosex culture of all males. Treatments with low stocking density registered higher growth as compared to treatments with high stocking density (Table 1). Fish in treatments where Malawi Gold Standard was provided as feed grew faster as compared with those that were fed maize bran with the same stocking density.

Stocking density and feed played a role in the weight gain and standard length gain in the different treatments. (Figure 1) shows the mean weight and standard length gain in the different treatments. The treatment with stocking density of 3 fish/m² and given Malawi Gold Standard feed gained much weight as compared to that with the same stocking density but given maize bran as feed. The treatment also had the largest standard length value.

Treatment also had a bearing on survival rate, specific growth rate and feed conversion ratio. There was high survival in treatment with small stocking density and Malawi Gold Standard as feed. There was least survival in a treatment with high stocking density and maize bran as feed. The specific growth rates were 4.2, 4.0, 3.6 and 3.3 in treatments 3 fish/m² fed MGS, 3 fish/m² fed MB, 5 fish/m² fed MGS and 5 fish/m² fed MB respectively.

Water quality parameters

There were no differences in water quality parameters. This means that the differences in growth for different treatments cannot be attributed to water quality.

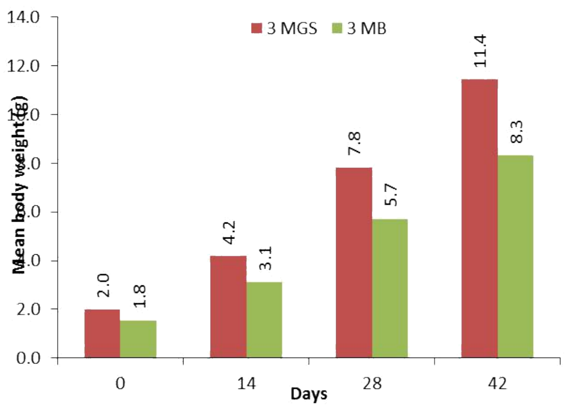
Discussion

The growth of an organism is said to be contributed by the genetic makeup of the organism and the environment [3]. The differences in growth in this study can be attributed to the differences in stocking density and feed since the environment of the experiment were constant for all the treatments. The results of this study show that there were significant differences (P<0.001, Table 1) between treatments fed Malawi Gold Standard and maize bran in terms of mean weight gain and standard body length. The observations show that body weight and standard length gain were greatest in treatments with Malawi Gold Standard as feed compared to treatments where maize bran was given as feed. This high increase in weight is attributed to the high average crude protein in Malawi Gold standard (CP=18%) as compared to maize bran. This is the case because there is a positive relationship between the quality of feed and the output obtained in aquaculture.

Factor	df	SS	MS	F-ratio	P-value
Density	1	46.021	46.021	24.834	.001
Feed	1	344.005	344.005	185.631	.001
Interaction	1	33.333	33.333	17.987	.001
Error		1393.583	1.853		

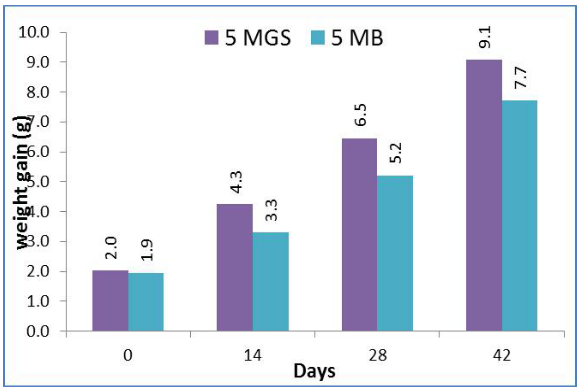
R squared=0.820

Table 2: Analysis of variance for body weight.



3MGS= 3 Fish/m² with MGS feed, 3MB=3 Fish/m² with MB feed

Figure 1: Comparison of treatments with stocking density of 3 fish/m².



5MGS= 5 Fish/m² with MGS feed, 5MB= 5 Fish/m² with MB feed

Figure 2: Comparison of treatments with stocking density of 5 fish/m².

The results also show that there was greater growth in treatments with low stocking density as compared with treatments with a higher density. The effect of stocking density among the treatments had significant differences (P<0.001, Table 1). This difference in growth is attributed to social interactions through competition for food and space which negatively affect fish growth. Therefore higher stocking densities lead to increased stress and consequent increase in energy requirements causing a reduction in growth rates and food utilization. These findings are in line with what was reported by [3,8].

Post hoc analysis using Duncan test showed that there were significant differences in body weight in treatments with 3 fish/m² fed MGS and treatment with stocking density of 5 fish/m² fed MGS. The highest body weight was in treatment with stocking density of 3 fish/m² which differed significantly with that of stocking density of 5 fish/m² both given MGS as feed (Figure 2).

The test also indicated that there were no significant differences at (P<0.05) between treatments with stocking density of 3 fish/m² and 5 fish/m² given maize bran as feed though direct observation showed differences. This can be attributed to the survival of the fish in the tanks stocked at 5 fish/m² which registered much mortality during stocking and sampling.

These findings on body weight are also in line with Charles (2001) who observed that poor weight gain in Oreochromis shiranus [9] stocked at a higher density becomes a source of stress and the fish needs to use energy stored in the body tissue as protein hence reduced growth (Figure 3). The findings of this research also agree with Garr et al. (2011); Mazlum, 2007 and Zhu et al. (2011), who observed that fish

Citation: Sanudi F, Jere B, Mzengereza K, Chirwa BB (2015) Effect of Stocking Density and Feed on Growth of Improved (F5) Mono-Sex Oreochromis Shiranus Reared in Tanks. J Fisheries Livest Prod 3: 148. doi:10.4172/2332-2608.1000148

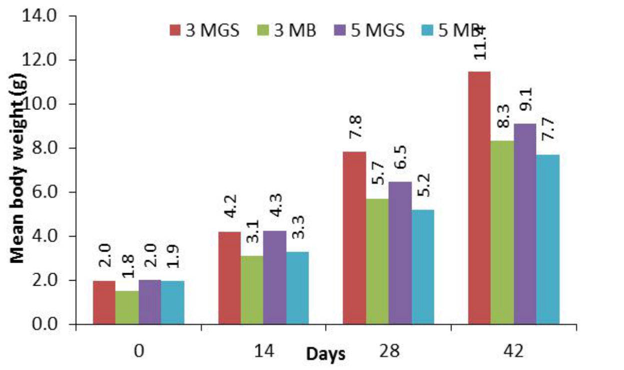


Figure 3: Weight gain over time in different treatments.

Parameter	3, MGS	3, MB	5, MGS	5,MB	P-value
SGR	0.42[a]	0.40[a]	0.36[b]	0.33[b]	<0.005
SR	94.7[a]	91.2[a]	93.6[a]	87.1[b]	<0.005
FCR	3.11[a]	3.45[b]	2.31[c]	2.33[c]	<0.005

Figures with different superscripts within a column are significantly different (P<0.05)

3 MGS=3 Fish/m^2 with MGS feed, 3 MB=3 Fish/m^2 with MB feed, 5 MGS=5 Fish/m^2 with MGS feed, 5 MBS= 5 Fish/m^2 with MB feed

Table 3: Effects of treatment on survival rate, specific growth rate and feed conversion ratio.

Factor	df	SS	MS	F-ratio	P-value
Density	1	4.798	4.798	22.127	0.001
Feed	1	26.664	26.664	122.975	0.001
Interaction	1	3.114	3.114	14.36	0.001
Error	752	163.049	0.217		

R squared=0.838

Table 4: Analysis of variance for standard length.

stocking density is one of the most important parameters affecting fish growth and health in a number of ways [10-12]. Pouey et al. (2011), Sorphea et al. 2010 reported those growth performance and survival rates are adversely affected by high stocking densities. It is evident that growth of fish is enhanced at lower stocking densities as demonstrated in the treatment with stocking density of 3 fish/m^2 which was higher throughout the study period [13,14]. This is in agreement with Yousif (2002) who reported that it is a generally accepted principle that increasing the number of fish (density) will adversely decrease growth. The observation of decrease in growth with increase of stocking density also corresponds to observations reported by Breine et al. (1996) [15,16].

There were no significant differences in terms of survival in the treatments regardless of the high stocking density in other treatments (Table 3). This may be attributed to what was reported by [2], that tilapias are hardy fishes and are able to survive poor conditions even under high stocking densities.

Specific growth rate and feed conversion efficiency were different in the various treatments (Table 4), with good SGR and FCR in treatments with low stocking density and given MGS as feed as compared to treatments given maize bran as feed.

Water quality parameters play an important role in the biology and physiology of fish [17]. Throughout the experiment period, the water quality in all the treatments remained within the range required for tilapias [18,19]. Therefore, the differences in growth in the different treatments cannot be attributed to variations in water quality parameters [20].

Conclusion

The study shows that stocking density and feed have an effect on the weight gain of the monosex culture of the improved strain of Oreochromis shiranus. It has been observed that fish stocked at a low stocking density grow faster as compared to fish stocked a higher stocking density given the same feed. It has also been observed that fish fed MGS grow faster as compared to fish fed maize bran. There is a direct relationship between stocking density and type of feed on the growth of the improved strain of the species.

Therefore the null hypothesis that there is no difference in growth performance between mono-sex culture of the improved strain of Oreochromis shiranus stocked at different socking densities and given different feed is rejected

The study has also established that 3 fish/m^2 is the optimum stocking density in treatments given MGS. However, a treatment fed maize bran with the same stocking density also performed very well compared to a treatment with stocking density of 5 fish/m^2 fed MGS.

Recommendations

Malawi Gold Standard and stocking density of 3 fish/m^2 has proven to be the best treatment. However, a stocking density of 3 fish/m^2 can be used by resource limited farmers to produce the result closer to that of MGS using at a stocking density of 3 fish/m^2 given maize bran as feed.

Furthermore, average resource fish farmers, can use MGS at a stocking density of 5 fish/m^2 to achieve a reasonable yield in each rearing period.

Acknowledgement

I also acknowledge the support from technical staff at National Aquaculture Centre for their technical support.

References

1. Ecker O, Qaim M (2011) Analysing nutritional impacts of policies: An empirical study for Malawi. World Development 39: 412-428.
2. Iclarm (1991) A Case study of Malawi: The context of small scale integrated-Agriculture aquaculture systems in Africa. International Center for Living Aquatic Resources Management, Manila, Phillipines: 189.
3. M'balaka M, Kassam D, Rusuwa B (2013) Effect of stocking density on the growth and survival of improved (F5 and F6) and unimproved native strains of Oreochromis shiranus (Trewavas) raised in hapas. Indian J Fish 60: 151-155.
4. Maluwa AO, Gjerde B (2006) Estimates of the strain additive, maternal and heterosis genetic effects for harvest body weight of an F2 generation of Oreochromis shiranus. Aquaculture 256: 38-46.
5. Tsadik GG, Bart AN (2007) Effects of feeding, stocking density and water-flow rate on fecundity, spawning frequency and egg quality of Nile tilapia, Oreochromis niloticus. Aquaculture 272: 380-388.
6. Le'veque C (2002) Out of Africa: The success story of tilapias: Environmental Biology of Fishes 64: 461-464.
7. Oleman R (2001) Cichlid and science, Bad cichlids? Cichlid news magazine, USA 10.
8. Aksungur N, Aksungur M, Akbulut B, Kutlu I (2007) Effects of stocking density on growth performance, survival and food conversion ratio of Turbot (Psett maxima) in the net cages on the southeastern coast of the Black Sea. Turkish J Fish Aquat Sci: 7-152.
9. Charles B (2001) Effects of stocking density on feed efficiency, protein

utilisation and body Composition of *O shiranus*. M. Sc. Thesis, Aquaculture and Fisheries Science, Bunda.

10. Garr AL, Lopez H, Pierce R, Davies (2011) The effect of stocking density and diet on the growth and survival of cultured apple snails, Pomacea paludosa. Aquaculture 311: 139-145.
11. Mazlum Y (2007) Stocking density affects, survival, and cheliped injuries of third instars of narrow-clawed crayfish, Aatacusleptodactylus Eschscholtz, 1823 juveniles. Crustaceana 80: 803-815.
12. Zhu YJ, Yang DG, Chen JW, Yi JF, Liu WC, et al. (2011) An evaluation of stocking density in the cage culture efficiency of Amur sturgeon Acipenser schrenckii. J appl Ichthyol 27: 545-549.
13. Pouey JLOF, Piedras SRN, Rocha CBT, Avares RA, Santos JDM (2011) Reproductive performance of silver catfish, Rhamdiaquelen, juveniles stocked atdifferent densities. Ars Veterinaria 27: 241-245.
14. Sorphea S, Lundh T, Preston TR, Borin K (2010) Effect of stocking densities an feed supplements on the growth performance of tilapia (Oreochromis spp) raised in pond and in the paddy field. Livest Res Rural Dev 22: 227.
15. Yousif OM (2002) The effects of stocking density, water exchange rate, feeding frequency and grading on size hierarchy development in juvenile Nile tilapia, Oreochromis niloticus L. Emir J Agric Sci 14: 45-53.
16. Breine JJ, Nguenga D, Teugels GG, Ollevier F (1996) A comparative study on the effect of stocking density and feeding regime on the growth rate of Tialpia cameronensis and Oreochromis niloticus (Cichlidae) in fish culture in Cameroon. Aquatic Living Sources 9: 51-56
17. Boyd CE, Tucker CS (1998) Pond Aquaculture Water Quality Management. Kluwer Academic Publishers, Norwell, MA: 541-575.
18. Boyd CE (1990) Water Quality in Ponds for Aquaculture. Birmingham Publishing Company.
19. Pillay TVR (1993) Aquaculture Principles and Practices. Blackwell, Oxford.
20. Russell A, Grotz P, Kriesemer S, Pemsl D (2008) Recommendation domains for pond aquaculture: Country case study: Development and status of freshwater aquaculture in Malawi. The World Fish Center, Penang, Malaysia: 1-59.