EFFECT OF STOCKING SIZES ON THE YIELD AND SURVIVAL OF NILE TILAPIA (*Oreochromis niloticus* L.) ON-GROWN IN PONDS

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Abstract

In the grow-out phase, twelve (12) 500m^2 ponds were used in the study to determine the growth, yield and survival of Nile tilapia (*Oreochromis niloticus* L.) in ponds. The treatments consisted of the following: I- direct stocking at size #22; II- stocking at size #14; and III- stocking at size #10. The various treatments and replicates were assigned randomly in the ponds following a completely randomized design.

Treatment III gave the highest extrapolated fish yield (3,799 kg ha^{-1}) followed by Treatment II (3,065 kg ha^{-1}) then Treatment I (2,738 kg ha^{-1}). Analysis of variance on fish yield showed significant difference between Treatments I and III ($P<0.05$). Specific growth rate likewise significantly differed among treatments ($P<0.01$).

Survival rate of Nile tilapia was also significantly affected by stocking size of fingerlings. Higher survival rate was obtained with bigger size fingerlings.

Introduction

The stocking size of tilapia for grow-out pond production has been dictated by the common size of fingerlings available from tilapia hatcheries. For instance, since size #24 and size #22 are the common and readily available fingerling sizes, farmers tend to stock at these sizes directly into grow-out ponds. In the past, farmers avail fingerling sizes as big as 10-20 grams from hatcheries to stock in their grow-out ponds until harvest or until they reach marketable size. Table 1 presents the tilapia fry sizes commonly available in the Philippines.

Table 1. Tilapia fry sizes commonly available in the Philippines.

Fry sizes	Approximate fish weight in grams
#10	6.00
#14	1.75
#22	0.20

Lanuza (2000) studied the effect of different stocking sizes on the growth, yield and survival of Nile tilapia on-grown in ponds. Using stocking sizes ranging from 0.10 to 1.20 grams, there were no significant differences on the growth, yield and survival of Nile tilapia after 90 days of culture.

Bigger size fingerlings are thought to survive better, grow faster, and reach market size sooner (Arce and Lopez, 1981). Acquiring small-sized fingerlings may require a two-staged production system where fry from hatcheries are transferred to nursery ponds and then stocked into grow-out ponds when they attain the weight of about 10-20 grams. Production characteristics of pond culture of Nile tilapia with a nursery phase to produce stocker-size fingerlings have not been evaluated.

This study was conducted to determine the growth and survival rate of producing various stocking sizes of Nile tilapia fingerling in the nursery hapas in ponds and to determine the effect of fingerling size on the growth, survival, and yield at harvest of Nile tilapia cultured in grow-out ponds.

Materials and methods

Nursery phase

Size #22 sex-reversed fingerlings of Nile tilapia (*Oreochromis niloticus*) of the Genomar Supreme Tilapia or GST strain were grown in fifteen (15) 2 x 2 x 1 m hapas in pond at a stocking density of 200 fish m^{-3} to attain size #10. After two weeks, another batch of size #22 sex-reversed fingerlings were grown in 15 nursery hapas at 200 fish m^{-3} to attain size #14. A commercial type of feed was provided to the fry based at the rate of 10-20% of the mean body weight of the fish. The rearing hapas were installed in a 500 m^2 pond that was fertilized with Urea (46-0-0) and Ammonium phosphate (16-20-0) at the rate of 28 kg N and 5.6 kg P ha^{-1} wk^{-1}.

Grow-out phase

Twelve (12) 500 m^2 ponds were used in the study. Three stocking sizes were designated as treatments, namely, Treatment I – direct stocking at size #22; Treatment II – stocking at size #14; and Treatment III – stocking at size #10. Each treatment was replicated four (4) times. To ensure size uniformity before stocking into the grow-out ponds, the fingerlings were size-graded.

The fish were provided with commercial feeds following the alternate day feeding strategy previously evaluated by the project (Bolivar *et al.,* 2003). The amount of feed was given at the rate of 7% in the first month of culture and at the rate of 2% towards the end of the culture period. Adjustment of the amount of feed was done every two weeks. Water quality parameters such as dissolved oxygen, temperature, pH, total ammonia nitrogen, alkalinity, phosphate and Secchi disk visibility were monitored starting at 9 AM every two weeks. All ponds were fertilized with inorganic fertilizers at the rate of 28 kg N and 5.6 kg P ha^{-1} wk^{-1}. Water depth in all ponds was maintained at 1 m.

A sample of 100 fish was obtained in each pond every two weeks to monitor weight gain and to determine the average fish body weight for the adjustment of feeding. The stocks were harvested by seining and then complete draining after 120 days of culture period. The total number of fish was counted and bulk weighed. Final mean weight, daily weight gain, gross yields and survival rates were calculated.

The production costs were estimated in the nursery phase to determine the cost of producing stocker-size fingerlings. Likewise, a simple cost and return analysis was made on the grow-out phase to compare the cost benefits among the different stocking sizes. Cost modeling did not take into account fixed costs, such as the cost of establishing and operating hatchery facilities. Similarly, labor costs were not factored into the comparison. Consequently our cost modeling considers only the direct costs of production, such as feed, fertilizers, and fingerlings.

The experimental data were compared statistically using the analysis of variance (ANOVA). Post-hoc test using the Duncan's Multiple Range Test (DMRT) was applied for the comparison of treatments means.

Results and discussion

Nursery phase

Figures 1a and 1b show the growth pattern of the Nile tilapia fingerlings reared from size #22 to #10 and from size #22 to #14 in the nursery hapas, respectively. The recovery rates for both sizes were 100%.

Simple cost and benefit analysis (Table 2) showed that rearing of fingerlings in nursery hapas from size #22 to size #10 had slightly better Cost Benefit Ratio (0.69) than rearing of fingerlings from size #22 to size #14 (0.70). The difference in Cost Benefit Ratio can be explained by the difference in the price of fingerlings and in the amount of commercial feeds given.

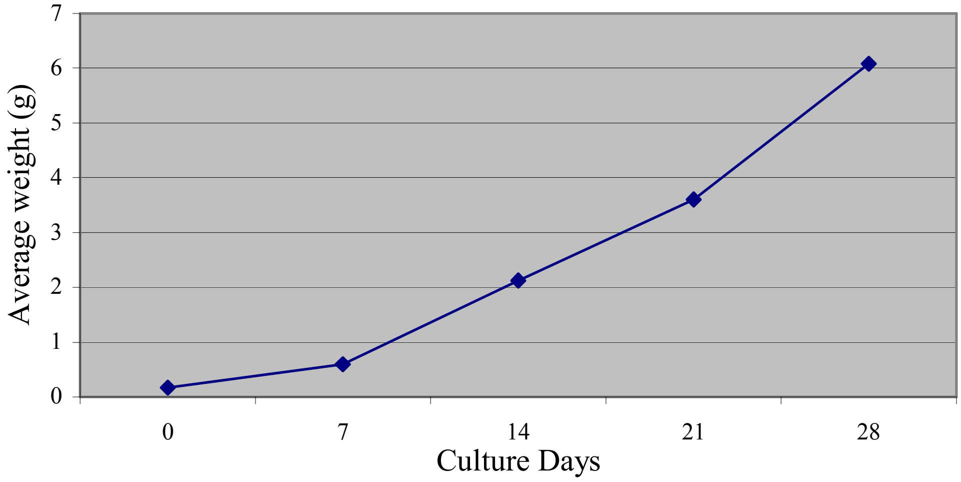

Figure 1a. Growth pattern of Nile tilapia fingerlings from size #22 to #10 in nursery hapas.

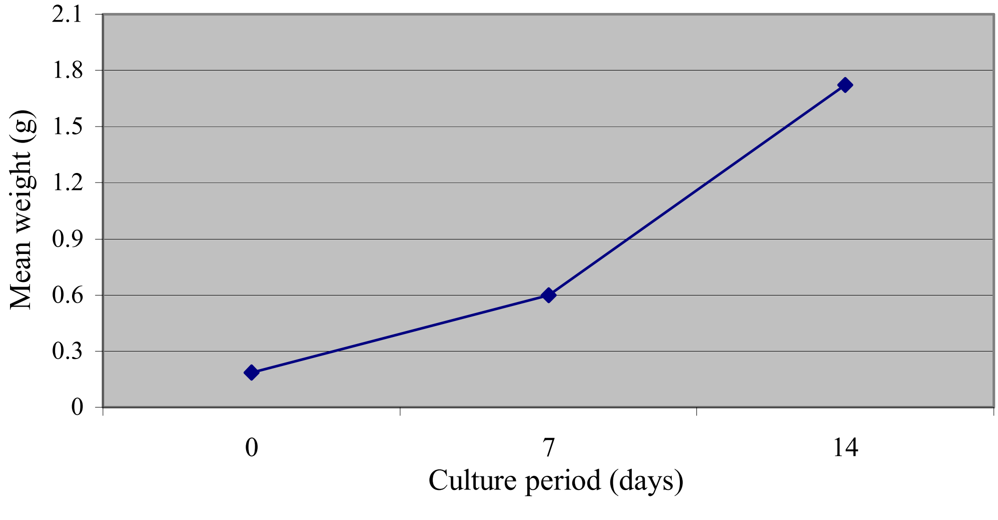

Figure 1b. Growth pattern of Nile tilapia fingerlings from size #22 to #14 in nursery hapas.

Table 2. Simple cost and benefit analysis of Nile tilapia fingerlings grown from size #22 to size #10 and from size #22 to size #14 in the nursery hapas.

Item	Size #22 to #10	Size #22 to #14
Gross Return*	38,000.00	30,000.00
Cost		
Fingerlings**	19,600.00	19,600.00
Feeds	6,468.00	1,226.40
Fertilizers		
46-0-0	55.12	55.12
16-20-0	25.76	25.76
Total Cost	26,148.88	20,907.28
Net Return	11,851.12	9,092.72
Cost Benefit Ratio	0.69	0.70

* based on GFII pricing, ** based on the required number of fingerlings in the grow-out ponds

Assumptions:

Stocking Density = 200 pcs m^{-3}
Price of Feeds = P28.00 kg^{-1}
Price of Fertilizers:
46-0-0 = P10.60 kg^{-1}
16-20-0 = P 9.20 kg^{-1}

GFII pricing for the various sizes of fingerlings are as follows: size #22 = P 0.49 pc^{-1}, size #14 = P 0.75 pc^{-1}, and size #10 = P 0.95 pc^{-1}.

The farmer wishing to apply the comparison of nursery phase production costs in planning a fingerling production run may wish to take into account the difference in the amount of time required to produce size #10 fry from size #22 fry, as opposed to the time required to produce size #14 fry from size #22 fry. If labor costs or limitations in the availability of hatchery space are significant concerns, then the two week production schedule needed to produce size #14 fry may have an advantage over the 4-week schedule for producing size #10 fry. Although the direct costs and cash returns were similar in the two nursery strategies, rapid turnover of hatchery products may be a desirable production goal.

Grow-out phase

Initial stocking mean weights were highly significantly different among treatments ($P<0.01$). At harvest, fish in Treatment I had the highest mean final weight of 130.18 g followed by Treatment III with 129.63 g and Treatment II with a mean final weight of 114.31 g. However, analysis of variance showed that there were no significant differences among treatments ($P>0.05$) with respect to the mean final weight and daily weight gain. The growth trend of Nile tilapia over 120 days of culture period is shown in Figure 2.

The specific growth rate for Treatments I, II and III were 5.39%, 3.49% and 2.54%, respectively. Analysis of variance showed that the differences in specific growth rates were highly significant among treatments ($P<0.01$).

The highest survival rate was obtained in Treatment III with 80.45% followed by Treatment II with 74.98% and the lowest was in Treatment I with 57.21%. Analysis of variance showed that Treatments II and III had no significant difference. Statistically significant differences using the analysis of variance were obtained between Treatments I and II and Treatments I and III ($P<0.05$). Figure 3 shows the mean final weight of tilapia in relation to survival rate.

The highest extrapolated fish yield per hectare was obtained in Treatment III with 3,799 kg ha^{-1} followed by Treatment II with 3,065 kg ha^{-1} and the lowest was in Treatment I with 2,738 kg ha^{-1}. Significant difference was obtained in the comparison of Treatments I and III ($P<0.05$). The lowest feed conversion ratio was found in Treatment I with 1.6 followed by Treatment II with 1.8 and highest was for Treatment III with 1.9. Significance difference in feed conversion ratio was obtained between Treatments I and III ($P<0.05$). Mean performance of Nile tilapia in ponds at different stocking sizes is shown in Table 3. A simple cost and return analysis in the grow-out of Nile tilapia at different stocking sizes is presented in Table 4.

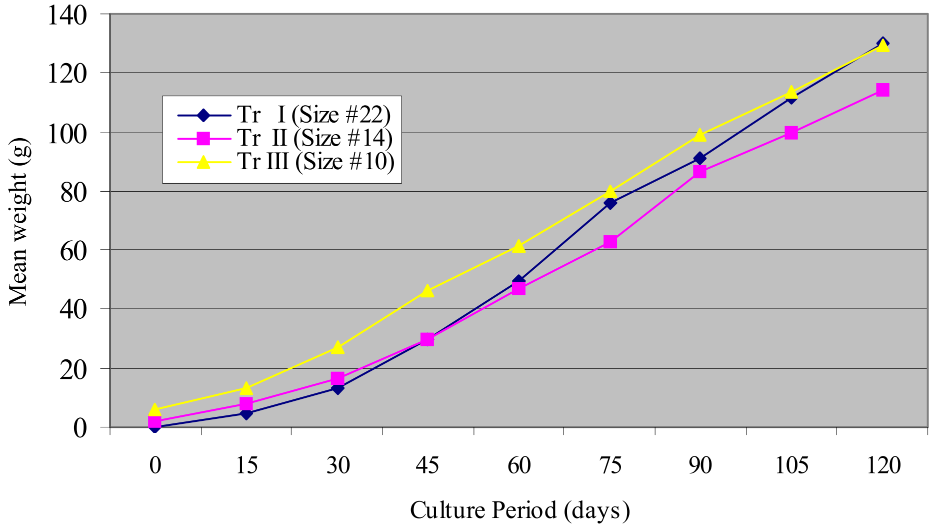

Figure 2. Growth trend of Nile tilapia on-grown in ponds at different stocking sizes.

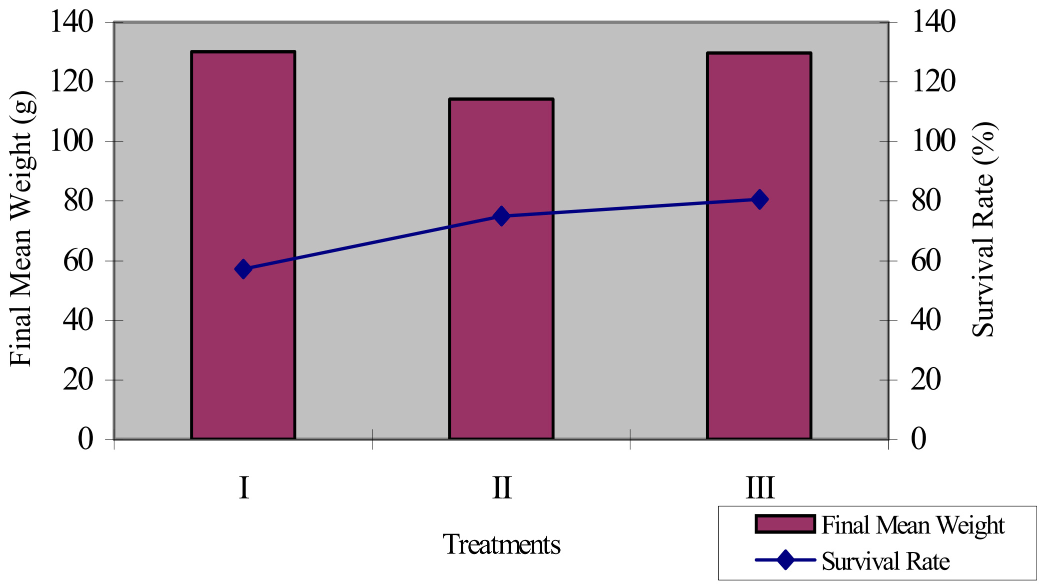

Figure 3. Final mean weight of Nile tilapia in relation to survival rate at different stocking sizes.

Table 3. Mean performance of Nile tilapia at different stocking sizes after 120 days of culture.

PARAMETERS	TREATMENTS		
	I	II	III
Initial mean weight (g)	0.20^{a}	1.72^{b}	6.08^{c}
Final mean weight (g)	130.18 ± 25.3^{a}	114.31 ± 15.7^{a}	129.60 ± 16.8^{a}
Total weight gain (g)	129.98 ± 25.3^{a}	112.58 ± 15.7^{a}	123.55 ± 16.8^{a}
Mean daily weight gain (g day^{-1})	1.08 ± 0.2^{a}	0.94 ± 0.13^{a}	1.03 ± 0.14^{a}
Specific growth (%)	5.39 ± 0.16^{a}	3.49 ± 0.11^{b}	2.54 ± 0.11^{c}
Survival (%)	57.21 ± 7.14^{a}	74.98 ± 12.77^{b}	80.45 ± 10.4^{b}
Feed conversion ratio	1.6 ± 0.2^{a}	1.8 ± 0.1^{ab}	1.9 ± 0.2^{b}
Extrapolated fish yield (kg ha^{-1})	2738 ± 582.5^{a}	3065 ± 417.6^{ab}	3799 ± 377.7^{b}
Extrapolated quantity of feeds (kg ha^{-1})	4026 ± 395.5^{a}	3946 ± 380.1^{a}	4679 ± 425.7^{b}

Mean values within row with the same superscript letter are not significantly different (P>0.05).

Table 4. Cost and return of tilapia production on-grown in ponds at different stocking sizes in Philippine peso per hectare.

ITEMS	TREATMENTS		
	I	II	III
Gross return (P)	117,734.00	131,795.00	163,357.00
Cost (P)			
Fingerlings	19,600.00	30,000.00	38,000.00
Fertilizers	5,740.00	5,945.00	5,330.00
Commercial feeds	73,766.80	72,624.00	85,354.00
Total cost	99,106.80	108,569.00	128,684.00
Net returns	18,672.20	23,226.00	34,673.00

Assumptions:

Price of fingerlings
- Size #22 – P0.49
- Size #14 – P0.75
- Size #10 – P0.95

Price of inorganic fertilizers
- 16-20-0 - P 9.60 kg^{-1}
- 46-0-0 – P10.60 kg^{-1}

Price of feeds
- Fry mash – P20 kg^{-1}
- Starter – P19 kg^{-1}
- Grower – P18 kg^{-1}
- Finisher – P17.80 kg^{-}

Price of marketable size tilapia – P43 kg^{-1}

Water quality

Table 5 presents the mean values of the water quality parameters in each treatment replicate. These water quality parameters include dissolved oxygen (DO), temperature (Temp), pH, alkalinity (Alk), total ammonia nitrogen (TAN), phosphate (Phos) and Secchi Disk Visibility (SDV). Water quality parameters appeared to be within the acceptable ranges for tilapia culture.

Table 5. Mean values of water quality parameters monitored in the grow-out ponds.

Treatment	Rep	DO (mg/l)	Temp (^oC)	pH	Alk (mg/l)	TAN (mg/l)	Phos (mg/l)	SDV (cm)
I	1	5.0	29.3	9.4	127	0.228	0.140	19
I	2	4.9	29.4	9.3	104	0.205	0.195	20
I	3	3.8	29.3	9.0	145	0.209	0.140	43
I	4	4.1	29.2	9.0	110	0.283	0.191	19
	Mean	4.5	29.3	9.2	122	0.231	0.167	25
II	1	4.2	29.1	9.0	100	0.216	0.192	21
II	2	4.5	29.1	8.9	118	0.182	0.156	20
II	3	4.8	29.2	8.8	126	0.157	0.221	17
II	4	4.5	29.3	8.9	119	0.136	0.188	20
	Mean	4.5	29.2	8.9	116	0.173	0.189	20
III	1	5.1	29.3	8.7	141	0.141	0.167	19
III	2	5.0	29.2	8.8	105	0.158	0.254	20
III	3	4.7	29.2	8.8	114	0.138	0.221	19
III	4	4.8	29.3	8.6	135	0.130	0.176	18
	Mean	4.9	29.3	8.7	124	0.142	0.205	19

Conclusions

Comparison of nursery-phase production models revealed very similar costs for the production of size #10 (6 g) fry from size #22 (0.2 g) fry, as compared with the production of size #14 (1.7 g) fry from size # 22 (0.2 g) fry. Cost benefit ratios of the two fry production strategies were nearly identical, although the profit potential for the latter strategy may be somewhat better because less time is required.

Our grow-out study revealed that initial stocking size did not affect mean final weights or daily weight gain, but the smallest stocking size (size #22) exhibited a reduced survival rate as compared with either of the larger initial (stocking) sizes. Production cost and profitability analyses reflected this difference: higher net returns was seen in the treatment stocked at size #14, but the highest net returns was found in fry stocked at size #10. These results suggest that mortality and stocking size are related, and that higher risk is involved when stocking smaller fry. Profit margins may be better when stocking larger fry, although the good growth seen in the treatment stocked with #22 fry suggests that the identification and elimination of mortality problems could make this choice of stocking sizes more desirable.

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