EFFECT OF DENSITY RATIO ON PERFORMANCE OF NILE TILAPIA AND CATFISH IN POLYCULTURE FISH FARMING SYSTEM

Zahidah[1], Yuli Andriani[1], Irfan Zidni[1]

[1]Universitas Padjadjaran, Bandung, Indonesia

Abstract

This study aims to determine the optimal stocking density ratio in the polyculture system of catfish and nile tilapia fish. This study is conducted experimentally using the Completely Randomized Design with the differences in the treatment of stocking density ratio, each repeated five times. The treatments of the stocking density ratio of both the catfish and the nile tilapia include: A (75 :75 fry/m^2), B (100:50 fry/m^{2,} and C (125:25 fry/m^2). The observed parameters are growth rate, survival rate and Food Conversion Ratio. The result of this study shows that the stocking density ratio significantly affects the growth rate and survival rate of the catfish and nile tilapia fry, while the feed conversion does not seem to affect them as much. The stocking density ratio that indicates the highest chance of growth rate and survival rate is 75 fry/m^2 for the catfish fry and 75 fry/m^2 for the nile tilapia fry.

Key words: Catfish fry, nile tilapia fry, growth rate, stocking density ratio

INTRODUCTION

The availability of land and water for aquaculture becomes more limited due to population growth. Besides the activities of the population that bring about pollutions, the activity of aquaculture itself produces wastes, particularly feed remains, faeces, and the result of fish metabolism rich in ammonia that is toxic for cultivated organisms [3]. Technological innovation is necessary in order to anticipate the decrease in aquaculture production caused by the reduction of lands for cultivation and decrease of water quality. An innovation that may be applied for this case is the polyculture system. The polyculture system commonly combines two species of fish with different feeding characteristics according to the feeding operation areas, one on the surface and the other at the bottom of the pond.

To identify how far the polyculture system can support the fish performance, a research has to be conducted through polyculture of catfish fry and tilapia fry in certain ratios. This study aims to determine the best stocking density ratio in the polyculture farming of catfish and nile tilapia.

MATERIALS AND METHODS

1. Materials

The materials used in this research are: a) 2,100 Sangkuriang catfish fry aged 54 days with the average weight of 3.07 grams, b) 1,050 nile tilapia fry weighing around 4-5 grams obtained from Balai Benih Ikan (Fish Hatcheries) in Ciparay, Bandung regency, West Java, and c) Fish feed in the form of commercial pellets with crude protein contents of 31% - 33%, crude lipid 3% - 5%, crude fibers 4% - 6%, ash 10% - 13%, and water 11% -13%.

2. Method

The research method used in this study is the experimental Completely Randomized Design (CRD) method, which consists of three treatments, each repeated five times. The types of treatment are listed as the following:

A=Stocking density ratio 75 fry/m^2 for catfish + 75 fry/m^2 for nile tilapia

*Corresponding author: yuliyusep@yahoo.com
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B= Stocking density ratio 100 fry/m^2 for catfish + 50 fry/m^2 for nile tilapia
C= Stocking density ratio 100 fry/m^2 for catfish + 50 fry/m^2 for nile tilapia

3. Procedure

The first step of the study is the acclimatization of the fish in a cubical fiberglass trough with 1 m x 1 m x 0.5 m dimension. The fish are reared for 49 days with densities according to the previously explained treatments. Feeding is conducted three times a day at 08.00 am, 02.00 pm and 08.00 pm, with the percentage of feed 4% from the fish biomass. Weights and water quality are measured every seven days. The number of samples in each observation is 30% from the total population of each treatment. The observed parameters of water quality are temperature, dissolved oxygen, pH, and ammonia concentration.

4. Observation Parameters

1. Growth Rate

Weight gain and growth rate are measured using the following equation [7] :

$$SGR = \frac{(\ln W_2 - \ln W_1)}{T} x\ 100\ \% \quad (1)$$

Legends:
SGR = Specific Growth Rate (%)
W_1 = first fish weight (g)
W_2 = final fish weight (g)
T = days of rearing (day)

2. Survival rate

Fish survival rate is calculated using the following equation [2] :

$$SR = \frac{Nt}{No} x\ 100\ \% \quad (2)$$

Legends:
SR = tested fish survival rate (%)
Nt = number of fish at the end of research
No = number of fish at the beginning of research

3. Feed Conversion Ratio

The equation to calculate the FCR value is as follows:

$$FCR = \frac{F}{(Wt+D)-Wo} \quad (3)$$

Legends:
F = total amount of feed given during rearing
Wo = weight of fish at the beginning of rearing (initial weight)
Wt = weight of fish at the end of rearing (final weight).
D = total weight of dead fish during rearing

6. Data Analysis

Analysis of variance was used for testing different parameters for statistical difference and test Duncan multiple range test was applied to rank the treatment means tested for significance.

RESULT AND DISCUSSION

1. Daily Growth Rate

The 49 days of rearing shows weight increase from each treatment as affected by the stocking density ratio. The highest average of weight gain is found at the ratio of 75 fry /m^2 for catfish and 75 fry/m^2 for nile tilapia, while the lowest average of weight gain is found at the ratio of 125 fry/m^2 for catfish and 25 fry/m^2 for nile tilapia. The results from the analysis of variance shows that the growth rate of both catfish and nile tilapia is influenced significantly by stocking density ratio.

The Duncan test as seen in Table 1, results show that the stocking density ratio of 75 fry/m^2 for catfish and 75 fry/m^2 for nile tilapia is significantly higher than other ratios. The low weight gain and growth rate are attributed to the competition for feed and limited space. The polyculture with high density causes negative interaction between species [8]. In a high stocking density ratio, excess energy output will occur since the fish defend their movement space and feed consumption, so that the energy for growth will decrease.

Table 1. Growth Rate of Catfish and Nile Tilapia Fry in Various Densities

Stocking Density Ratio	Daily Growth Rate (%)
75 L : 75 N	0.73 a
100 L : 50 N	0.58 b
125 L : 25 N	0.47 bc

Note: the means followed by the same small letters on the same column are not significantly different (P<0,05)

The polyculture system with the right combination of different species and appropiate density will consume food more efficiently, maximizing the relation between the polycultured fish and the synergy between the fish and their environment, while minimizing antagonistic interaction [6].

2. Survival rate

The stocking density ratio of 75 fry/m^2 for catfish and 75 fry/m^2 for nile tilapia shows the highest rate of survival rate of the catfish fry. It is assumed that in such treatment, a balance is achieved in the relationship between the fish and their environment. The results of the analysis of variance shows that the stocking density ratio significantly affects the survival rate of both the catfish and nile tilapia fry.

Table 2. Survival rate of Catfish and Nile Tilapia Fry at Various Density Ratios

Stocking Density Ratio	Catfish Fry Survival rate	Nile Tilapia Fry Survival rate
	(%)	
75 L : 75 N	79.56 a	76.09 a
100 L : 50 N	72.00 b	65.87 b
125 L : 25 N	63.68 c	50.93 c

Note: The means followed by the small letters on the same column are not significantly different (P<0.05)

The results of the Duncan multiple range test (Table 2) shows that the treatment with the ratio of 75 fry/m^2 for catfish and 75 fry/m^2 for nile tilapia results in the highest survival rate for both the catfish (79,56%) and nile tilapia (76,09%), while in the other types of treatment, the addition of more catfish fry decreasing the growth rate significantly. The catfish culture with a high stocking density ratio may reduce the nile tilapia population due to the canibalism tendency of the catfish towards the nile tilapia [1]. Otherwise, polyculture of goldfish and koi at a high stocking density ratio causes negative interaction as fish bites on koi's fins frequently happen, resulting in frequent wounds and even death [9].

The high survival rate is also closely related to water quality. The concentration of dissolved oxygen during the research fluctuates between 4.3 and 7.6 mg/L, above the limit suggested for farming fish fry, which is >4 mg/L [10].

3. Feed Conversion

The feed conversion mean in the catfish and nile tilapia polyculture shows differences in each treatment. The results of the analysis of variance shows that the stocking density ratio does not affect the values of feed conversion (Table 3).

Table 3. Feed Conversion in Catfish and Nile Tilapia Fry at Various Density Ratios

Stocking Density Ratio	Feed Conversion
75 L : 75 N	3,572 a
100 L : 50 N	3,576 a
125 L : 25 N	3,362 a

Note: the means followed by the same small letter on the same column are not significantly different (P<0.05)

The relatively high value of feed conversion is more influenced by the quality of water, especially pH, that affects the responses of the fish towards their feed. The *p*H during research decrease related to the degradation of the quality of water in the media (4.8-7.9). The decline in pH occurs due to the degradation of water quality caused by feed remains, faeces and fish respiration that may increase the level of CO_2 in the water [4]. Furthermore, the residue of fish metabolism in a pond whose water is never replaced will cause a decline in pH [5]. In this condition, the metabolism residue will be further accumulated in the pond and will sharply increase the toxicity level of ammonia. The existence of ammonia in the water may decrease the ability oh haemoglobin to retain oxygen, which further causes a decrease in the appetite of the fish.

CONCLUSION

According to the results above, this study concludes that:

1. The stocking density ratio significantly affects the growth rate and survival rate of both the catfish and nile tilapia fry in the polyculture system.

2. The stocking density ratio of 75 fry/m^2 for catfish and 75 fry/m^2 for nile tilapia is the best polyculture treatment because it results in the highest growth rate and survival rate.

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