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Effect of stocking density on growth and yield of GIFT tilapia under rice-fish production system

M. Hazrat Ali[1,*], Lun G. Mateo and Miguel L. Aragon
College of Agriculture, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines
Present Address: [1]Rice Farming Systems Division, Bangladesh Rice Research Institute
Gazipur 1701, Bangladesh
*Corresponding author

Abstract

The study was conducted at the Central Experimental Station, Philippine Rice Research Institute, Maligaya, Science City of Muñoz, Nueva Ecija, Philippines during the wet season to determine the suitable stocking density(s) for better growth and yield of fish under rice-fish production systems. Recovery rate of GIFT tilapia in different stocking densities ranged from 75.74 to 83.47%. Among different treatments, rice + 5,000 fingerlings/ha and rice + 10,000 fingerlings/ha resulted in the highest recovery rate of 83.33% and 83.47%, respectively. The lowest recovery rate of 75.75% was obtained from rice + 20,000 fingerlings/ha, but similar to that was obtained (78.56%) from rice + 15,000 fingerlings/ha. Significantly higher rate of gain in body weight and that of specific growth rate were recorded in the treatment from rice + 5,000 fingerlings/ha, while other treatments resulted in similar absolute and specific growth rate. Fish yield increased significantly with relatively higher stocking densities, but higher densities produced maximum number of smaller fishes and also lower recovery rate.

Key words: Rice-fish, Stocking density, Fish yield

Introduction

Fingerling population per unit area at stocking has great influence on marketable sizes and fish yield at harvest (Deng 1985). Generally, the production per unit area increases with the stocking in numbers and inversely the individual growth increases when the stocking decreases. However, stocking density depends on the size and productivity of the water. The more is stocked, the greater is the amount of natural food consumed resulting in natural food scarcity and growth stagnation. Literature also suggested that higher stocking with respect to number of fish result in better use of available natural food, hence higher production. According to Yuchang and Yixian (1992), stocking rates are closely related to fish yield. Therefore, to achieve the maximum fish yield, stocking density could be maximized considering the carrying capacity of water bodies to minimize the adverse effect on the growth rate of the fish. This study has been undertaken to determine appropriate stocking density for obtaining optimum growth, recovery rate and fish yield in the rice-fish culture system.

Materials and methods

The study was conducted at the Central Experimental Station, Philippine Rice Research Institute, Maligaya, Science City of Muñoz, Nueva Ecija, Philippines during the wet season. The experiment was conducted in 15 plots and the size of each plot was 11.6m x 10.6m. Five treatments were employed as: the treatments were: T_1= Rice alone (Control), T_2= Rice + 5,000 fingerlings/ha, T_3= Rice + 10,000 fingerlings/ha, T_4= Rice + 15,000 fingerlings/ha, T_5= Rice + 20,000 fingerlings/ha. Each treatment was replicated three times and the experimental plots were laid out in RCB design. Traditional method of rice cultivation was followed in the system. To provide adequate water for fish, dikes of each plot having the width of 50 cm at the base and 30-40 cm at top with the height of 40-50 cm as suggested by Sevilleja (1978).

A pond refuge covering 10% of the land was excavated in each plot, except the control plot, as shelter for fish during adverse condition. In addition, plots were also provided with separate screen for water inlets and outlets and to protect the fish from escaping the plots.

Fingerlings of GIFT (genetically improved farmed tilapia) tilapia with average body weight of 12.09 g were stocked in the plots as per treatments after 15-days of rice transplanting. The GIFT strain has been developed by combining the best performing genetic groups, based on their additive genetic performance from eight diverse Nile tilapia strains and their crosses (Eknath *et al.* 1993). It can survive in extremely adverse conditions and provided opportunity for better yield from rice-fish culture systems. The depth of water was maintained 11-15 cm in all the treatments throughout the growing period. A supplementary feed was supplied two times a day (50% at 7-8 a.m. and remaining 50% at 4-5 p.m.) based on 10 percent of the body weight at stocking. Feed supplying started 1-day after releasing of fingerlings. Fishes were harvested at 92 days cultured period immediately after the harvest of rice.

Fish mortality, recovery percentage, final weight, absolute growth, absolute growth rate, and specific growth rate and fish yield were recorded from the harvested individuals. All collected data were analyzed by using analysis of variance (ANOVA) and means were computed by DMRT in IRRISTAT Version 3.1.

Results and discussion

***Recovery rate*:** GIFT tilapia is a hardy fish that has higher survival rate. No dead fish was found in the rice field day after release and onwards. However, at harvest, the recovery rate ranged from 75.74 to 83.47%. The highest recovery was recorded at lower densities with 5000 and 1000 fish per ha and the lowest (75.74%) was derived from the highest stocking densities with 20,000 fingerlings/ha (Table 1). Kim and Kim (1992) found 92% survival rate of tilapia in rice field after four months of cultured period. Results also suggested that the contribution of big size fishes in total recovery rate ranged from 32.52 to 74.73% (Table 1). During the study period, sometimes heavy rain occurred causing the rice field overflow. As a result, some fish might have escaped from the field and also some fishes hid under the mud. These factors might have made the variation of recovery at harvest. Nevertheless, the results suggest that lower stocking density produces higher recovery rate while higher stocking density produces lower recovery rate.

Table 1. Mortality and recovery rate of GIFT tilapia with different stocking in rice-fish culture systems, wet season, Philippines

Treatments	At release (nos.)	At harvest				Recovery rate (%)
		Big size (nos.)	Medium (nos.)	Small (nos.)	Total (nos.)	
Rice + 5,000 fingerlings	62	46.33 b (74.73)	5.33 c (8.60)	-	51.66 d	83.33 a
Rice + 10,000 fingerlings	123	80.0 a (65.04)	16 ab (13.01)	6.67 (5.42)	102.67 b	83.47 a
Rice + 15,000 fingerlings	185	80.67 a (43.60)	31.67 b (17.12)	33.0 (17.84)	145.33 c	78.56 b
Rice + 20,000 fingerlings	246	80.0 a (32.52)	56.33 a (22.90)	50.0 (20.33)	186.33 a	75.75 b
CV(%)	-	8.7	33.5	-	3.7	2.8

Means followed by a common letters is not significantly different at 5% level by DMRT

Figure within the parenthesis indicate the values of contribution (%) in total recovery rate in the respective parameters.

Growth performance of GIFT tilapia

Results indicated that the average final body weight gain (big, medium and small) of GIFT tilapia ranged from 121.10 to 89.06 g. The highest average growth (121.10 g) gain was obtained from rice + 5,000 fingerlings/ha while the lowest (89.06 g) was derived from rice + 20,000 fingerlings/ha (Table 2). Results also showed highly significant difference between the growth parameters obtained in the lowest stocking density (rice + 5,000 fingerlings/ha) and the growth parameters recorded in the rest of the stocking densities. However, the mean growth obtained from the rest of the stocking densities (10,000-20,000 fingerling/ha) were identical (Table 2).

Final body weight gain of individual size of fish showed that only big size fish produced the highly significant differences in body weight gain. The highest body weight (160.64g) was obtained from rice + 5,000 fingerlings/ha and the lowest (126.18 g) was obtained from rice + 20,000 fingerlings/ha.

The body weight gain of medium and small fish showed negligible variations which were not statistically different within their respective treatments. The results of the medium and small fish indicated that the body weight of these two groups of fish did not depend on stocking density which was observed in bigger size fish. The mean values of absolute growth, absolute growth rate, and specific growth rate for three groups of fish decrease with the increase in stocking density gave a similar trend as observed in the final body weight (Table 2).

Table 2. Growth performance of GIFT tilapia under various stocking densities in rice-fish culture systems

Treatments	Initial weight (g)	Final weight (g)	Average growth (g)	Average growth rate (g/day)	Specific growth rate (%)
Rice + 5,000 fingerlings/ha	12.09	121.10a	109.01a	1.18 a	2.44 a
Rice + 10,000 fingerlings/ha	12.09	94.65 b	82.56 b	0.90 b	2. 19 b
Rice + 15,000 fingerlings/ha	12.09	90.57 b	78.48 b	0.85 b	2.13 b
Rice + 20,000 fingerlings/ha	12.09	89.06 b	76.97 b	0.84 b	2.12 b
CV (%)	-	4.3	4.9	5.1	1.6

Means followed by a common letter are not significantly different at 5% level by DMRT.

Fish yield

Mean fish yield of three fish sizes (big, medium and small) showed highly significant differences among the treatments (Fig. 1). The yields obtained from the treatments ranged from 639.84 to 1435.15 kg/ha with the highest fish yield (1434.15 kg/ha) in treatment (rice + 20,000 fingerlings/ha) and the lowest fish yield (639.84 kg/ha) in treatment (rice + 5,000 fingerlings/ha) as shown in Fig. 1. Kim and Kim (1992) obtained 2,720 Kg/ha of tilapia from rice field with four months stocking period.

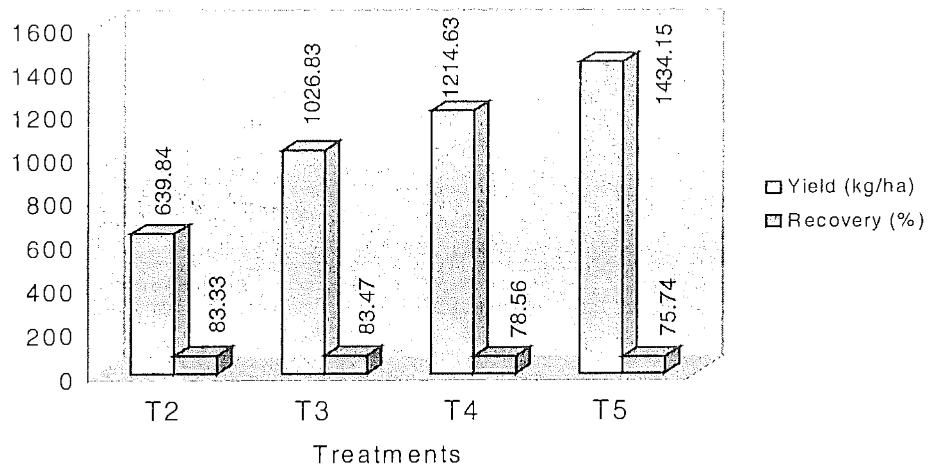

Fig. 1. Fish yield and recovery rate in the different treatments with various stocking density in rice-fish culture systems.

The contribution of big, medium and small size of the fish ranged from 57.20 to 94.54, 5.46 to 25.23 and 3.4 to 17.57%, respectively. These results suggested that the contribution of bigger fish in total fish yield much more than medium and small size fishes.

Principles of aquaculture suggest that higher stocking density results in higher fish yield. Stocking density, however, depends on the size and productivity of the water body. Where stocking densities is higher, there is the greater amount of natural food consumed. This results in insufficient calories, for each individual fish offered by the natural food, which results in growth stagnation unless supplementary feed is given to the fish. In the study, however, the rice field was supplemented with fish feed (rice bran 75 % and commercial feed, floating pellet 25%). Therefore, the feed perhaps was enough to optimize growth resulting in higher fish yield even if stocking density was increased.

Based on the results of the study, it could be suggested that increase in stocking density reduces individual body weight. Conversely, reduced stocking results in an increase in individual growth of fish that takes advantage of the period during which growth reaches at its maximum.

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