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# Growth performance, recovery rate and fish yield of GIFT strain at various water depths under rice-fish culture systems

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**Abstract**
Effect of water depth on recovery rate, growth performance and fish yield of GIFT in the rice-fish production systems was studies in experimental plots of 123 $m^2$ with a pond refuge of 1meter deep which covered 10% of the total land area.

Mortality rate of fish was very low ranging from 0.81-1.63%. However, at harvest, recovery rate ranged from 76.69-82.93% with the highest recovery at 11-15 cm of water depth. Significantly the highest absolute growth (99.97) and specific growth rate (2.42%) were found at 21-25 cm water depth. The same treatment also produced significantly higher fish yield (909.76 kg/ha) although statistically similar to the fish yield (862.60 kg/ha) obtained at 11-15 cm of water depth. Results also suggested that higher water depth can produce bigger fish but no significant effects of water depth was found on fish yield in the treatments 11-15 cm and 21-25 cm water depths of this experiment.

**Key words** : Rice-fish farming, GIFT, Water depth

## Introduction

Small harvestable size and low fish yield are the most important drawbacks of rice-fish production system. With the use of high yielding rice varieties, having a culture period of about 90 days from transplanting, fish culture can last only for an average of 80 days. This short fish culture period limits the fish to grow to its maximum potential harvestable size unless the stocking size is larger. Nile tilapia (*Oreochromis niloticus*) is commonly used for rice-fish culture in the Philippines have shown poor growth due inbreeding and intra-specific hybridization (Macaranas *et al.* 1986) resulting in low yields. However, the advent of a genetically improved farmed tilapia popularly known as GIFT are faster growing. Results of on-station and on-farm trials proved Gift strain to be superior over those widely cultured commercial strain of *O. niloticus* in the Philippies (Fernandez and Bartolome 1998).

Since GIFT is a new strain of *O. niloticus*, there is a very little information available regarding recovery rate, growth performance of this strain in a well-managed wetland irrigated rice-fish culture.

This study to some extent assessed the effects of water depth on recovery rate, growth performance and yield of GIFT strain Nile tilapia integrated with rice farming system.

## Materials and methods

A field experiment was undertaken at the Central Experimental Station, Philippine Rice Research Institute, Maligaya, Science City of Muñoz, Nueva Ecija, Phillipines during the dry season (DS), 2001. The experimental plots measured 11.6 m long and 10.6 m wide having a pond refuge of 10 percent of the total rice land with a depth of 1 meter.

The experiment was conducted with five treatments having three replications. The treatments were laid out in Randomized Complete Block Design. The treatments used are shown below:

| Treatments | Description | Abbreviations used |
|---|---|---|
| 1 | Rice alone at 5-10 cm of water depth (Control) | $T_1$ |
| 2 | Rice-fish at 5-10 cm of water depth | $T_2$ |
| 3 | Rice-fish at 11-15 cm of water depth | $T_3$ |
| 4 | Rice-fish at 16-20 cm of water depth | $T_4$ |
| 5 | Rice-fish at 21-25 cm of water depth | $T_5$ |

Treatment 1 was the conventional rice monoculture and rest of the four treatments were imposed to determine the effect of water depth on fish growth and development. Therefore, treatment 1 was not considered to assess the recovery rate, growth performance and fish yield.

Dikes with base width of 50 cm, top width of 30-40 cm and height of 40-50 cm was constructed in each plot as suggested by Sevilleja *et al.* (1992). This was made in order to supply adequate water for each treatment as mentioned. In addition, a pond refuge was excavated covering 10 percent of total land area of each plot having 1 m deep which was connected with one end of all rice plots, except the control plot.

The experimental field was prepared using one plowing, three harrowings and one leveling to fully incorporate and decompose the weeds and rice straws. A high yielding rice variety, PSB Rc 66 of 29-day old seedlings were transplanted using 20 cm x 20 cm with 2-3 seedlings per hill.

The plots were fertilized with chemical fertilizer at the rate of 120 N - 40 $P_2O_5$ - 40 $K_2O$ kg/ha. Split applications of fertilizers were done with $^1/_2$ N and whole PK as basal and $^1/_2$ N as top dressing. Basal fertilizer was incorporated during final harrowing whereas top dressing was done in two splits at 24 days after transplanting (DAT) and 43 DAT using $^1/_4$ N in each occasion.

In order to prevent the growth of apple golden snail and facilitate quick seedling establishment, a shallow water depth of 3-5 cm was maintained during the first week of transplanting. Water depth was increased as required by the treatments when fingerlings were released. Water was monitored everyday following the imposed water depth

Golden snails were also hands picked up to 7 DAT. Furthermore, replanting was also done up to 7 days after transplanting.

Fingerlings of Nile tilapia (*Orechromis niloticus*), GIFT (Genetically Improved Farmed Tilapia) were released at 10,000 per ha. into the rice field 11 DAT Supplementary feed was given two times in a day (½ at 7-8 a.m. and ½ at 4-5 p.m.) based on 10 percent of initial body weight.

Fish was harvested after 79-day culture period at the same day of rice harvest. Growth performance of the harvested fish in terms of absolute growth, absolute growth rate and specific growth rate was determined over time. These were computed based on body weight at harvest using the formula as described below:

Absolute growth (AG) = $W_2 - W_1$,

$$\text{Absolute growth rate (AGR)} = \frac{W_2 - W_1}{t},$$

$$\text{Specific growth rate (SGR)} = \frac{\ln W_2 - \ln W_1}{t} \times 100,$$

Where, $W_1$ = initial weight (g ), $W_2$ = final weight (g), t = time (rearing period), and ln = natural logarithm.

Fish yield, however, was expressed as total biomass at harvest. Survival rate was computed using the formula as:

$$\text{Survival rate (\%)} = \frac{\text{No. of adult fish at harvest}}{\text{No. of fingerlings at stocking}} \times 100$$

All collected data were analyzed with a computer using analysis of variance (ANOVA), DMRT in a Randomized Complete Block Design. Three replications were used programmed in IRRISTAT Version 3.1 for treatment comparisons.

## Results and discussion

### *Recovery rate of GIFT strain Nile tilapia*

The recovery rate of GIFT under rice-fish culture systems with various depths of water is presented in Table 1. Results indicated that the mean recovery rate of the different sizes of fish (big, medium and small) ranged from 76.69 to 82.93 percent. The highest (82.93%) although statistically similar to the other treatments were obtained from rice+fish with 11-15 cm depth of water. The other treatments demonstrated similar recovery rates.

The results of mortality and survival rate of the individual size of Nile tilapia indicated that the mortality of fingerlings of the Nile tilapia was minimal ranging from 0.81 to 1.63 percent (Table 1). The lowest mortality (<1%) was found in the treatment of rice + fish with water depth of 11-15 cm. The rest of the treatments showed similar mortality rates.

At harvest, the harvested fish was classified into three groups, based on body weight gain: big size fish (100g >), medium size fish (70-100g) and small size fish (< 70g). The number of big size fish at harvest was found significantly higher ($p<0.05$) in the treatment with rice + fish at 11-15, 16-20 and 21-25 cm water depth than in the treatment with rice + fish at 5-10 cm water depth. The lowest number of big fish and the highest number of small fish were harvested from these reared in 5-10 cm water depth under rice-fish culture systems.

However, statistically similar number of fish of different sizes (big, medium and small) was harvested from the treatments of 11-15 cm, 16-20 cm and 21-25 cm water depth.

Table 1. Mortality and survival rates of GIFT as influenced by water depth in rice-fish culture

| Treatments | At release (No.) | Mortality (No.) | At harvest | | | | Recovery (%) |
|---|---|---|---|---|---|---|---|
| | | | Big size (No.) | Medium size (No.) | Small size (No.) | Total (No.) | |
| Rice + fish at 5-10 cm water depth | 123 | 2.00 (1.63) | 31.33 a | 37.33 | 25.67 [b] | 94.33 | 76.69 |
| Rice + fish at 11-15 cm water depth | 123 | 1.00 (0.81) | 48.67 b | 40.67 | 12.66 [a] | 102.0 | 82.93 |
| Rice + fish at 16-20 cm water depth | 123 | 1.66 (1.35) | 47.67 b | 34.0 | 16.33 [a] | 98.00 | 79.67 |
| Rice + fish at 21-25 cm water depth | 123 | 1.66 (1.35) | 48.67 b | 37.67 | 12.0 [a] | 98.34 | 79.95 |
| CV (%) | - | - | 6.2 | 9.1 | 17.8 | 5.0 | 5.2 |

Mean followed by a common letter is not significantly different at 5% level by DMRT.
Within the parenthesis values indicate mortality rate (%)

Cagauan (1998) reported 84 percent survival rate of GIFT under rice-fish culture systems. The results further suggested that the big fish contributed to the highest percentage in total recovery rate where fish was reared with rice at the water depth of 11-

15 cm and onwards. Contribution of small size fish was the lowest. On the other hand, the treatments with rice-fish at 5-10 cm water depth where medium size fish were harvested contributed to highest percentage of total recovery rate.

Recovery rate largely depends on fingerling mortality, how carefully the fish was harvested. Also predators and theft are limiting factors for higher recovery rates. Results showed that the mortality rate of fingerling was found very low and much more attention was taken during the time of fish harvest resulted to higher recovery rate for all the treatment.

*Growth performance of Nile tilapia*

Growth was expressed in relative terms so that comparisons can be made with fish having different initial weight (Chiu 1989). Growth performance, however, in terms of final body weight, absolute growth, absolute growth rate and specific growth were computed.

**Final body weight** : The mean values of final weight of the three categories of Nile tilapia at 79 culture days during dry season in various depths of water ranged from 90.91 to 99.97g (Table 2).

Table 2. Growth performance of GIFT grown in rice-fish culture systems

| Treatments | Initial body weight (g) | At harvest | | | |
|---|---|---|---|---|---|
| | | Final weight (g) | Absolute growth (g) | Absolute growth rate (g/day) | Specific growth rate (%) |
| Rice-fish at 5-10 cm water depth | 13.90 | 90.91 b | 77.01 b | 0.97 | 2.33 b |
| Rice-fish at 11-15 cm water depth | 13.90 | 93.25 b | 79.35 b | 1.00 | 2.36 b |
| Rice-fish at 16-20 cm water depth | 13.90 | 91.95 b | 78.05 b | 0.99 | 2.33 b |
| Rice-fish at 21-25 cm water depth | 13.90 | 99.97 a | 86.07 a | 1.09 | 2.42 a |
| CV(%) | - | 1.8 | 2.4 | 6.4 | 1.2 |

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

The highest body weight (99.97 g) was obtained from the treatment with rice + fish at 21-25 cm of water depth. The other treatments produced statistically similar body weights. Analysis of variance revealed the significant effect ($p<0.01$) of various levels of water depth on fish weight. This effect was observed in the treatment with rice + fish at 21-25 cm water depth at harvest.

**Absolute growth**: The highest mean absolute growth of 86.07g was obtained from the treatment with rice+fish at 21-25 cm of water depth. The lowest of 77.01 was obtained from the treatment in rice + fish at 5-10 cm water depth (Table 2). Statistical analysis showed highly significant difference ($p>0.01$) among the treatments.

**Absolute growth rate** : The values of mean absolute growth rate of the fish of different sizes are shown in Table 2. Small variations of absolute growth rate were observed across treatments. The daily increments ranged from 0.97 to 1.09g but the difference of absolute growth rate values was not significant among the treatments.

**Specific growth rate** : The overall average specific growth rates of the fish of different sizes harvested are also shown in Table 2. Statistically higher ($p>0.05$) specific growth rate (2.02%) was observed in the treatment with rice + fish at 21-25 cm depth of water then the other treatments. Rice+fish at 5-10, 11-15 and 16-20 cm water depth produced identical values of 2.33, 2.36 and 2.33 percent, respectively.

*Fish yield*

In general, average fish yield ranged from 708.94-906.76 kg/ha (Fig. 1). Statistical analysis of this yield indicated that the treatments with different water depth under rice-fish culture revealed significant variation ($p>0.05$) in gross fish yield (kg/ha).

The highest fish production (909.76 kg/ha) was obtained from the treatment with rice + fish at 21-25 cm water depth ($T_5$) followed by rice + fish at 11-15 cm water depth ($T_3$) (862.60 kg/ha). The lowest yield (708.94 kg/ha) obtained from the treatment rice + fish at 5-10 cm water depth ($T_2$). Fish yield (kg/ha) of $T_3$ and $T_5$ were identical.

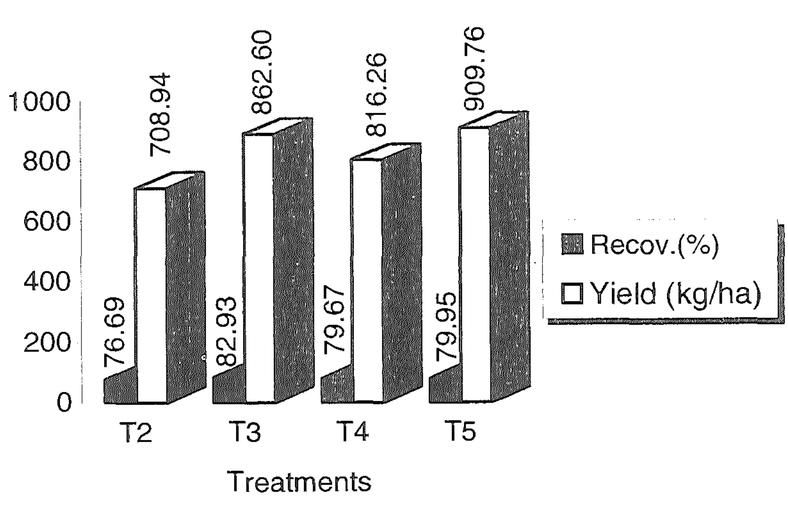


Fig. 1. Recovery rate and fish yield from different treatments with various water depths in rice-fish culture systems.

Results suggest that fish yield increases with the increase of water depth although the difference in the increase was more beyond 5-10 cm water depth, which might have more favorable environment when water was more. More water might allow availability of natural fish food and more space for their growth and development which leads higher fish yield.

Higher yield performance of GIFTa under rice-fish production system was obtained from rice+fish at 21-25 cm water depth ($T_5$) followed by rice+fish at 11-15 cm water depth ($T_3$). Cagauan (1998) obtained mean yield of 220 kg/ha of a GIFT strain in wetland irrigated rice-fish culture with pond refuge. The final mean individual body weight was 52.0 g. In China, yield of tilapia was 422 kg/ha with 86 days culture period (Li, 1992) while Muknopadhya *et al.* (1992) reported fish yield of 800-1200 kg/ha with supplementary feeding from rice-fish culture systems.

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