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Mohammad Ashaf-Ud-Doulah
Senior Scientific Officer, Bangladesh Fisheries Research Institute, Freshwater Sub-Station, Chanchra, Jashore, Bangladesh

Md. Shariful Islam
Senior Scientific Officer, Bangladesh Fisheries Research Institute, Freshwater Sub-Station, Chanchra, Jashore, Bangladesh

Nafia Binte Ryhan
Lecturer, Department of Fisheries, EXIM Bank Agricultural University Bangladesh

Shaheed Nasrullah Al Mamun
Research Associate, World Fish Bangladesh & South Asia

Md Salmon Hasan Biplob
Senior Upazilla Fisheries Officer, Department of Fisheries, Bangladesh

Sunny Khan Majlish
Senior Upazilla Fisheries Officer, Department of Fisheries, Bangladesh

Kazi Atiah Taiyebi
Assistant Director, Department of Fisheries, Bangladesh

Corresponding Author:
Md. Shariful Islam
Senior Scientific Officer, Bangladesh Fisheries Research Institute, Freshwater Sub-Station, Chanchra, Jashore, Bangladesh

Effects of fertilizar on growth performance of tilapia and shing in rice cum-fish culture

Mohammad Ashaf-Ud-Doulah, Md. Shariful Islam, Nafia Binte Ryhan, Shaheed Nasrullah Al Mamun, Md Salmon Hasan Biplob, Sunny Khan Majlish and Kazi Atiah Taiyebi

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Abstract
Field experiments demonstrated that rice-fish farming indeed increased the productivity of rice field and help to achieve ecological, economical, and social benefits. An experiment was accompanied in the rice field plots to ascertain the felicitous fertilization effects on the growth performance of Nile Tilapia (*Oreochromis niloticus*) and Shing (*Heteropneustes fossilis*) cultured in the rice fish farming system. Each treatment of fish species cultured with different doses of fertilizer such as T_1 control: without any fertilization; T_2 with 10 kg/decimal compost and T_3 with 100% recommended fertilizer: Urea 100g, TSP 100g, MOP 50g, MOK100g/decimal respectively for fish culture. Current study showed a direct relationship between nutrient supplies and yielding of rice; increasing nutrient supply highlighting an increase of yielding fish. These indicated significantly greater fish yield at treatment T_3 followed by treatment T_2 and T_1 in Shing with rice culture. Concerning Tilapia with rice culture, the same occurrence was observed. The gross production of Tilapia were found 5.04 ± 2.66, 8.65 ± 2.42 and 12.02 ± 1.45 kg/decimal in T_1, T_2 and T_3, respectively and gross production of Shing were found 3.06± 1.76, 6.17 ± 1.84 and 8.83 ± 2.88 kg/decimal in T_1, T_2 and T_3, respectively. During the experimental period the ranges of water temperature were (27.26 to 31.22 °C), dissolved oxygen (5.66 to 7.20 mg/L), pH (7.25 to 7.65 mg/L), total alkalinity (148.00 to 176.00 mg/L), free CO_2 were (1.40 to 3.00) mg/L and found within the productive limit and more or less similar in all the plots under the T_1, T_2 and T_3. The outcome in T_3 provided the maximum yields amongst all treatments, followed by treatments T_2 and T_1 representing that the fertilizer is the furthermost suitable nutrient input regime aimed at the rice- fish integrated culture scheme. The results of the study revealed that polyculture of tilapia and Shing could be practiced in rice field.

Keywords: fertilizer, rice-fish culture, growth performance

Introduction

Rice and fish are an important source of food and nutrition security, income, and livelihood options for many people in Bangladesh. Integrated rice-fish farming systems are a potential option which responds to scarce land and water resources but their potential has not been fully explored in the country.

Most of the rural people directly or indirectly engage with agriculture for their daily livelihood and about 48% of labor is employed in this sector (BER 2012) [4]. From ancient times, agriculture, including fisheries, has been an integral part of the life of the Bangladeshi people, and plays a major role in food security, employment, nutrition, foreign exchange earnings and other aspects of the economy. Fish with rice is the national diet, giving rise to the proverb Maache-Bhate Bangali ("A Bengali is made of fish and rice"). Despite the fact that rice is still the staple food and that there is self-sufficiency in production to feed 160 million people (BBS 2010) [3]. The total area of rice fields in Bangladesh is about 10.14million hectare which can play an important role in increasing fish production (Haroon and Pittman 1997) [14]. Bangladesh is one of the top nations in terms of producing and consuming rice and fish, and both are associated with the daily food culture of the Bangladeshi people, especially for poor rural people. Due to high population growth, economic development and urbanization demand for rice and fish is increasing day by day.

On the other hand, the supply is threatened due to conversion of agricultural land, climate change and the environmental impact of overuse of fertilizer and pesticides during the green revolution period. Thus, there is an urgent need for a sustainable option which can produce rice and fish in a sustainable manner. Introduction of fish into the rice fields in a managed way have a number of advantages, such as it helps in increasing yield of rice by take up harmful insects, pests and weeds (Coche 1997 and China Freshwater Fish Committee 1973) [6, 9] and increase the farm fertility by adding organic excreta. It raises the profit per unit area of land one or two fold. It is argued that rice fish culture can be used as a tool in integrated Pest Management (IPM) as insecticide application on pest resistance rice varieties are largely uneconomical. In this technology as a "do not spray" strategy could be changed to a more attractive strategy "grow fish" (Weibel 1992) [31].Rice fish farming is an appropriate, low cost method of improving food grain and protein supply of resource poor farmers with potential to make significant contribution to the country's total fish production.

Rice-fish farming systems are globally important in terms of food security and appear to be globally important in terms of three global environment issues: climate change, shared waters and biodiversity. Methane is a major greenhouse gas emitted by rice fields, with emission determined by farming practices, plant metabolism and soil properties. Irrigated systems tend to contribute more emissions than rain-fed systems. Irrigated rice-fish systems are therefore major concern for climate change and even though they may be under some form of public or private management, they need a subsidy for generating the information required for mitigation measures. There is scope for considering the applicability of global environmental subsidies from the global environment facility for generating this information where national developing economics are unable to allocate them the desire priority. From a biodiversity perspective, rice-fish farming systems embody low-moderate rice genetic diversity due to intense varietal selection primarily for yields and secondarily for system maintenance and economic viability; moderate-high fish species diversity for some protein production and secondary importance especially in subsistence production systems; and low-moderate aquatic biodiversity due to transformation of complex swamp systems into simple agro-ecosystems (Fernando 1996) [12]. Fish species and aquatic biodiversity appear richer in traditional and low intensity rain-fed than in high intensity irrigated rice-fish systems. The adequacy of this biodiversity for different ecosystems functions, as in agro-ecosystems in general, needs careful examination in terms of global environment in comparison to natural swamp ecosystems. Productivity of a water body by using fertilizers is a prerequisite for scientific fish culture as the plankton constitutes the basis of food chain in an aquatic ecosystem. Fertilizers are the cheapest and simplest means of increasing aquatic productivity. Both organic and inorganic fertilizers are used in fish pond. Inorganic fertilizers increase mainly the phytoplankton populations of pond water and are believed to be superior as the nutrients because the inorganic fertilizers dissolve more readily in water and accelerate the nutrients product in the water body. Saha *et al.* (1991) [25] reported that chemical fertilizers enhanced the more growth of phytoplankton and less growth of zooplankton which in turn results the better growth of the fish.

Fertilization in the rice-fish farming is as a crucial management exercise for enhancing rice and fish manufacture, though farmers are utilizing fertilizer at a diversity of doses which could occasionally be 3 or 4 times greater than typical dose, optimistic as more profit. However, currently, in several countries, we can talk about a catastrophe in term of the mineral fertilizers usage, where a severe puzzling is circumstance due to excessive and inappropriate use. As well, the agriculturalists are fronting monetary forfeiture to purchase additional fertilizer. However, there are very modest research works which regulates the standard quantity of fertilizer need for the supreme yields from the rice-fish farming. Consequently, it is significant to commence investigations to discover the standard fertilizer dose for greater fish and rice manufacture. Bearing in mind the above consequence, the current investigation was undertaken to determine the optimum dose of fertilizer practice in rice-fish farming. However, presently crisis of the chemical fertilizer in the country is an acute problem. Moreover, the farmers are facing financial loss for buying excess fertilizer. So, far there has been little works to determine the optimum kind of fertilization needed for maximum fish production in fish culture, Therefore, it is important to conduct research to find the kind of fertilizer for higher fish production in mixed culture, to reduce the cost of fertilization.

Materials and Methods

The present research was conducted at the rice field of the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to assess the effect of fertilization on growth performance of tilapia and Shing in integrated rice fish farming system.

Site Characteristics

The experiment was conducted in a flood free area where sufficient sunshine was available throughout the experimental period. The experimental site is under the old Brahmaputra Flood Plain Agro-ecological Zone (AEZa) having non-calcareous dark grey soils of silt loam texture. The experimental field is located at 24°75′N latitude and 90°50′E longitude and altitude of 18 m above sea level. Here, the median monthly rainfall was approximately 330 mm during experiment. The monthly temperature varies from 17 to 32 °C during the monsoon and 12 to 31 °C during the dry season. The soil at the study location was a non-calcareous deep grey flood plain soil; the consistency class was a silt clay loam, with an average soil pH 6.2, organic carbon occurred 1.4%, nitrogen content 0.25%, available phosphorus 16.72 ppm, exchangeable potassium 0.12 ppm and available sulfur 14.2 ppm respectively.

The experimental area comprised about 0.06 ha in a relatively medium high land area near the deep tube-well drainage of the field laboratory. The site consisted of 18 experimental plots, each comprising an area of $15m^2$(5m×3m) and rectangular in shape. Rainwater and irrigation water from the farm deep tube-well were the sources of water supply to the experimental plots during the experimental period. Small water channels (0.70 m width and 0.30 m depth) were made between the plots to supply water to them. Each plot had an inlet and outlet in the dykes for regulation of water depth.

Experimental Design

The experiment was conducted in 9 experimental plots each having an area of $40m^2$ from January to April, 2019 in a randomized complete block design (RCBD) with three treatments viz., T1, T2, and T3. The treatments were randomly assigned in each block with three replications viz., R1, R2 and R3.

Table 1: Layout of the experiment

Fish	Stocking/ m2	No fertilizer	Compost	Recommended Fertilizer
Tilapia	3	T1	T2	T3
Shing	15	T1	T2	T3

Land Preparation

The land was ploughed properly two times before rice transplantation by using power tiller. The first ploughing was done 35 days before rice transplantation and the second ploughing was done 5 days before rice plantation. The weeds were removed from the plots before the transplantation of rice seedlings. The plots were then leveled by laddering to keep even water depth throughout the plot. During first and second ploughing, the plots were flooded with water at a depth of 10 cm, as practiced in the Philippines (Valera 1977) [30].

Construction of ditches

To provide refuge during high water temperature and low water depth a small ditch was constructed in the edge of each plot containing fish. The area of each ditch was 3 m^2 and the depth was about 0.6 m.

Rice-variety and transplantation of seedlings

For the current experiment high yielding variety of rice BRRI dhan 29 was selected. Seeds of BRRI dhan 29 were incubated for 48 hours after soaking in water for 24 hours. The seedlings of rice were raised in a separate seedbed near the experimental field in the Agronomy field laboratory on the 12th December, 2018. Forty four days old seedlings were uprooted carefully and then transplanted in the experimental plot on 26th January, 2019 by giving alternate row spacing of 25 cm and 15 cm, which is recommended by Hossain *et al.* (1990) [18]. The plant to plant distance given was 15 cm. The alternate row spacing would provide enough space for easy movement of the fishes. It also allows the sunlight to penetrate into the water between the rows. This improves the growth of plankton and thus ultimately the yield of fish.

Fertilization of the ponds

100% recommended fertilizer was applied in T_3 and 10 kg/decimal compost was applied in T_2.

Table 2: Fertilization of the ponds

Name of the fertilizer	Fertilizer dose(g/decimal)
Urea	100
TSP	100
MOP	50
MOK	100

Urea was dissolved in a bucket and then applied by spreading with a mug on the plot surface. TSP was dissolved in water for 24 hours in a plastic bucket and then applied by spreading over the pond surface with a mug. Compost was mixed with the soil during the land preparation.

Collection and Stocking of Fish Fingerlings

The fish to be stocked in rice fields should be capable of tolerating a harsh environment characterized by shallow water, high and variable temperatures low oxygen levels and high turbidity (Hora and Pillay 1992) [17]. The environmental condition of rice fields is less suitable for fish than the pond, river, haor, baor, lake, floodplain etc. Due to its shallowness, the change in water temperature and Oxygen depletion takes place very rapidly. Therefore, the collection and stocking of fish fingerlings were done very carefully. The fish to be cultured in the rice fields must be resistant to temperature and Oxygen changes. Fast growth is also a desirable characteristic so that the fish could attain marketable size when the rice is ready for harvest. Fingerlings of mono sex Tilapia (*O. niloticus)* and Shing (*Heteropneustes fossilis*) were collected from a private nursery of Mymensingh district and stocked properly after conditioning the fingerlings of *O. niloticus* and *H. fossilis* were transported directly from the pond to the experimental plots. The fingerlings were released in the experimental plots at 12 days after transplanting of rice seedlings. The fingerlings were kept in a bucket in the experimental plots for about 15 minutes to adjust with the new environment. Then the healthy and strong fingerlings were gradually released in the experimental plots. The mean initial weight of the each species of fish was recorded separately at the time of stocking in the rice plots. Stocking of fish after 15 days of rice seedlings has been recommended by Ghosh *et al.* (1984) [13] and Sinha [27] (1979). Sollows (1992) [28] mentioned that it is best to wait until the rice seedlings are well established before releasing fish seeds, particularly if the fish are large.

Management of Rice

For proper management of rice, all the activities were done according to the recommendation of Hossain *et al.* (1990) [18]. Water level was kept as low as 2-4 cm up to 15 days after transplanting to allow the rice seedlings to well establish and to initiate tillers growth. However, the water requirement for tropical rice production varies widely depending on environment, management and soil conditions. Furthermore, rice requires different amounts of water at different growth stages (Singh *et al*. 1980) [26].

Management of Fish

For maintaining the suitable water depth for fish in the rice field water was supplied regularly from the deep-tube well. During heavy rainfall the excess water was removed through the outlet. Water level was kept among 10-15 cm for 15 days after transplanting to grow natural food in the rice fields for stocked fish. During the period of experiment water level was varied in-between 15-25 cm in the plots. Water level was raised gradually with the growth of rice, fish.

Study of Water Quality Parameters

The productivity of aquatic habitats is governed by the interaction of physico-chemical factors. Therefore, during the study period the status of physico-chemical parameters of water like temperature, dissolved oxygen, alkalinity, CO_2, pH etc. were recorded fortnightly. Water temperature and dissolved oxygen were measured directly in the field with the help of a Celsius thermometer and a digital electronic DO meter respectively and pH was measured with the help of an electrical pH meter in the Water Quality and Pond Dynamics Laboratory of Fisheries Faculty from the water collected from the rice fields. The concentration of nitrate-nitrogen (mg/l) of water samples were determined in the laboratory after filtering the water samples taken from each rice field plot by using spectrophotometer (Model: HACK DR 2000).

Harvesting of Rice and Fish

The rice was harvested after 98 days of transplanting seedlings by cutting the plants at the water level with sickle. Tilapia and Shing were harvested immediately after harvesting of rice i.e. after 77 days of stocking of fish fingerlings. The fish were collected from each experimental plot by hand picking after draining out water from the plots. The collected fish from the plots were counted and the number was recorded separately plot-wise. The total length (cm) and weight (g) of fish were taken randomly without any bias from each plot to determine the survival rate and yield of fish.

Estimation of Survival Rate, Growth and Production of Fish

i. The survival rate was estimated by the following formula

$$\text{Survival Rate}(\%) = \frac{\text{No. of harvested fishes}}{\text{Initial no. of fishes}} \times 100$$

ii. Calculation of gross fish production (kg/m^2)

$$= \frac{\text{Gross weight(Kg)of fish perdecimal per month} \times 250 \times 12}{1000}$$

Morphometric Measurements of the Fish

After fifteen days, the fishes were measured for wet body weight. After obtaining the data, Weight gain was calculated using following formula:

Weight gain (g) = Final weight (g) - initial weight (g)

$$\text{Percentage (\%) weight gain} = \frac{\text{Mean final weight(g)- mean initial weight(g)}}{\text{Weight of sample}} \times 100$$

The fishes in each treatment were counted and weighed on termination of the experiment. Growth performance was determined by evaluating a number of growth indices, including weight gain, percentage weight gain, specific growth rate (SGR),The growth parameters was calculated as follows:

$$\text{SGR}(\%) = \frac{\ln(W_2 - W_1)}{T} \times 100$$

Where,
W_1 = the initial live body weights
W_2 = the final live body weights
T = the number of days of fertilization

Data Analysis

All the data collected during the experiment were recorded and saved in computer. Mean values and standard deviations were calculated using Microsoft Office Excel. The one-way analysis of variance (ANOVA) followed by Tukey's post hoc test was used to assess statistically significant differences among the different treatments. Statistical significance was set at $P<0.05$. For statistical analysis SPSS-20 software was used. Graphs were drawn using Microsoft Office Excel.

Results

Effects of Fertilization on Survival and Growth Performance

In the present study, fish were checked at every 15 days. At the end of experiment, survival rate (%) and growth performance such as, weight gain, percent weight gain, specific growth rate (SGR) and gross production of fish were determined which are described as follows:

Survival rate (%)

The survival rate (%) of *O. niloticus* was found to be 85.02± 2.00, 83.17± 1.78 and 85.55± 1.22 in T1, T2 and T3, respectively (Table 1). The survival rate (%) of *H. fossilis* was found to be 88.11± 2.00, 78.11± 1.78 and 75.92± 1.22 in T1, T2 and T3, respectively (Table 2). No significant differences were found in survival rate of both fishes in terms of any treatments.

Table 1: Growth responses of *O. niloticus* in different treatments

Growth Parameters	Treatments		
	T1	**T2**	**T3**
Initial BW (g)	20.75 ± 0.53^a	20.68 ± 0.90^a	20.24 ± 0.36^a
Final BW (g)	61.07 ± 2.70^{ab}	92.69 ± 2.90^b	121.65 ± 4.67^a
Weight gain (g)	40.32 ± 3.12^{ab}	72.01 ± 1.85^b	101.41 ± 4.58^a
% weight gain	67.21 ± 21.98^a	78.27 ± 12.54^b	83.36 ± 19.30^a
SGR (% / day)	0.52 ± 0.06^{ab}	0.93 ± 0.04^b	1.08 ± 0.05^a
Gross fish production (kg/dec)	5.04 ± 2.66	8.65 ± 2.42	12.02 ± 1.45
Survival (%)	85.02 ± 2.00^a	83.17 ± 1.78^a	85.55 ± 1.22^a

Values with different alphabetical superscripts in a row differ significantly ($p<0.05$) among different salinities. All values expressed as mean ± SD.

Table 2: Growth responses of *H. fossilis* in different treatments

Growth Parameters	Treatments		
	T1	**T2**	**T3**
Initial BW (g)	10.55 ± 0.43^a	10.38 ± 0.70^a	10.40 ± 0.16^a
Final BW (g)	18.05 ± 2.70^{ab}	22.09 ± 2.90^b	26.45 ± 3.67^a
Weight gain (g)	8.07 ± 2.12^{ab}	11.71 ± 2.85^b	16.05 ± 2.58^a
% weight gain	44.73 ± 11.28^a	53.01 ± 12.34^b	60.68 ± 12.30^a
SGR (% / day)	0.07 ± 0.06^{ab}	0.15 ± 0.04^b	0.20 ± 0.05^a
Gross fish production (kg/dec)	3.06± 1.76	6.17 ± 1.84	8.83 ± 2.88
Survival (%)	88.11 ± 2.00^a	78.11 ± 1.78^a	75.92 ± 1.22^a

Weight gain

The average weight gain of *O. niloticus* were found 40.32 ± 3.12, 72.01± 1.85, and 101.41 ± 4.58g in T1, T2 and T3 respectively (Table 1) and average weight gain of *H. fossilis* were found 8.07± 2.12, 11.71± 2.85 and 16.05 ± 2.58gin T1, T2 and T3 respectively (Table 2). Statistical analysis showed that significantly (p<0.05) highest weight gain of *O.niloticus* was observed in T3 compared to T1. On the other hand, significantly (p<0.05) highest weight gain of *H. fossilis* was observed in T3 and T2compared to T1.

Percent weight gain

The percent weight gain of *O. niloticus* were found 67.21 ± 21.98, 78.27 ± 12.54,83.36 ± 19.30 in T1, T2 and T3, respectively (Table 1) and percent weight gain of *H. fossilis* were found 44.73 ± 11.28, 53.01 ± 12.34, 60.68 ± 12.30in T1, T2 and T3, respectively (Table 1). Statistical analysis showed that significantly (p<0.05) highest percent weight gain of *O. niloticus* observed in T3 while lowest percent weight gain was observed in treatment T1.Significantly differences were found in percent weight gain of *H. fossilis* in terms of treatment.

Specific growth rate (SGR)

The specific growth rates of *O. niloticus* were found 0.52 ± 0.06, 0.93 ± 0.04, 1.08 ± 0.05 in T1, T2 and T3, respectively (Table 1) and that for *H. fossilis* were found 0.07 ± 0.06, 0.15 ± 0.04, 0.20 ± 0.05 in T1, T2 and T3, respectively (Table 2). Statistical analysis showed that significantly (p<0.05) highest specific growth rates of *O. niloticus* and *H. fossilis* observed in T3 and T2, while lowest specific growth rates was observed in treatment T1.

Gross production of fish

The gross production of *O. niloticus* were found 5.04 ± 2.66 8.65 ± 2.42 12.02 ± 1.45 in T1, T2 and T3, respectively (Table 1) and gross production of *H. fossilis* were found 3.06± 1.76, 6.17 ± 1.84, 8.83 ± 2.88in T1, T2 and T3, respectively (Table 2). Statistical analysis showed that significantly (p<0.05) highest gross production of *O. niloticus* observed in T3 while lowest gross production was observed in treatment T1. On the other hand, significantly (p<0.05) highest gross production of *H. fossilis* observed in T3 and T2 compared to T1.

Water Quality Parameters in Rice Fields

Throughout the experimental period a number of physico-chemical parameters of water of all the experimental plots such as water temperature, pH, dissolved oxygen, free CO_2, total alkalinity were determined to find out suitability and fluctuations of the parameters.

Temperature

During the experimental period water temperature of the experimental plots under T1, T2 and T3 varied from 27.99±0.64, 28.20±0.36, 28.25±0.26 °C (Table 3). The fortnightly variations of average values of water temperature of the ponds .

Table 3: Water quality parameters (Mean ± SD) during the study periods

Parameters	Treatments		
	T1	T2	T3
Temperature (ºC)	27.99±0.64	28.20±0.36	28.25±0.26
pH	7.19±0.16	7.51±0.13	7.85±0.13
Dissolved oxygen (mg/L)	5.06 ±0.32	5.57±0.47	7.60±0.12
Free CO2 (mg/L	1.60±0.44	3.03±0.10	2.40±0.25
Total alkalinity (mg/L)	152.67±3.00	158.33±5.51	196.00±2.00

Dissolved oxygen (mg/L)

During the experimental period dissolved oxygenof the experimental plots under T1, T2 and T3 varied from 5.06 mg/L to 7.60 mg/L (Table 3).

Free CO_2(mg/L)

During the experimental period free $CO_2$of the experimental plots under T1, T2 and T3 varied from 1.60 mg/L to 3.00 mg/L (Table 3).

pH

During the experimental period pHof the experimental plots under T1, T2 and T3 varied from 7.19 to 7.85 (Table 3).

Total alkalinity (mg/L)

During the experimental period total alkalinity of the experimental plots under T1, T2 and T3 varied from 152 mg/L to 196 mg/L (Table 3).

Discussion

The present study was conducted to determine the effects of kinds of fertilizers on growth and production of fishes of Nile Tilapia (*O. niloticus*) and Shing *(H. fossilis*) with rice. Fish production can be increased with accurate application of fertilizers in rice-fish culture system. The main purpose of fertilization is to augment the production of plankton which serves as natural food of the fishes; because fertilization stimulates equally the autotrophic and heterotrophic stages which upsurge fish yield (Grag & Bhatnagar 2000) [14]. Fish production can be boosted equal to 5,000 kg/ha by feeding as well as fertilization (Ekram 2002) [11]. The wellsprings of supplements going into the rice-fish fields were after fertilizers and diets (Grist 1986; Boyd 1995) [5, 15], but these nutrients were collected into the water column of the trench. From the current study result presented that a direct relationship between nutrient supplies and yielding of rice could be observed; increasing nutrient supply highlighting an increase of yielding rice and fish. These are indicated by the significantly greater fish yield at treatment T3 followed by treatment T2, T1. Concerning *O. niloticus* with rice culture, the same occurrence was observed. The rice-fish culture with regular fertilization and feeding obtained in the present study are similar to the production from the rice-prawn system obtained by Nguyen *et al.* (1993) [24]. In regarding the fertilization effects, in the inorganic and organic fertilizer dose was higher in gross production than that no fertilizer treatments. Thus, inorganic and organic fertilizer dose 100 kg/ha/month is superior to those of others and can be prescribed at simply carp poly-culture. Miah *et al.* (1997) [21] obtained 3,434.07 kg/ha fish in 10 months by applying cow dung, additional diet and 50 kg/ha inorganic fertilizer in carp poly-culture scheme. In the present experiment, the survival rates were different in different experimental plots. The survival rate (%)of this fish 53% and 55% recorded by Akhteruzzaman *et al.* (1993) [1] and Chowdhury (1999) [7] respectively were slightly lower than the same recorded in the present study, whereas the survival rate 81.06% reported by Islam *et al.* (1998) [19] was much higher than the present study. Muddana *et al.* (1990) [23] reported a wide range of survival rate (40-85%) of this fish in rice-fish culture. Water temperature is regarded as the most important single factor in fish production. During the experimental period water temperature of the experimental ponds under T1,T2 and T3 varied from 27.21 °C to 30.42 °C.Almost similar ranges of water temperature were also reported by Ali (1990) [2], Uddin (1998) [29], Chowdhury (1999) [7], Mondal (2001) [22] and Das (2002) [10] in their studies in rice fields and the ranges of it obtained by them were 27-40 °C, 27-29 °C, 21.9-33 °C, 27-31.20 °C, 26.90-29.60 °C and 25.32-32.04 °C respectively. The range of dissolved oxygen (3.7-6.0 mg/I) reported by Uddin (1998) [29] was also close to the values obtained in the present study. These results are more or less similar to the results of Chowdhury (2005) [8], and Uddin (1998) [29]. According to Lagler (1972) [20], free co_2 more than 20 mg/ L may be harmful to fishes and even lower concentration may be equally harmful when dissolved oxygen content is less than 3 mg/L The ranges of pH values obtained by Whitton *et al.* (1988) [32], Ali (1990) [2], Uddin (1998) [29], Chowdhury (1999) [7], Mondal (2001) [22] and Das (2002) [10] were 6.53-7.08, 7.1-8.0, 6.7-7.8, 5.63-8.20, 5.80-6.90 and 6.75-8.30 respectively which considered by them within productive level for rice-fish culture

Summary and Conclusion

Integrated rice fish farming in rice fields expands the utilization of land and water and leads to higher fish, achieving higher economic gains than in the rice monoculture. Rice monoculture cannot alone provide a sustainable food supply, while integrated rice-fish farming would be the best in terms of resources exploitation, food supply and productivity thus makes the rice field ecosystem with an efficiently and environmentally comprehensive production system for rice and fish.

During the study period the status of physico-chemical parameters of water like temperature, dissolved oxygen, alkalinity, CO_2, pH etc. were recorded fortnightly. The gross productions of *O. niloticus* under T1, T2 and T3 were 5.04 ± 2.66, 8.65 ± 2.42 and 12.02 ± 1.45kg/decimal respectively and the gross production of *H. fossilis* under T1, T2 and T3were 3.06± 1.76, 6.17 ± 1.84 and 8.83 ± 2.88 kg/decimal respectively. The survival rate (%) of *O. niloticus* was found to be 85.02± 2.00, 83.17± 1.78 and 85.55± 1.22 in T1, T2 and T3, respectively. The survival rate (%) of *H. fossilis* was found to be 88.11± 2.00, 78.11± 1.78 and 75.92± 1.22 in T1, T2 and T3, respectively. During the experimental period water temperature, dissolved oxygen, free CO_2, pH, total alkalinity of the experimental plots under T1, T2 and T3 varied from 27.21 °C to 30.42 °C, 5.06 mg/L to 7.60 mg/L, 1.60mg/L to 3.00 mg/L, 7.19 to 7.85, 152 mg/L to 196 mg/L.

It may be concluded that the introduction of fish in rice fields has profound impacts on the availability of nutrients in the water and soil which ultimately increase the yield of rice grain and straw and at the same time provides an additional yield of fish from the same land. Thus the rural resources poor farmers will be benefited economically and nutritionally to a considerable extent by adopting rice-fish culture through increased yield of rice grain and straw and additional yield of fish. In addition, fertilizer is the best for fish culture plots and it is a very important limiting factor as nutrient for productivity.

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