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Growth, production and economics of carp polyculture in fertilizer and feed based ponds

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ABSTRACT

The growth, production and economics of three Indian major carps (*Labeo rohita, Catla catla* and *Cirrhina mrigala*) and three exotic carps (*Hypophthalmichthys molitrix, Ctenopharyngodon idella* and *Cyprinus carpio*) were reared in polyculture under fertilized and supplementary feeding conditions for a period of six months during April to September, 2009 at Nischintopur under Bagha Upazila of Rajshahi district. There were two treatments with three replications each. Treatments were: T_1) the fertilizers *viz.* urea+TSP+cow dung+ poultry droppings were applied weekly at the rate 35 kg/ha, 12 kg/ha, 230 kg/ha and 60 kg/ha respectively; T_2) the supplementary feeds given to fishes were consisting of rice bran (30%), mustard oil cake (25%), fish meal (10%) and maize bran (35%) at the rate of 3-5% of the body weight per day. The ponds were stocked with fish fingerlings at 5000/ha in the ratio of 5:2:3:8:3:1. The ranges of physico-chemical factors of water such as water temperature, transparency, dissolved oxygen, free carbon dioxide, pH were found suitable and comparatively better in T_2. The highest growth rate by length and weight of all the fishes was recorded in T_2. There were statistically significant differences in the production of fish between two treatments (2360 kg/ha in T_1 and 4022.5 kg/ha in T_2). The cost and return were 132500 Tk. and 192275 Tk. in T_1 and 177500 Tk. and 335812.5 Tk. in T_2 respectively. The benefit-cost ratio was 1:0.45 in T_1 and 1:0.89 in T_2.

INTRODUCTION

Fisheries sector is second to agriculture in the overall national economy of Bangladesh. It plays an important role in the development of agro dependent economical condition, nutrition, employment generation, protein intake, poverty alleviation and foreign exchange earnings and in the improvement of the socio-economic condition of poor fishermen. It contributes about 3.74 % to the national GDP about 5% to the national income and more than 4.04 % to the export earning of the country (DoF, 2009). About 1.2 million people directly and 12 million people indirectly depend on fisheries sector for their livelihood (DoF, 2009). Fish production has increased significantly over the last few years. During 2007-2008 total fish production in Bangladesh was 25,63,296 metric tons (DOF, 2009).

Marine fish production has reached maximum sustainable yield and that further major increases may not be possible. Therefore, any effort to increase fish production must be concentrated on aquaculture. As augmentation of fish production from rivers and estuaries is quite difficult, we need to depend on pond aquaculture for increased production, dependable supply of fish, employment generation and poverty alleviation in the rural areas (FAO 2006).

Pond fish culture in Bangladesh is mainly major carp oriented farming practice. Some exotic species of fish such as Silver carp, Grass carp, Common carp and Thai sarputi have been introduced to Bangladesh for their aquaculture potentiality. Importation or introduction of exotic species is not the solution of getting increased production from pond aquaculture. Use of high yielding, fast growing fish with proper species

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combinations and stocking densities along with appropriate production technologies may help us to boost up fish production. And thus practice of polyculture on the scientific basis by the fish farmers is of great importance.

Polyculture is the system in which fast growing compatible species of fish with different feeding habits are stocked in different proportions in the same pond (Jingran, 1983). It is a fact that polyculture may produce and expected result if fish with different feeding habits are stocked in proper ratios, densities and combinations (Halver, 1984). In Bangladesh polyculture in one of the major culture technique, which people have been following traditionally but expected result could not be achieved without proper knowledge especially about species selection, applications of fertilizers or use of supplementary feed along with the economical justification in fish farming. Intensive fish culture is mainly dependent on closely artificial fish feeds and this type of culture is not suitable economically in our country for large-scale production. Whereas, semi-intensive fish culture is considerably less expensive using fertilizers, supplementary feed and both fertilizers and supplementary feeds.

Application of fertilizers and use of supplementary feed can play a vital role in increasing the fish production in polyculture system (Gupta et al., 1990). The composition of supplementary feeds or diets should be simpler and less expensive. In order to be economically beneficial, the efficiency of supplementary diets must be as high as possible. This depends to a large extent on the level of feeding and the composition of the diet (Hepher and Prauginin 1981). Different fertilizers with their doses and different composition of supplementary feed are used in ponds in our country and there exists a few published reports on polyculture with supplementary feed and fertilization. But the information regarding present aspects of the study in very limited. Therefore, the present study has been planned to achieve maximum growth and production of fishes under polyculture system of three Indian carps (*Labeo rohita, Catla catla,* and *Cirrhinus mrigala*) and three exotic species of fish (*Hypophthalmichthys molitrix*, *Ctenopharyngodon idella* and *Cyprinus carpio*) with fertilized and supplementary feeding condition. The success of fish culture should not be just from the higher production records rather economic return of the farmers that must be reconsidered before recommending a particular technology package to the farmers.

Therefore, considering the need for assessment of growth performance of the individual fish, production cost and sustainability of the semi-intensive aquaculture system, the present study was under taken with the aim to compare the growth, production and economics of stocked species of fish under different situations of pond culture system.

MATERIALS AND METHODS

Ponds

A total of six-ponds of farmer at Bagha Upazilla of Rajshahi district having areas of 50 to 132 decimals were selected for this study. The water depth of the ponds ranged from 1.70 to 2.5 meters. All the ponds were in good condition for fish culture, receiving adequate quantity of sunlight through the day. Aquatic weeds, insects and other unwanted materials in were removed from the ponds manually. After netting the ponds were treated with lime at the rate of 250kg/ha. Within 5-10 days of liming, ponds were fertilized with urea, triple super phosphate (T.S.P) and cowdung at the rate of 35, 20 1200 kg/ha respectively.

Experimental design

The present experiment was conducted in Completely Randomized Design (CRD). Two treatments *viz.*, T_1 and T_2 were given in this study. In treatment-1 (T_1) fishes were reared under fertilized condition with urea, T.S.P, cow dung and poultry dropping. In treatment-2 (T_2) the fishes were fed with supplementary feed consisting of rice bran (30%), mustard oil cake (25%), fish meal (10%) and maize bran (35%). Ponds under T_1 were fertilized weekly with urea and triple super phosphate (T.S.P) at the rate of 33 kg/ha and 12 kg/ha respectively. Cow dung and poultry dropping was provided to all the ponds under T_1 fortnightly at the rate of 133 kg/ha and 8 kg/ha respectively. The ponds under T_2 were fed once in a day at the rate of about 3-5% of the body weight of fishes. Singh and Singh (1975) and Galasum and Suspitsyna (1979) were fed the fish with artificial feed at eh same rate. The feed was given to fish by broadcasting method in the form of small balls.

Stocking of fish

Six species of fish *viz.* Rui (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhina mrigala*), Silver carp (*Hypophthalmichthys molitrix*), Grass carp (*Ctenopharyngodon idella*), Common carp (*Cyprinus carpio*) were stocked into the individual fish pond in the ratio of 5:2:3:8:3:1 respectively. The stocking density was 5000/ha. 14.9 to 21.1 cm long, healthy and quality fish fingerlings having a body weight of 39.6 to 115.4 g were released into the ponds.

Estimation of water and fish quality

The physico-chemical parameters of the pond water including water temperature, transparency, dissolved oxygen (DO) and free carbon dioxide (CO_2) and pH were also done at regular interval of 15 days. The growth of fish 5 individuals of each species were sampled monthly with the help of a seine net or cast net from each pond then the length (cm) and weight (g) of individual fish were recorded.

Sampling and analysis

The sampling was done on monthly basis by using seine and cast net. 10% fishes of each species were sampled for the determination of their total weight and the body length. The fish were released into the respective ponds immediately after sampling. After 6 months of rearing the fishes were harvested and all of records were maintained regarding the total weight of fish harvested, their final length and weight and selling prices. Analysis of the benefit cost ratio of each treatment was calculated from the collected data

RESULTS AND DISCUSSION

Physico-chemical parameters of pond water

Water temperature

During the study period, the water temperature varied from 28.7 to 32.7 ^{0}C in treatment-1, 28.5 to 32.8 ^{0}C in treatment-2. The average values of water temperature in ponds under the treatments T_1 and T_2 were 31.13 ^{0}C and 31.18 ^{0}C respectively (Figure 1). The maximum water temperature (32.8^{0}C) was recorded in treatment-2 at 16 September, whereas the minimum water temperature (28.58 ^{0}C) was recorded in treatment-2 at 1 April. Quddus and Banerjee (1989) denoted that the water temperature between 29 ^{0}C and 32 ^{0}C is suitable for the faster growth of fish spawn and aquatic organisms under natural conditions. Rahman et al. (1992) found water temperature ranged 25.5 ^{0}C to 30.0 ^{0}C which is favorable for fish culture. Britz and Hecht (1987) obtained higher growth rates between 25 ^{0}C and 33 ^{0}C, the best was at 30 ^{0}C. The observed fluctuation in water temperature in the present study was probably due to change in the climatic condition with time.

Water transparency

Water transparency is a gross measure of pond productivity. During the study period, the water transparency varied from 24 to 39 cm in treatment-1, 30 to 44 cm in treatment-2. The average values of water transparency with the treatments T_1 and T_2 were 32.58 cm and 36.42 cm respectively. The highest value of water transparency (44 cm) was recorded in treatment-2 at 1 April, whereas the lowest value of water transparency (24cm) was recorded in treatment-1 at 1 May. Boyd (1990) recommended a transparency between 15 and 40 cm as appropriate for fish culture. Wahab et al. (1995) suggested that the transparency of productive water should be 40 cm or less.

Dissolved oxygen (DO)

During the study period, the dissolve oxygen contents of the water recorded were found to vary from 5.35 to 8.0 mg/l in treatment-1, 4.5 to 7.4 mg/l in treatment-2. The average values of dissolve oxygen content obtained with the treatments T_1 and T_2 were 6.84 mg/l and 6.18 mg/l respectively (Figure 1). The highest value of dissolve oxygen content (8.0 mg/l) was found in treatment-1 at 16 September; whereas the lowest value (4.5 mg/l) of the same was observed in treatment-2 at 16 April. Bhuyan (1970) reported that the DO content of water ranging from 5 to 8 mg/l was within the good productive range. Banerjee (1967) stated that the ponds were unproductive when oxygen ranged from 3 to 5 mg/l; whereas Alikunhi (1957) stated that a good pond for fish culture should have fair amount of dissolved oxygen ganging form 5 to 7 mg/l. From the facts stated above it can be concluded that the amount of dissolved oxygen contents of water in all the ponds under different treatments were within the satisfactory range for carp polyculture.

Free carbon dioxide (CO_2)

Free carbon dioxide contents of water recorded were found to vary from 5.5 to 8.2 mg/l in treatment-1, 5.8 to 8.6 mg/l in treatment-2 during the period of study. The average values of carbon dioxide content obtained with the treatments T_1 and T_2 were 6.60 mg/l and 7.03 mg/l respectively (Figure 1). The highest value of carbon dioxide content (8.6 mg/l) was found in treatment-2 at 1 April; whereas the lowest value (5.5 mg/l) of the same was observed in treatment-1 at 16 September. The concentration of free carbon dioxide was found directly related to the amount and nature of biological activity in the water. The amount of carbon dioxide in the experimental ponds under different treatments was within the production ranges.

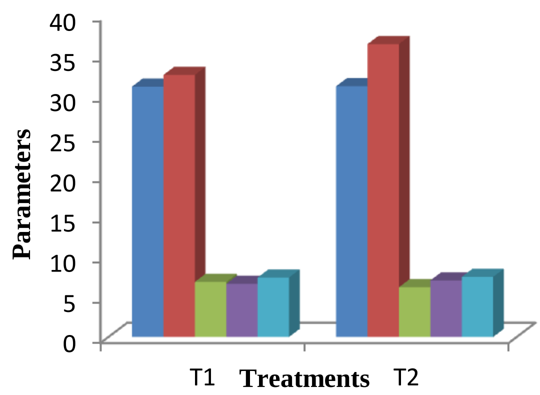

Figure 1
Average value of temperature (^{0}C), transparency (cm), dissolve oxygen (mg/l), carbon dioxide (mg/l) and pH in two treatments.

pH

The ranges of pH values recorded in treatment 1 and 2 were found to range between 6.7 to 8.2 and 6.5 to 7.9 respectively. The average pH values obtained with the treatments T_1 and T_2 were 7.39 and 7.47 respectively (Figure 1). The highest pH value (8.2) was recorded in treatment-1 at 16 July and the lowest of the same (6.5) was recorded in treatment-2 at 1 August. The recorded pH value agreed with the findings of Sarker et al. (2005), Hossain et al. (2007) who recorded pH 6.85-7.03, 6.62-7.85 and 6.5-8.0 respectively in different treatments. The ranges of pH values recorded were within productive range and almost near to the ranges recorded by them.

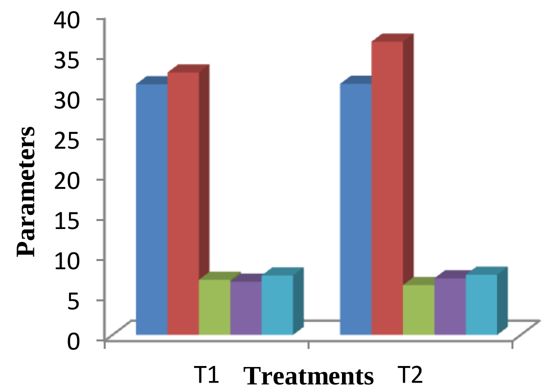

Figure 1
Average value of temperature (^{0}C), transparency (cm), dissolve oxygen (mg/l), carbon dioxide (mg/l) and pH in two treatments.

Growth and production of fishes

Growth

The net increase by length and weight recorded in *L. rohita* were 14.6 cm and weight 272 g in treatment-1, 27.7 cm and 599.8 g in treatment-2, in *C. catla* they were found to be 10.2 cm and 302.2 g in treatment-1, 17.4 cm and 622.4 g in treatment-2, in *C. mrigala* they were 15.6 cm and 320.4 g in treatment-1, 20.6 cm and 600 g in treatment-2, in *H. molitrix* they were 13.7 cm and 484.6 g in treatment-1, 21.2 cm and 764.8 g in treatment-2, in *C. idella* they were 13.7 cm and 396 g in treatment-1, 18.4 cm and 765.9 g in treatment-2 and in *C. carpio* the values of the same recorded were 12.2 cm and 466 g in treatment-1, 16.2 cm and 946 g in treatment-2 respectively (Figure 2, 3 and Table 1).

By monthly average increase in length and weight, almost all the fishes showed more or less rapid growth rate at the beginning and then gradually increase the growth towards the end of the experiment. All the species showed highest growth rate by net increase in treatment-2 where the fishes feed with supplementary feed containing rice bran (30%), mustard oil cake (25%), fish meal (10%) and maize bran (35%), and slowest growth rate in treatment-1. The highest growth rate recorded in treatment-2 might be attributed to good quality or high protein content in supplementary feed supplied to fishes. These finding agree with the finding of Singh and Singh (1975), Chakabarty et al. (1976), Hussain et al. (1987) and Karim (1989). Bhanot and Gopalakrishnan (1973) also stated that the carp could grow well with various types of supplementary feed in absence of natural food. Lakshmanan et al. (1971) by feeding Indian and exotic carp also obtained similar result with supplementary feed containing rice bran and mustard oil cake in composite culture. Distinct impact on growth of *labeo rohita* and *Catla catla* using rice bran as supplementary feed was reported by Medda et al. (1993).

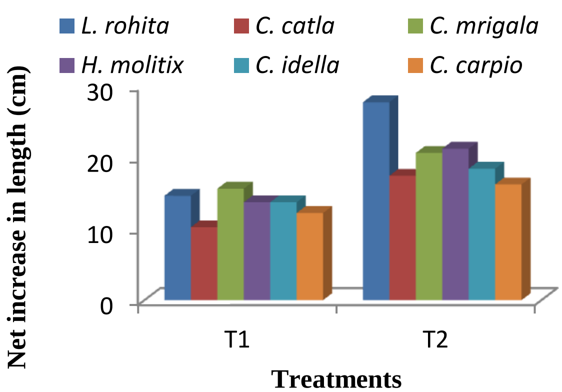

Figure 2
Showing the comparative growth rate gain by the different fish species in two treatments by net increase in length during the period of study.

Specific growth rate

The nutritional treatments were found to have significant effect on the specific growth rate of fishes. Average SGR was higher (4.38) in case of treatment-2, lowest in treatment-1 (3.42). Among different species of fishes the values of SGR were higher in *Cyprinus carpio* (4.38) followed by *Cirrhina mrigala* (4.30) and *Catla catla* (3.42) showed the lowest SGR which seemed to be due to slow growth (Table 1).

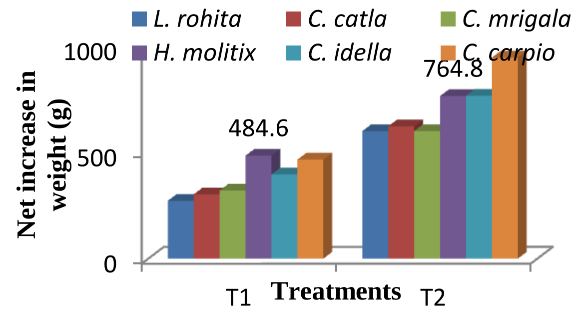

Figure 3
Showing the comparative growth rate gain by the different fish species in two treatments by net increase in weight during the period of study.

Monthly growth profile

From the data (not shown) of cumulative monthly growth increment of fishes in terms of gain in body weight, it is evident that *Cyprinus carpio* exhibited the highest growth over other species in all occasions followed by *Hypophthalmichthys molitrix* and *Ctenopharyngodon idella*. The growth rate was slower in case of *Labeo rohita*.

Production

It is seen from the Table that the total yield of all species of fish was 2360 kg/ha/6 months under treatment-1 (T_1), whereas the total yield of fish was 4022.5 kg/ha/6 months under treatment-2 (T_2). The highest production of fishes was recorded in treatment-2 (4022.5 kg/ha/6 months) where fishes were fed with supplementary feed containing more protein. The present increment of fish yield under treatment-2 over treatment-1 was 170.44 % (Figure 4 and Table 1).

In the experiment it was found that the growth rate of all species hampered in treatmet-1 (T_1). On the other hand, all species of fishes showed the highest rate of growth in all respects in treatment-2 (T_2) which was probably due to supplementary feeding application. This is similar to the results of Rabanal (1967). Kuronuma (1968) conducted an experiment for 5 months by stocking 1.41 metric tons of carp fingerlings in 6 net cages of which 3 were 181 m^2 and the rest were 29 m^2 and 9.4 tons of fish were harvested by supplying 13.1 tons of feed and the net production was 29 kg/ m^2.

Higher production from the supplementary feeding ponds than the fertilized ponds was also recorded by Chaudhuri et al. (1975), Singh and Singh (1975) and Gupta et al. (1990). Hepher et al. (1971) recorded about four folds yield from supplementary feeding ponds than the fertilized ponds in their study. In the present study more than two folds of yield of fish was obtained in supplementary feeding ponds than the fertilized ponds. Khan and Jhingran (1975) and Gupta (1990) also reported double yield of fish from supplementary feeding ponds than the fertilized ponds.

Table 1
Treatment, species, initial weight, final weight, stocking density and yields of different fish species under the farming conditions during the experimental period of six months.

Treatment	Species	Average weight per fish species		SGR %	Stocking density (no./ha)	Yield (kg/ha/6 months)
		Initial weight (g)	Final weight (g)			
T_1	*L. rohita*	78.0	350	3.44	1250	437.5
	C. catla	107.8	410	3.42	500	205.0
	C. mrigala	39.6	360	3.84	750	270.0
	H. molitrix	115.4	600	3.76	1500	900.0
	C. idella	84.0	480	3.71	250	120.0
	C. carpio	104.0	570	3.77	750	427.5
	Total					2360
T_2	*L. rohita*	80.2	680	4.09	1250	850.0
	C. catla	107.6	730	3.99	500	365.0
	C. mrigala	50.0	650	4.30	750	487.5
	H. molitrix	115.2	880	4.14	1500	1320
	C. idella	84.1	850	4.28	250	212.5
	C. carpio	104.0	1050	4.38	750	787.5
	Total					4022.5

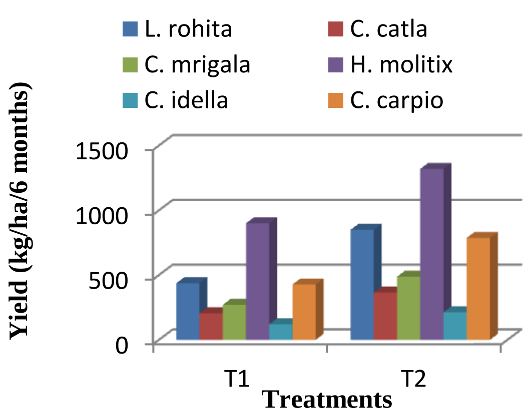

Figure 4
Comparison yield (kg/ha/6 months) of different fish species under two treatments.

Percent contribution of different species to the total yield

Percent contribution of *L. rohita*, *C. catla*, *C. mrigala*, *H. molitrix*, *C. idella* and *C. carpio* to the total yield in treatment-1 (T_1) were found to be 18.54 %, 8.69%, 11.44%, 38.14%, 5.08% and 18.11% respectively. In treatment-2 (T_2), *L. rohita*, *C. catla*, *C. mrigala*, *H. molitrix*, *C. idella* and *C. carpio* contributed to 21.13%, 9.07%, 12.12%, 32.82%, 5.28% and 19.58% respectively.

Economic analysis

It is indicated that the highest cost of fish production (335,812.5 Tk./ha) was found for treatment-2 (T_2) and the lowest fish production cost (192,275 Tk./ha) was found for treatment-1 (T_1) (Table 2). The highest total return (335,812.5 Tk./ha) was found for treatment-2 (T_2) and the lowest total returns (192,275 Tk./ha) was obtained for treatment-1 (T_1). The values of total returns for treatment-1 and treatment-2 were significantly different from each other (Table 3).

The highest cost- benefit ratio (1:0.89) was observed in treatment-2 (T_2) and the lowest cost benefit ratio (1:0.45) was found in treatment-1 (T_1). The values of benefit cost ratio of two different treatments were significantly different from each other (Table 4).

Table 2
Per hectare production cost and economic return of T_1 and T_2 under farming condition during the experimental period.

Sl. no.		T_1		T_2	
	Items	Quantity	Cost (Tk./ha)	Quantity	Cost (Tk./ha)
1.	Pond preparation	-	18,000	-	18,000
2.	Lime (kg)	250	4,000	250	4,000
3.	Fish fry (numbers)		38,000	-	38,000
4.	Fertilizers (kg)				
	Urea	855	8,550	1,950	19,500
	T.S.P.	300	7,500	775	16,250
	Cow dung	5,880	2,990	120	6,500
	Poultry dropping	1,600	960	2,525	22,750
5.	Disease control (salt) (kg)	100	1000	100	1,000
6.	Watering	-	10,500	-	10,500
7.	Security	-	6,000	-	6000
8.	Labor	-	4,000	-	4,000
9.	Netting charge	-	3,000	-	3,000
10.	Pond lease value	-	25,000	-	25,000
10.	Others	-	3,000	-	3,000
Total			132,500		177,500

Table 3
Species wise production (kg/ha), rate (Tk./ha) and return/income (Tk./ha) income (Tk./ha) in two different treatments.

Treatment	Species	Production	Rate (Tk./kg)	Return/income (Tk./ha)
T_1	Rui	437.5	110	48,125
	Catla	205	120	24,600
	Mrigal	270	85	22,950
	Silver carp	900	60	54,000
	Grass carp	120	70	8,400
	Common carp	427.5	80	34,200
	T_1 Total			*192,257*
T_2	Rui	850	110	93,500
	Catla	365	120	43,800
	Mrigal	487.5	85	41,437.5
	Silver carp	1320	60	79,200
	Grass carp	212.5	70	14,875
	Common carp	787.5	80	63,000
	T_2 total			335,812.5

Table 4
Total production cost, total income and benefit cost ration (BCR) in different two treatments.

Attribute	T_1	T_2
Fish yield (kg/ha/6 months)	2360	4022.5
Total income (Tk./ha)	192,275	335,812.5
Total cost (Tk./ha)	132,500	177,500
Cost benefit ratio (BCR)	1:0.45	1:0.89

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