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Production and growth performance under carps polycuture with different stocking densities in hilly creeks of Kaptai lake, Rangamati

Abstract

An experiment was conduct to compare the performences of different carps i.e. rui (Labeo rohita), catla (Catla catla) and mrigal (Cirrhinus cirrhosus) in different stocking densities of polyculture. Three treatments each with three replicates were maintained and the stocking densities of carps were 80 (rui 30+catla 30+mrigal 20), 70 (25+25+20) and 60 (25+20+15) per decimal in T1, T2 and T3 respectively. Creeks were fertilized regularly; commercial feed was given for 300 days. The water quality parameter such as pH, temparature dissolved Oxygen and transperency were observed fortnightly. The obtained results showed that the highest weight was gained at 622.50±293.50g in treatments T3 by catla, followed by rui (572.40±153.90g) and mrigal (532.0±117.54g). However, lowest weight gain was in treatment T1 for all species. On the other hand, the highest SGR was found in treatment T3 for rui (1.22±0.03) and the lowest SGR was in T1 for catla (0.89±0.04). Furthermore, the highest production was obtained in treatment T1 (468 kg/0.1ha/10 months or 4623 kg/ha/10months) followed by T2 (452kg/0.1ha/months or 4465kg/ha/10 months) and T3 (470kg/0.1ha/months or 4643kg/ha/10 months). Survival rate of T3 were highest for three species among the three treatments. The finding of this experiments revealed that, among three treatments, the stocking density of 60 fingerlings per decimal (T3) is the most suitable to ensure highest production on polyculture in creek.

Keywords: creeks, stocking density, polyculture, growth performances

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Introduction

The area of the Chittagong Hill Tracts is about 13,2945km^2, which is approximately one-tenth of the total area of Bangladesh. Topographically, the Chittagong Hill Tracts are the hilly area in Bangladesh. The depression of hilly slope connected with the main Lake or its stream and become inundated with enormous hilly streams during monsoon is called the creek. Fish culture in creeks of the three hill districts has good prospects. Three sides of arms of the creek should be surrounded by hilly land while the rest remain directly linked with the main body of the Lake or not. A total number of 4727 creeks (covering 4297 ha areas) in Chittagong Hill Tracts (CHT) among them 1200 creeks are adjacent to the Kaptai Lake.[1] The production capacity of these creeks is 2100kg/ha that is eight to nine times more than the Kaptai Lake.[2] As a consequence of Bangladesh Fisheries Development corporation (BFDC) records, in the year 2002-03 total fish production of the Kaptai Lake was 4556 MT but it was 9364 MT in the year 2015-16. Over fifteen years, production of total fish from this Lake got attention but it is very noticeable that production of major carps (*Labeo rohita*, *Catla catla*, *Cirrhinus cirrhosus*) species decreased remarkably whereas small fishes especially (*Gudusia chapra* and *Corica soborna*) increased briskly. In spite of, the stocking of huge number of carp fingerling in the Lake per year but alarming decreases aforementioned species. According to Bashar,[3] production from Lake is reported to have declined due to lack of optimum flow of water, siltation which reduces the rate of water flow and causes habitat degradation, the loss of spawning ground and decline of natural seed production of major carps fishes. Meanwhile, the current fish production at these Lake is going downwards and requires serious management effort through creek aquaculture in order to fully utilize the Lake's fishery potential.

The annual fish production of Chittagong Hill Tracts is 14773.46 MT (culture, capture and Kaptai Lake) which is comparatively less amount of total annual inland catch (FRSS, 2014). Our demand is increasing and cultivable land is decreasing for population explosion. To overcome these problems we have to take initiatives to produce more products by proper utilization of the limited resources. In this purpose, polyculture is the best culture system for maximum utilization of pond food web, ecosystem.[4] The Department of Fisheries is trying to modernize creeks aquaculture activities in hill districts and conducted training programme for improvement of existing creeks by repairing and some steps were taken to create new creeks for fish culture. Bangladesh Fisheries Research Institute is trying to adopt fish culture technique and carrying out different research project on fish production improvement in the hilly creeks. The results of this study were helped to to popularize fish production technology in the creeks of Chittagong Hill District.

Materials and methods

Study area and experimental design

The experiment was carried out in a completely randomized design as given in Table 1. Fingerling were stocked at the rate of 80, 70 and 60 fingerling per decimal. Fingerling size was 7-10cm.

Creeks selection and preparation

Creeks was selected by examining creeks site, water retention capacity, and water depth (01 to 05m). Preparation of the creeks was done by repairing mouth of the creeks and unwanted sludge was removed from the creeks bottom. Lime was applied @ 250kg/ha. A concerned creeks was fertilized with compost (mixture of chopped and sun dried green plants 88%, cow dung 10%, urea 1% and lime 1%) @1,250kg/ha, urea @37.5kg/ha and TSP @25kg/ha). Then the creeks were left for10 days to promote algal development.

Collection and stocking of quality fry/Fingerling

Good quality fingerlings was collected and required number of fingerlings was stocked in each creek after proper acclimatization.

Feeding management and fertilization

Formulated feed (25-28% protein) was supplied twice daily @ 10 to 5% body weight of fish. The feed was adjusted periodically in accordance with the growth performance of fishes. Water of the creeks were fertilized monthly with urea @37kg/ha, TSP @25kg/ha and cow dung @1235kg/ha.

Fish growth and water quality parameters monitoring

At least 10% of each species of fishes was collected by seine net and growth was recorded fortnightly. Water quality parameters like air and water temperature, DO, free CO_2, total hardness, total alkalinity, P^H was monitored fortnightly by using chemicals Kit Box. Transparency was measured by using secchi disc and water depth was measured manually by using meter scale.

Final harvest and production estimation

After 10 months of rearing, all fishes were harvested; growth and production was estimated.

Economic analysis

An economical analysis was performed to estimate the net return and benefit–cost ratio in different treatments. The following equation will be used: R=I–(FC+VC+Ii) where, R=net return, I=income from sale, FC=fixed costs VC=variable costs and Ii=interest on inputs. Benefit cost ratio (BCR)=Total net return/Total input cost.

Data analysis and report writing

For statistical analysis of data, a one-way ANOVA (Analysis of Variance) and DMRT (Duncan's Multiple Range Test) was done by using the SPSS (Statistical Package for Social Science) version-11.5. Significance was assigned at 1% level.

Participatory approach at different stages of technology development

A group of entrepreneurs living within the immediate vicinity of the creek, which have property right (beneficiaries), was assigned for overall management of the project. At least ten to fifteen beneficiaries was considered for a group selection including a team leader. Entrepreneurs was responsible for guarding, cleaning shoreline of creeks, administering feed as per requirement, taking part of fish harvesting, etc. By attending in all stages of technology development, they were capable to undertake such type of aquaculture system individually at the end of project period.

Results and discussion

Water quality parameters

Dissolved oxygen, pH, water transparency and temperature were recorded monthly during the study period. The mean values of water quality parameters are presented in the Table 1.The P^H values of creeks water found to be fluctuated and ranged from 6.2 to 8.2. In treatment T_1, T_2 and T_3, the average P^H of water were 7.3±0.45, 7.3±0.94 and 7.2±1.00 respectively. Again, the Dissolved Oxygen concentrations of different creeks were ranged from 3 to 14. The Dissolved oxygen concentrations under different treatments were found to be fluctuated around 6.12±1.13, 6.27±0.66 and 6.10±0.74 in the treatments T_1, T_2 and T_3. Significant different ($p>0.05$) was not observed among the three treatments (Tables 1& Table 2).

Air temperature of creek water was found to be almost similar in different treatments without any significant difference. In T_1, T_2 and T_3 treatments it had figures of 26.26±3.8°C, 28.35±2.67°C and 28.93±3.58°C respectively. Water temperature was 27.24±4.26, 26.03±6.47 and 25.73±6.51 in T_1, T_2 and T_3 respectively. The transparency of the treatments T_1, T_2 and T_3 were 1.35±0.35m, 1.82±1.19m and 32.61±1.02m, respectively. Significant difference ($P>0.05$) was not observed between the treatments (Table 1). The transparency values in different treatments indicated that creek seemed to be within the productive range for fish culture.[3,5–7] Carbon-di-oxide (CO_2) of the treatments T_1, T_2 and T_3 were 3.52±1.6, 4.02±1.33 and 3.33±6.33, respectively. Significant difference ($P>0.05$) was not observed between the treatments (Table 1). Total alkalinity and total hardness were significantly difference among the three treatments in Table 1.

Growth performance of fish in different treatments weight gain

It was observed that in treatment T_3 weight gain was higher compared to other treatments. However, significant differences were not observed among different fish species (Table 2). It might be due to the highest stocking density in treatment T_1 and the lowest stocking density in treatment T_3. In the present study, the highest weight gain was found in catla (622.50±293.50g) in T_3 then rui and the lowest weight gained in mrigal (493.60±112.36g) in T_1. In contrary, Islam[8] found the highest weight gain in rui (231±0.87) in six month culture period. The specific growth rate (SGR) of rui was not significantly different among three treatments. However, SGR value of catla, rui and mrigal showed no significant difference ($p<0.05$) among the treatments (Table 3).The SGR value 2.28±.05 of rui in treatment T_1 was higher compared to Milstein et al.[9] who recorded SGR of rui ranged from 1.16 to 0.99. The significant variation of SGR was found in mrigal, catla and silver carp. The highest SGR was found in silver carp in T_1 (2.87±0.03) and the lowest SGR was found in catla in treatment T_3 (1.51±0.06). Likewise, Modac (2006) found the SGR value of rui at 1.65±0.74 in the Indian carp polyculture system which was almost similar result.

The total production was expressed in kg/ha/10 monthly (Table 3). The combined production was the highest in treatment T_3 (470kg/0.1ha/10 months or 4643kg/ha/10 months) followed by treatment T_1 (468kg/0.1ha/10 months or 4623kg/ha/10 months) and treatment T_2 (452kg/0.1ha/10 months or 4465kg/ha/10 month). In this study, it was found that the production performance of each individual fish was not similar in the three treatments (Table 4). In general, the

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total fish production was the highest for all species in treatment T_3 appropriate stocking density (60 nos/dec). On the contrary, in case of catla, the gross production was the highest in T_1 compared to T_2 and T_3. The gross production of rui was the highest in T_3 compared to T_1 and T_2. Moreover, mrigal, treatment T_2 and T_3 gave the almost same production but T_1 gave lower production.

Individual growth performance (g)

Rui, catla, mrigal were stocked in three treatments at the rate of 80 (T_1), 70 (T_2) and 60 (T_3) fingerlings per decimal. The highest weight gain (Table 3) of rui (572.40±153.90), catla (622.50±293.50) and mrigal (532.50±118.32) was recorded in T_3. Furthermore, the weight gains of rui. catla and mrigal were not significantly different among three treatments. Survival rate of T_3 were highest for three species among the three treatments. Survival rate of all treatment were all most 50 percent because fish feed were collected from other district. Creeks were situated very remote area and communication of creeks is not good. Sometime fish seed were carried to the creeks with aluminum pot from pick up for 2-3 hours. 10 hours were required for releasing fish seed from the time of collecting hatchery. Figure 1&2 shows the monthly growth performance of rui, catla and mrigal. In this experiment, the highest total production was found from treatment T_3 (470kg/0.1ha/10 months or 4643kg/ha/10 months) followed by treatment T_1 (468kg/0.1ha/10 months or 4623kg/ha/10 month) and treatment T_2 (452kg/0.1ha/10 months or 4465kg/ha/10 month), respectively. From polyculture system, the gross production was recorded 1,817 kg ha^{-1} by Kohinur[10] and1,970kgh^{-1} Kadir[11] during five months of culture period and 2,560 kg ha^{-1} by Roy[12] during 7 months. The present study supported the finding of Sagor[13] and Hossain.[14] Our finding indicated that stocking density 60nos/dec is most appropriate for polyculture. The net profit was calculated Tk. 86630.00, 83400.00 and 87280.00 in treatment 1, 2 and 3, respectively per 0.1 ha creek per 10 months duration (Table 5) . Benefit-cost ratio (BCR) was obtained 1.35, 1.27 and 1.31 in T_1,T_2 and T_3 respectively. BCR was higher in treatment T_3 because the numbers of the three species were high other then two treatments (T_2, T_3). Similar finding was observed by NC Roy[12] in their experiment. Among three treatments, only carps polyculture made Tk. 94, 925 net benefit per 7 months. BCR of this experiment was 3.94:1. From the overall discussion, it was found that successful polyculture of rui, catla and mrigal in creeks could be done with better production using the stocking density 60 fingerlings per decimal.[15,16]

Table 1 Experimental design of the project

Treatments	Stocking density (No./dec)	Species	Sizes (cm)
T_1 Rangamati Sadar	80	Rui (30), Catla (30), Mrigal (20)	7-10
T_2 Naniachar	70	Rui (25), Catla (25), Mrigal (20)	7-10
T_3 Langadu, Rangamati	60	Rui (20), Catla (25), Mrigal (15)	7-10

Table 2 Water quality parameters in three different creeks during experiments

Treatments		Parameters							
		Air temp (^{0}C)	Water temp (^{0}C)	pH	CO_2 (mg/l)	Total alkalinity (mg/l)	Total hardness (mg/l)	Transparency (m)	DO (mg/l)
T_1	Range	21.46-29.06	22.98-31.5	6.85-7.45	2.24-5.12	36.14-63.2	32.1-52.3	1.22-2.26	4.99-7.25
	Mean	26.26±3.8a	27.24±4.26a	7.3±0.45a	3.52±1.6a	52.32±3.51a	42.05±4.22a	1.35±0.35a	6.12±1.13a
T_2	Range	25.68-31.02	19.56-32.5	6.36-8.24	2.69-6.35	41.2-70.5	45.1-65.3	1.25-2.44	4.36-6.93
	Mean	28.35±2.67a	26.03±6.47a	7.3±0.94a	4.02±1.33a	70.3±0.2b	60.5±4.8b	1.82±1.19a	6.27±0.66a
T_3	Range	25.35-32.51	19.22-32.24	6.2-8.20	3.33-6.33	59.3-72.1	59.9-72.5	0.54-2.50	5.36-6.84
	Mean	28.93±3.58a	25.73±6.51a	7.2±1.00a	4.83±1.50a	65.7±6.4c	66.2±6.3c	1.52±0.98a	6.10±0.74a

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Table 3 Growth performance of craps under polyculture management after 300 days of culture in three different creeks

Treatments	Stocking density	Creek size (ha)	Carp species	Initial		After 300 days		Weight gain (g)	Survival rate (%)	SGR (%)	FCR
				Length (cm)	Weight (g)	Length (cm)	Weight (g)				
			Rui	6.3c±0.66	14.60±1.51	32.90b±1.20	545.00±15.09	530.40±15.09	42	1.20±.03	1.53
T_1 Sadar	80 /dec	0.1	Catla	7.26±0.40	42.20a±3.39	33.70±2.31	616.40±154.23	574.20±154.85	42	0.89±.04	1.38
			Mrigal	8.00±1.25	21.60±1.90	33.00a±1.15	515.20±111.57	493.60±112.36	40	1.05±.05	1.56
			Rui	7.07b±0.78	14.50±1.08	31.70c±1.25	553.20±92.76	538.70±92.46	47	1.20±.04a	1.81
T_2 Naniarchar	70 /dec	0.1	Catla	7.54±0.68	39.00b±2.26	33.40±2.50	630.60±124.50	591.60±124.97	45	0.92±.06b	1.53
			Mrigal	8.50±1.08	22.80±1.10	31.60c±1.43	528.80±88.41	506.00±88.93	44	1.04±.07c	1.49
			Rui	8.40a±1.17	14.70±0.95	33.50a±1.35	587.10±153.30	572.40±153.90	52	1.22±.03a	1.54
T_3 Longodu	60/dec	0.1	Catla	8.00±0.82	38.80c±1.93	34.80±2.94	661.30±292.93	622.50±293.50	51	0.94±.08b	1.75
			Mrigal	7.90±0.88	22.10±2.77	32.70b±0.67	554.60±117.54	532.50±118.32	54	1.07±.07c	1.81

Table 4 Average survival, gross production, net production and production of carp fish under polyculture management in three different creeks

Treatments	Carp species	Survival (%)	Gross production	Net production	Production of fish (No/0.1ha)	Total production (kg/0.1ha/10 months)	Total production (kg/ha/10 months)
	Rui	42	171	161	315		
T_1	Catla	42	194	163	315	468	4623
	Mrigal	40	103	93	200		
	Rui	47	160	151	292		
T_2	Catla	45	176	152	280	452	4465
	Mrigal	44	116	105	220		
	Rui	52	190	181	325		
T_3	Catla	51	168	149	255	470	4643
	Mrigal	54	112	104	202		

Table 5 Comparison of economics of three different creeks calculated on the basis of 0.1 hectare creek

Items		Quantity	Price rate (BDT)*	T1	T2	T3
A. Cost	[(i)+(ii)+(iii)]	-	-	67163	65203	63243
	Fixed cost	-	-	-	-	-
	Land rent	-	25000 ha-1,yr^{-1}	2110	2110	2110
	Rotenone	1.25 kg	240 kg^{-1}	300	300	300
	Lime	25 kg	30 kg^{-1}	750	750	750
	Urea	3 kg	50 kg^{-1}	150	150	150
A (i):	TSP	10 kg	30 kg^{-1}	300	300	300
	Compost	100 kg	5 kg^{-1}	500	500	500
	Rui	750 no.	7 fry^{-1}	5250	4375	3500
	Catla	750 no.	7 fry^{-1}	5250	4375	4375
	Mrigal	500 no.	7 fry^{-1}	3500	3500	2625
	Sub total	-	-	18110	16360	14610

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	Variable cost	-	-	-	-	
	Feed	800 kg	30 kg^{-1}	24000	24000	24000
A(ii):	Labour	-	300 Tk day^{-1}, 40 days	12000	12000	12000
	Other	-	-	5000	5000	5000
	Sub total	-	-	41000	41000	41000
Total fixed and variable costs [A(i)+A(ii)]	-	-		59110	57360	55610
A(iii):	Bank interest on cost for 300 days		12% yearly	8053	7843	7633
	B(i): Carp sale price	-	-	-	-	
B. Benefit [B(i)]	Rui	-	200,200 and 200 kg^{-1}	34200	32000	38000
	Catla	-	180,180 and 180 kg^{-1}	34920	31680	30240
	Mrigal	-	170, 170, and 170 kg^{-1}	17510	19720	19040
C. Net profit (B-A)				86630	83400	87280
D. Benefit cost ratio, BCR (B÷A)				1.28	1.27	1.38

*BDT, Bangladesh taka.

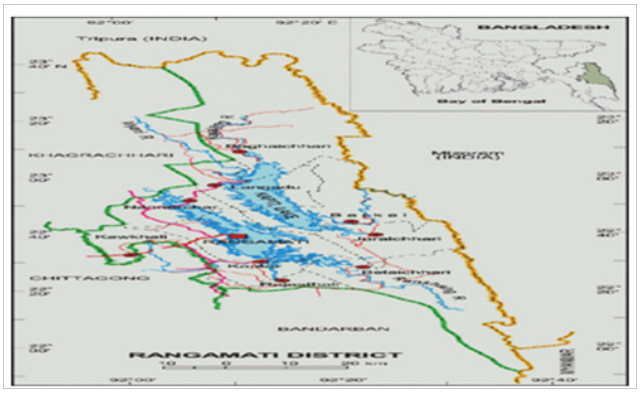

Figure1 Map showing the study sites of Sadar , Langadu, Naniarchar Upazilla of Rangamati hill tracts of Bangladesh.

Figure 2 Growth performance of fishes.

Conclusion

In conclusion; it can be corroborated that on the basis of growth performance and economic return; 60fish/decimal exhibited the highest performance to all stocking densities. Therefore; stocking density of 60fish/decimal recommended for the successful polyculture in hilly creeks. This study has implications of sustainable and cost-effective polyculture practices in hilly creeks.

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Conflict of interest

The author declares no conflict of interest

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