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Study the optimization of stocking density of tilapia and carps in poly-culture system at earthen ponds of Bapard campus of Gopalganj district

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Abstract
An experiment was conducted to determine the growth and production of tilapia (*Oreochromis niloticus*) with rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus mrigala*) and silver carp (*Hypophthalmichthys molitrix*) in poly-culture system for a period of 135 days at nine earthen ponds. The experiment was carried out under three treatments each with three replications. The stocking density was 220 fingerlings per decimal (tilapia 200, rohu 5, catla 5, mrigal 5 and silver carp 5) under T_1, 270 fingerlings per decimal (tilapia 250, rohu 5, catla 5, mrigal 5 and silver carp 5) under T_2 and 320 fingerlings per decimal (tilapia 300, rohu 5, catla 5, mrigal 5 and silver carp 5) under T_3. The average initial length and weight of the fingerlings of tilapia (*Oreochromis niloticus*), rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus mrigala*) and silver carp (*Hypophthalmichthys molitrix*) were 2.15±0.10 cm, 6.10±0.30 cm, 7.81±0.23 cm, 6.15±0.54 cm, 5.20±0.42 cm and 7.50±0.16 g, 23.50±0.14 g and 20.12±0.15 g, 19.20±0.18 g, 21.25±0.17 g respectively. The ponds were fertilized fortnightly with urea and TSP at the rates of 100 g and 50 g per decimal respectively. Mean survival rates of fish under T_1, T_2 and T_3 were 76%, 74.8% and 68% respectively. The specific growth rates (SGR, % per day) of fish under T_1, T_2 and T_3 were 2.21%, 2% and 1.80%. The calculated net fish production of the ponds under T_1 was 27.29 kg/dec. and that of the ponds under T_2 was 25.08 kg/dec. and 21.79 kg/dec. inT_3. The BCR was calculated 1:1.38 for T_1, 1:1.20 for T_2 and 1:1.06 for T_3. The findings of this experiments revealed that among three treatments, the stocking density 220 per decimal (T_1) is the most suitable.

Keywords: stocking density, tilapia, carps and poly-culture

Introduction

Poly-culture is the practice of culturing more than one species of aquatic organism in the same pond. The motivating principle is that fish production in ponds may be maximized by raising a combination of species having different food habits. The concept of poly-culture of fish is based on the concept of total utilization of different tropic and spatial niches of a pond in order to obtain maximum fish production per unit area. The mixture of fish gives better utilization of available natural food produced in a pond. The compatible fish species having complimentary feeding habits are stocked so that all the ecological niches of pond ecosystem are effectively utilized. Poly-culture began in China more than 1000 years ago. The practice has spread throughout Southeast Asia, and into other parts of the world. Importance of pond based carp poly-culture as a popular technique for fish production in Bangladesh is well documented [3]. Carps contributed 45.35% of the total fish production [8] and it has further potentials to increase fish production. Mean fish production of pond is found as 4,618 kg ha^{-1} at present and it needs to be increased up to 5,000 kg ha^{-1} through proper management [8]. Tilapia was first introduced in Bangladesh in 1954. About 80 species of tilapia have been described out of which 10 species are reported to be used for culture [17]. Tilapias have distributed to so many different types of water, to so many different types of culture systems in the world that they have been even labeled as the "aquatic chicken" [16]. They have good resistance to poor water quality and disease, tolerance of a wide range of environmental conditions, ability to convert efficiently the organic and domestic waste into high quality protein rapid growth rate and tasty flavor [6]. The existing strain Nile tilapia (*Oreochromis niloticus* L.) was first introduced into this country by the United Nations International Children Emergency Fund (UNICEF) in 1974 and later by the Bangladesh Fisheries Research Institute (BFRI) from Thailand [10]. Farmed tilapia productions in 2010 exceeded 3.2 million metric tons per annum, surging further ahead of the salmon and catfish industries [9]. Production of tilapia, for home or local consumption and for export, has risen tremendously in the last few decades. The tonnage of worldwide tilapia production (in 2010, about 3 million tons) is second, among fish, only behind to carps. Global production of tilapia was estimated to be 2.5 billion US$ in 2010 [2]. In view of the increasing commercialization and continuing growth of the tilapia industry, the commodity is not only the second most important farmed fish globally, next to carps, but is also described as the most important aquaculture species of the 21st century [22]. The fish is being farmed in about 85 countries worldwide, and about 98% of tilapia produced in these countries is grown outside their original habitats [9].

In Infofish Tilapia 2010 Conference it was forecasted that the world's total tilapia production would reach 3.70 million tons by the end 2010. Carp polyculture is mainly practiced in southern tropical region of Nepal characterized by freshwater pond aquaculture involving three species of Indian major carps, rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*), and species of large exotic carps including silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*). Poly-culture results in high yield as the pond niches are fully utilized by fish species of different feeding habits. No published information affordable for the rural farmers is available on optimum stocking density of Tilapia (*Oreochromis niloticus*) with carp poly-culture in Bangladesh. The present study was undertaken to observe optimum stocking density of Tilapia in carp poly-culture with supplemental feed, under condition of Bangladesh aquaculture.

Material and Methods

Study area

The present experiment was carried out for a period of 135 days from 1st August/2020 to 15th December/ 2020. It has been located at the Pond of BAPARD campus, Gopalganj (located at 22.9833°N 89.9917°E) (Fig. 1).

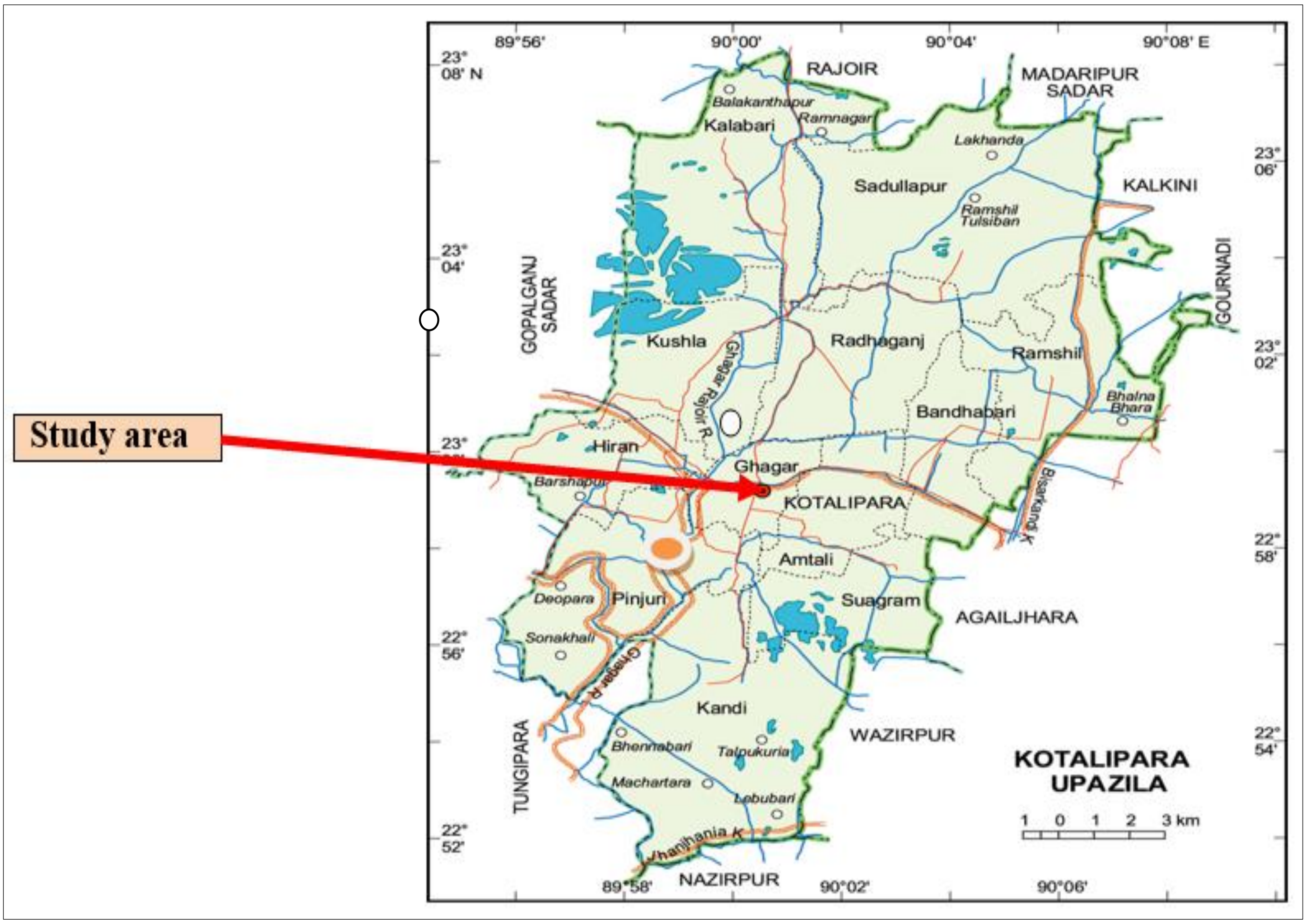

Fig 1: Map of Kotalipara Upazilla showing the study area in Gopalganj district

Experimental design

Table 1

SL	Treatments	Replications	Species Name	Stocking Density (Dec^{-1})
01	T_1	3	Tilapia (*Oreochromis niloticus*)	200
			Rui (*Labeo rohita*)	5
			Catla (*Catla catla*)	5
			Mrigal (*Cirrhinus cirrhosis*)	5
			Silver carp (*Hypophthalmichthys molitrix*)	5
02	T_2		Tilapia (*Oreochromis niloticus*)	250
			Rui (*Labeo rohita*)	5
			Catla (*Catla catla*)	5
			Mrigal (*Cirrhinus cirrhosis*)	5
			Silver carp (*Hypophthalmichthys molitrix*)	5
03	T_3		Tilapia (*Oreochromis niloticus*)	300
			Rui (*Labeo rohita*)	5
			Catla (*Catla catla*)	5
			Mrigal (*Cirrhinus cirrhosis*)	5
			Silver carp (*Hypophthalmichthys molitrix*)	5

Pond preparation

The ponds were drained out completely and aquatic weeds were removed manually. Liming was done in all ponds at the rate of 1 kg/decimal. One week after liming the ponds were filled with water and fertilized with urea and TSP at the rate of 200 gm/decimal and 100 gm/decimal respectively. TSP was soaked overnight, then urea and TSP were dissolved together and spread manually on pond water surface at sunny day (10-10.30 am). To enhance the growth of natural food for the carps, fertilization was done with urea (200 gm/dec) and TSP (100 gm/dec) ten a month. The ponds were same in size (10 dec.) and similar in shape and depth.

Fig 2: Pictorial view of lime application

Collection of experimental fish

All the carp were collected from Sonali Fish Farm and hatchery (Pvt) Ltd, Kotalipara, Gopalganj.

Water quality parameters

Water quality parameters of the experimental ponds were recorded throughout the study period. The water temperature (ºC), dissolve oxygen (ppm) and hydrogen ion concentration (pH), ammonia (NH_3) and Nitrite (NO_2) were monitored at the beginning and end of the experiment by using proper instrument.

Estimation of growth performance

Sampling was done 15 days interval from each pond by cast net and the weight of fish was recorded by using electric balance (Model:FKS-5000). After harvesting of fishes final weight were recorded and following parameters were used to evaluate the growth and production of the fishes.

Mean length gain (cm) = Mean final length (cm) – Mean initial length (cm)

Mean weight gain (g) = Mean final weight (g) – Mean initial weight (g)

$$\textbf{Specific growth rate (SGR \%)} = \frac{\log_e W2 - \log_e W1}{T_2 - T_1} \times 100$$

Here, W_2= the final live body weight (g) at time T_2 day
W_1=the initial live body weight (g) at time T_1 day
T_2= time duration at the end of the experiment
T_1 = initial time of the experiment (day).
Fish production = Number of fish harvested × final average

Weight Data analysis

The recorded data were entered into the spreadsheet in MS Excel 2010 and then summarized properly before statistical analysis. After entering the data, the descriptive statistical analyses were done by MS Excel. The inferential T-test was carried out using SPSS (Statistical Package for Social Sciences) version 22.

Result

Water quality parameters

Table 1: Water quality parameters in different treatment during experiments

Treatments	pH	Ammonia	Dissolved oxygen	Temperature (°C)	Transparency
T_1	7.61±0.11	0.25±0.20	4.50±0.50	21.20.±0.20	30.89±1.10
T_2	7.67±0.15	0.50±0.21	4.30±0.51	20.25±0.21	34.51±0.77
T_3	7.71±0.15	1±0.22	4.18±0.52	20.14±0.25	32.61±1.15

Growth performance of tilapia with carp poly-culture

Table 2: Production performance of tilapia with carp poly-culture under different stocking densities

Parameters		Treatments		
		T_1	T_2	T_3
Stocking Density (dec.)	Tilapia	200	250	300
	Rohu	5	5	5
	Catla	5	5	5
	Mrigal	5	5	5
	Silver carp	5	5	5
Initial length (cm)	Tilapia	2.15±0.00	2.15±0.00	2.15±0.00
	Rohu	6.10±0.00	6.10±0.00	6.10±0.00
	Catla	7.81±0.00	7.81±0.00	7.81±0.00
	Mrigal	6.15±0.00	6.15±0.00	6.15±0.00
	Silver carp	5.20±0.00	5.20±0.00	5.20±0.00
Initial weight (g)	Tilapia	7.50±0.16	7.50±0.16	7.50±0.16
	Rohu	23.50±0.14	23.50±0.14	23.50±0.14
	Catla	20.12±0.15	20.12±0.15	20.12±0.15
	Mrigal	19.20±0.18	19.20±0.18	19.20±0.18
	Silver carp	21.25±0.17	21.25±0.17	21.25±0.17
Culture duration (days)=135 days				
Final length (cm)	Tilapia	13.25±0.15	11.15±0.15	10.09±0.12
	Rohu	23.65±1.16	20.39±1.19	16.80±1.75
	Catla	25.40±1.50	21.18±1.20	18.18±2.15
	Mrigal	23.33±1.10	20.33±0.70	17.13±1.20
	Silver carp	35.10±0.54	30.27±0.50	25.80±0.45
Final weight (g)	Tilapia	130.10±0.17	110.15±0.10	100.35±0.20
	Rohu	444.50±0.30	311.53±0.20	243.19±0.25
	Catla	413.10±0.76	309.17±0.25	217.11±0.60
	Mrigal	401.70±0.30	310.62±0.15	206.80±0.45
	Silver carp	460.12±0.75	325.18±0.90	221.75±0.64
Survival rate (%)	Tilapia	80	74	60

	Rohu	80	80	60
	Catla	80	80	60
	Mrigal	60	80	80
	Silver carp	80	60	80
SGR (%)	Tilapia	2.11	1.99	1.92
	Rohu	2.17	1.91	1.73
	Catla	2.24	2.02	1.85
	Mrigal	2.25	2.06	1.76
	Silver carp	2.28	2.02	1.74
FCR	(Only for Tilapia)	1.70	1.80	2.00
Production (kg/dec.)	Tilapia	20.81	20.37	18.60
	Rohu	1.78	1.25	0.73
	Catla	1.65	1.24	0.65
	Mrigal	1.21	1.24	0.83
	Silver carp	1.84	0.98	0.98
Total production=		27.29	25.08	21.79

Table 3: Economic analysis of tilapia with carp poly-culture

Components	Treatments		
	T_1	**T_2**	**T_3**
Expenditure (Tk./dec.)			
Fingerlings cost	400/-	450/-	500/-
Feed cost	1,769/-	1,833.50/-	1,860/-
Urea (10.00 Kg)	160/-	160/-	160/-
TSP (5.00 Kg)	110/-	110/-	110/-
Lime cost (5.00 Kg)	80/-	80/-	80/-
Medicine	-	-	160/-
Total expenditures (Tk/dec.)	2,519/-	2,633.5/-	2,870/-
Income			
Gross return (Tk/dec.)	3,469.20/-	3,150.90/-	2,710.50/-
Net return (Tk/dec.)	950.20/-	517.40/-	159.50/-
BCR (Benefit Cost Ratio)	1:1.38	1:1.20	1:1.06

Tilapia 1taka per piece
Carp fingerlings average 10 taka per piece
Commercial Feed 50 Taka per kg
Tilapia 120 Taka per kg
Carps fishes 150 Taka per kg

Discussion

Water Quality Parameters

The growth of aquatic organisms depends on the water quality parameters of a water body [24]. Maintenance of all the factors becomes necessary for getting maximum yield from a fish pond. Good water quality is characterized by adequate oxygen, proper temperature, transparency and other environmental factors that affect fish culture [7, 25]. Temperature changes affect fish metabolism, physiology and ultimately affect the production. Suitable water temperature for carp culture is between 24 and 30 ^{0}C [25]. In T_1, T_2 and T_3 treatments it had figures of 21.20.±0.20°C, 20.25±0.21°C and 20.14±0.25°C, respectively which was suitable for tilapia and carps [12, 25]. Transparency depends on several factors such as suspended clay particles, dispersion of plankton organisms, particulate organic matters and also the pigments caused by the decomposition of organic matters. The secchi disk transparency between 30 and 40 cm indicates optimum productivity of a pond for good fish culture [7]. Transparency ranged from 30 to 34 cm and the mean values were 30.89±1.10, 34.51±0.77 and 32.61±1.15 cm in T_1, T_2 and T_3 respectively. Since the ponds were not turbid or muddy rather greenish, this indicated the ponds were productive [7]. Water pH between 7 to 8.5 is suitable for biological productivity [7]. In treatment T_1, T_2 and T_3, the average pH of water were 7.61±0.11, 7.67±0.15 and 7.71±0.15 respectively, which was more or less similar to the findings of [4, 25] and suitable for fish culture [7]. Dissolved oxygen of water of any culture system affects the growth, survival and physiology of fishes [4, 5]. The Dissolved oxygen concentrations under different treatments were found to be fluctuated around 4.50±0.50, 4.30±0.51 and 4.18±0.52 in the three treatments T_1, T_2 and T_3. Oxygen depletion in water leads to poor feeding of fish, starvation and reduced growth either directly or indirectly [7].

Growth and Production Performance

Each fish species stocked in the ponds has individual feeding niches and thus exerts influence on the environment in a somewhat different way, largely depending on their size and feeding regime. Tilapia feeds commercial feed whereas Rohu feeds in the middle column and Catla, Silver carp in the surface and Mrigal feeds in the bottom. The productions of fishes in different treatments were found to vary among treatments due to difference in survival, growth rate and production. The obtained results showed that the highest weight was gained at 130.10±0.17g in treatments T_1 by Tilapia, followed by Silver carp (460.12±0.75g), Mrigal (401.70±0.30 g), Catla (413.10±0.76 g) and Rohu (444.50±0.30 g). Similarly, the highest length was obtained in treatment T_1 by Tilapia at 13.25±0.15 cm followed by Silver carp at 35.10±0.54 cm, Rohu at 23.65±1.16 cm Catla at 25.40±1.50 cm and Mrigal 23.33±1.10 cm. However, both the weight gain and the length gain were the lowest in treatment T_3 for all species. Mean Length gain (cm) of fishes in this present study was agreed with the findings of [21]. Weight gain (g) as observed in this study appeared to be suitable for fish culture which agreed with the findings of [20]. On the other hand, the highest SGR% was found in treatment

T_1 for Silver carp (2.28) and the lowest SGR% was in T_3 for Rohu (1.73). The result of the study is about same to the findings of [20]. The highest survival (%) of the fishes was found in treatment T_1 than those of treatments T_2 and T_3. Similar result also observed by [17]. The variation of production of fishes was found in three treatments. Between three treatments, the higher production of fish was recorded in T_3, followed by the production of T_1 and T_2. Kadir *et al.*, (2006) [15] obtained 1970 kg/ha production in poly-culture during 150 days culture period. Sagor (2008) [23] obtained the average production of carps 1676 kg/ha/year. Haque (2010) [14] reported good results from the poly-culture of Indian carps in three treatments with the productivity ranging from 2618.85±57.5 to 2747.47±116.47 kg/ha/year. The BCR was calculated 1:1.38 for T_1, 1:1.20 for T_2 and 1:1.06 for T_3. In traditional tilapia with carps poly-culturs in Bangladesh the production range was 3119 to 4067 kg/ha/year [11, 18]. Awal *et al*. (1995) [1] stated that a net production of native, exotic and mixed carp poly-culture system were 1196, 1617 and 982 kg/ha per 6 months, respectively. So, the level of fish production in the present study was more or less similar to the result quoted above.

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Conclusion

Higher stocking densities resulted in lower BCR because of high cost of fingerlings coupled with poor fish growth and very low survival rate. On the other hand, at the lowest stocking density T_1 (220 fingerlings per dec), BCR was very high because cost for fingerlings was very low and at the same time survival rate and fish growth rate was satisfactory resulting high fish yield. Present study confirms that stocking density along with mixture ratio of tilapia and carp has tremendous influence on the productivity and profitability of fish production. For higher productivity, tilapia with carp poly-culture in T_1 (220 fingerlings per dec) can be recommended.

References

1. Awal S, Wahab MA, Ahmed GU, Rahman MM and Ahmed F. Economics of different polyculture system involving native and exotic carp. Bangladesh Journal of Fisheries,1995:15-18(1-2):37-43.
2. Avnimelech Y. Tilapia Production Using Biofloc Technology (BFT). Proceedings of the ninth international symposium on tilapia in aquaculture. Shanghai Ocean University, Shanghai, China, 2011.
3. Asadujjaman M, Hossain MA. Fish growth, yield and economics of conventional feed and weed based polyculture in ponds. Journal of Fisheries,2016:4(1):353-360.
4. Ali MM, Ali ML, Islam MS, Rahman MZ. Preliminary assessment of heavy metals in water and sediment of Karnaphuli River, Bangladesh. Environmental Nanotechnology, Monitoring and Management,2016a:5:27-35.
5. Ali MM, Ali ML, Islam MS and Rahman MZ. Assessment of toxic metals in water and sediment of Pashur River in Bangladesh. Water Science & Technology,2018:77(5):1418-1430.
6. Balarin JD, Halle RD. The Intensive Culture of tilapia in tanks, raceways and cages. In: recent advances in aquaculture, J. F. Muir and J. J. Roberts (Eds.). Westview Press, Boulder, Colorado,1982, 265-365.
7. Bhatnagar A and Devi P. Water quality guidelines for the management of pond fish culture. Int J Environ Sci,2013:3:1980-2009.
8. DoF. National Fish Week 2017 Compendium (in Bengali). Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh,2017, 160.
9. Fitzsimmons K, Martinez GR, Gonzalez AP. Why tilapia is becoming the most important food fish on the planet. Proceedings of the ninth international symposium on tilapia in aquaculture. Shanghai Ocean University, Shanghai, China,2011, 22-24.
10. Gupta MV, Ahmed MM, Bimbao A, Lightfoot C. Socio-economic impact and farmers assessment of nile tilapia (*Oreochromis niloticus*) culture in Bangladesh. ICLARM technical report no. 35, international center for living aquatic resources management, Manila, Philippines,1992, 50.
11. Hossain MA, Toyub MA, Islam MN, Hasan MR. Effect of species combination on the growth of major and Chinese carps in demonstration pond under Feni district. Bngladesh Agril. Sciences,1997:21(2):257-266.
12. Hossain MA, Hossain AA, Sultana N. Over-wintering growth of normal and mono-sex GIFT Tilapia, Oreochromis niloticus in Bangladesh fed on formulated diet. Journal of Aquaculture in the Tropics2005;20:271-286.
13. Hossain MA, Bhuiyan AS. Study of water quality in fish ponds under the red soil zone of northern Bangladesh. Journal of Subtropical Agricultural Development,2007:5(5):347-351.
14. Haque R. Growth and production performance of carps in different stocking densities of polyculture, MS Thesis, Department of Aquaculture, Bangladesh Agricultural University, My men singh,2010, 35.
15. Kadir A, Kundo RS, Milstein A and Wahab MA. Effects of silver carp and small indigenous species on the pond ecology and carp polyculture in Bangladesh. Aquaculture,2006:261:1065-1076.
16. Maclean JL. Tilapia the aquatic chicken ICLARM newsletter,1984, 12-17.
17. Macintosh DJ, Little DC. Brood stock management and fry production of the nile tilapia (*Oreochromis niloticus*). In: N.R. Bromage and R.J. Roberts, (Eds.). Brood fish management and egg and larval quality. Blackwell Science, Oxford,1995, 277-320.
18. Mazid MA, Zaher M, Begum NN, Ali MZ, Nahar F. Formulation of cost effective feeds from locally available ingredients for carp polyculture system for increased production. *Aquaculture*,1997;151:71-78.
19. Miah MS, Shahabuddin M, Shah MS. Effect of stocking ratio on the growth and production of fishes in mixed polyculture system. Bangladesh Journal of Fisheries,1997:20(1-2):135-138.
20. Miah MS, Shahabuddin M, Shah MS. Effect of fertilizers on the growth of fishes under carp polyculture system. Bangladesh Journal of Fisheries,1998:21(2):89-92.
21. Saha SB, Gupta MV, Hossain MG, Shaha MS. Growth

and survival of rohu (Labeo rohita) fry in rearing ponds at different stocking densities. Bangladesh Journal of Fisheries,1999:16(2):119-126.
22. Shelton WL. Tilapia Culture in the 21st Century P. 1-20. In the Proceedings of the International Forum of Tilapia Farming in the 21st Century (Tilapia Forum 2002), Gurrero RD III, Guerrero-Del Castillo MR (Eds.) Philippine Fisheries Association Inc. Los Bonos, Laguna, Philippines, 2002, 184.
23. Sagor MFH. Effects of different combinations of carp on pond ecology and fish production in carp Mola poly culture, MS Thesis, Department of Aquaculture, Bangladesh Agricultural University, My men singh, 2008.
24. Shahin J, Mondal MN, Wahab MA, Kunda M. Effects of addition of tilapia in carp-prawn- mola polyculture system. J Bangladesh Agril Univ,2011:9(1):147-157.
25. Sarker MR, Ali MM, Monir MS, Paul M, Barman AC. Growth and production performance of tilapia (*Oreochromis niloticus*) polyculture with carps in homestead pond. Marine Res Aqua,2014:2(1):1-6.