Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(3): 833-837

Received: 27-03-2017
Accepted: 28-04-2017

Md. Abdul Halim
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

MM Nabi
Deputy Director, Bangabandhu Academy for Poverty Alleviation and Rural Development (BAPARD), Kotalipara, Gopalgonj-8110, Bangladesh

S Nahar
Director, Bangabandhu Academy for Poverty Alleviation and Rural Development (BAPARD), Kotalipara, Gopalgonj-8110, Bangladesh

Correspondence
Md. Abdul Halim
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Study on optimization of stocking density of climbing perch (*Anabas testudineus*, Bloch 1792) in marginal farmer earthen ponds

Md. Abdul Halim, MM Nabi and S Nahar

Abstract

The present study was carried to optimize the stocking density of Vietnamese koi (*Anabas testudineus*) in marginal farmer earthen ponds in Kotalipara Upazilla under Gopalgonj district Bangladesh out from April to July 2015. Three stocking densities (treatments) were compared: ponds with 300, 350 and 400 individuals per decimal. All treatments (T_1, T_2 and T_3) were randomly imputed and in duplicate. SGR (%) value (2.01) was recorded in T_1 and the lowest (2.01) in T_3. The survival rates were 90±.20, 85±0.38 and 80±0.15 for T_1, T_2 and T_3 respectively. The FCR was 1.5±0.30, 1.75±0.35 and 1.85±0.14 in T_1, T_2 and T_3 respectively. The highest production was 6669.00 kg/ha in T_1, followed by T_2 (6246.63 kg/ha) and T_3 (6086.08kg/ha) respectively. The highest benefit or net return for T_1 Tk. 325941.40/ha and BCR of 1.54 followed by Tk. 146172.13/ha and BCR value of 1.22 in T_2 and Tk. 96171.92/ha and BCR value of 1.13 in T_3. The stocking density of 300 individuals per decimal was the most profitable system. More research will be needed to further optimize stocking density of Vietnamese koi in marginal farmer earthen ponds.

Keywords: Stocking density, optimization, Vietnamese koi, Marginal farmer

1. Introduction

The climbing perch fish *Anabas testudineus* (Bloch) is one of the important freshwater small indigenous fish of Bangladesh [3]. It is locally known as koi. Because it is very popular for its delicious taste and flavor [3]. It is found in paddy fields, haors, baors, ponds, swamps, marshes and canals. It can withstand harsh environmental conditions such as low oxygen, wide range of temperature and other poor water conditions [16]. The fish contain high values of physiologically available iron and copper essentially needed for hemoglobin synthesis [31]. In late 1980s, the number of this fish have drastically reduced from open waters due to environmental degradation, over fishing, use of large amount of pesticides, herbicides and fertilizers, destruction of suitable habitats, obstruction to breeding migration, poor management etc. In the face of diminishing natural population of climbing perch-planners, policy makers, aqua culturists, and fisheries biologists are thinking of its cultivation through intensive farming [14]. Indiscriminate destructive practices have caused havoc to aquatic biodiversity [17]. It contributes 1.4% in the total inland water fish production [15]. Recent studies suggest that worldwide 20% of all fresh water species are extinct, endangered or vulnerable [26]. International Union of Conservation of Nature [18] enlisted *A. testudineus* as not threatened perch fish in Bangladesh. But due to rough and unplanned water management policy for irrigation, over exploitation, illegal practice of capture fisheries and various ecological changes in its natural habitat; this native species is threatened now [9]. Considering the importance of this species in nutritional, economics and biodiversity point of view, it is required to develop an appropriate culture technique of *A. testudineus*. Keeping these in view, seed production technology through artificial propagation was developed in captive condition by the Bangladesh Fisheries Research Institute. But in culture aspects, the growth rate of native strain is very slow in ponds ecosystem [21]. To improve this situation, another variety of koi known as Vietnamese koi (*A. testudineus*) have been imported from Vietnam in 2013 by Sarnolata Agro Fisheries Ltd [3]. Induced breeding was proved helpful to get the seeds at large scales. The seedlings thus obtained were used for rearing in ponds in different regions of the country. But to standardize the culture technology with a view to get maximum growth, yield and economic benefit experiments were conducted through a designed manner and the results are worthy for publication. Now days farmers have been cultured this species with high stocking densities to earn more profit. But they have been unable to earn more profit. Because various problems (diseases, oxygen depletion, increase ammonia gas etc) have been occurred due to high stocking densities. For this purpose this experiment has been undertaken to optimize stocking densities of *A. testudineus* in marginal farmer earthen ponds. So that farmers achieve more knowledge about stocking densities and obtain more profit.

2. Materials and Methods

2.1 Experimental site and pond facilities

The present experiment was carried out for a period of 120 days from April to July 2015, in nine experimental ponds have been located in nine villages in Kotalipara Upazilla (located at 22.9833°N 89.9917°E) under Gopalgonj distract. The ponds were same in size (30±0.15 dec.) and similar in shape and depth.

2.2 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. Four days after liming the ponds were manured with cow dung at the rate of 2 kg/decimal. One week after liming the ponds were filled with water and fertilized with urea and TSP at the rate of 100 gm/decimal and 50 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).

2.3 Collection of experimental fish and stocking

All the tilapia fingerlings with mean initial weight of 9±0.15 g were collected from Sarnolata Agro Fisheries Ltd hatchery, Sadar Mymensingh and stocked densities for were compared: ponds with 300, 350 and 400 individuals per decimal.

2.4 Experimental design

The experiment was carried out with three treatments (T_1, T_2 and T_3) each with three replications.

2.5 Feeding

Fertilization was done weekly in the ponds of all treatments at the same rate (cow dung, 1 kg/dec; urea, 100g /dec and TSP, 50 g/dec). Supplemental feeds (commercial pellet floating Mega feed containing 30% protein) were given in all treatments. The feed was applied at the rate of 20% of the body weight of fishes at the beginning of the experiment and then it was reduced to 15% after one month and 10-3% after periods. Feed was applied twice a day, half in the morning (9.00 am) and the rest in the afternoon (4.00 pm). The feeds were gently thrown over the ponds water on a particular site of the ponds regularly.

2.6 Sampling

Five percent of the total fish were sampled at 15 days interval by a cast net to monitor the fish growth and to adjust feeding ratio. The weight of fish during sampling was measured by using a portable digital balance.

2.7 Water quality parameters

Physico-chemical parameters of pond water were monitored every 15 days interval between 9.00 and 10.00 h. Water temperature was recorded using a Celsius thermometer and transparency (cm) was measured by using a Secchi disc of 20 cm diameter. Dissolved oxygen and pH were measured directly using a digital electronic oxygen meter (YSI, Model 58, USA) and an electronic pH meter (Jenway, Model 3020, UK). Total alkalinity was determined by titrimetric method [7]. Total ammonia of water samples was determined with the help of a Hach Kit (Model DR 2010, USA).

2.8 Economic analysis

An economic analysis was carried to estimate the net profit from different treatments. The analysis was based on local market prices for harvested fish and all other items. The costs of fingerlings, fertilizer and supplemental feeds are shown in Table 3. The cost of leasing ponds was not included in the total cost. An additional 7.5% on total cost was included as operational cost [1]. The net return was measured by deducting the gross cost from the gross return per decimal. The benefit cost ratio was also measured as a ratio of net benefit to gross cost.

2.9 Statistical analysis

Computer analysis of the data was done by using MS excel, SPSS (Statistical Package for Social Science) version-20. Significance was assigned at 0.05% level.

3. Result

3.1 Water quality parameters

Water quality parameters like air temperature, water temperature, water pH, soil pH, dissolved oxygen, ammonia, transparency and total alkalinity were observed at 15 days interval throughout the study period (Table 1.).

Table 1: Water quality parameters observed during the experimental period.

Parameters	Treatments		
	T_1	T_2	T_3
Air temperature (^{0}C)	29.1±2.15	29.5±1.45	30±2.82
Water temperature (^{0}C)	28.25±1.30	28.25±0.50	29.5±1.41
Water pH	8.50±0.25	8.45±0.20	7.70±0.25
Soil pH	6.10±0.70	6.6±0.07	5.75±0.07
DO (ml/L)	4.90±0.60	4.95±0.38	3.85±0.21
Ammonia	0.25±0.25	0.50±0.25	1±0.25
Transparency	28.50±0.45	30±0.25	31.50±0.35
Total alkalinity	180.5±1.40	182.5±1.37	183.40±7.53

3.2 Production performance

The mean production of koi fish was 6669.00, 6246.63 and 6086.08 kg/ha in T_1, T_2 and T_3, respectively. A. *testudineus* production was higher in T_1 and lowest in T_3. However, total production of A. *testudineus* differed significantly (>0.05) among the three treatments (Table 2). On the other hand, cost of production in treatment T_3 was consistently higher than treatments T_2 and T_1 (Table 2). Highest net benefit was recorded in T_1 (325941.40 Tk.) followed by T_2 (146172.13 Tk.) and T_3 (96171.92 Tk.) /ha respectively. It was found that the weight (kg/ha) had been obtained 100.5±1.80 g for T_1, stocking with 74100 individuals/ha, while the fish attained 85±2.10 g in weight in T_2 stocking with 86450 individuals/ha and 77.5±2.83 g in weight in T_3 with stocking 98800 individuals/ha (Table 2). The growth rate in treatment T_1 was higher than treatment T_2 and T_3. SGR in treatment T_1 (2.01) was significantly higher than T_2 (1.78) and T_3 (1.69) and was significantly different (>0.05) (Table 2). SGR (%) value of different treatments were shown in (Figure 1) during culture periods. The data were represented 15 days intervals. FCR was comparatively higher in treatment T_3 (1.85±0.14) than T_2 (1.75±0.35) and T_1 (1.5±0.30) respectively (Table 2). The highest survival rate was observed in T_1 (90±.20), T_2

(85±0.38) and T_3 (80±0.15) respectively. There was a significant variation (>0.05) in the survival rate in A. *testudineus* among different treatments (Table 2).

Table 2: Growth and production of koi (A. *testudineus*) were observed in different treatments during the experimental period.

Parameters	Treatments		
	T_1	T_2	T_3
Ponds area (dec.)	30±0.05	30±0.05	30±0.05
Stocking densities (No./dec.)	300	350	400
Initial weight (gm)	9±0.15	9±0.15	9±0.15
Culture duration (days)	120	120	120
Final weight (gm)	100.5±1.80	85±2.10	77.5±2.83
Weight gain (gm)	91.5±1.65	76±1.95	68.5±2.68
% Weight gain	1016.67	844.44	761.11
FCR	1.5±0.30	1.75±0.35	1.85±0.14
SGR (%)	2.01	1.78	1.69
Survival rate (%)	90±.20	85±0.38	80±0.15
Production (Kg/Dec)	27.00	25.29	24.64
Production (Kg/ha)	6669.00	6246.63	6086.08

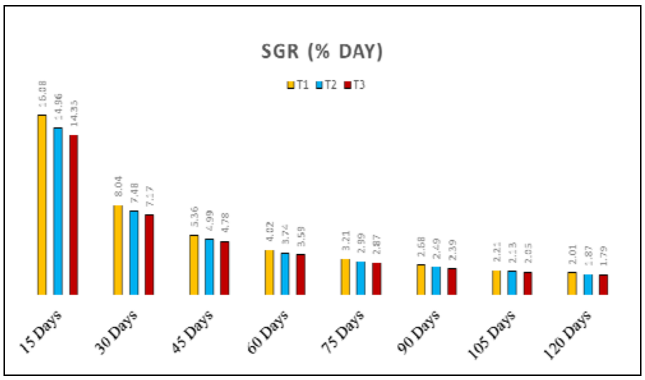

Fig 1: Specific Growth Rate (SGR% Day) during culture periods.

Table 3: Economic analysis for koi production in ponds reared for 120 days

Components	Treatments		
	T_1	T_2	T_3
Expenditure (Tk/dec.)			
Fingerlings cost	300.00	350.00	400.00
Feed cost	1822.50	1991.58	2051.28
Lime cost (15 Tk/kg)	41.25	41.25	41.25
Cow dung	10.00	10.00	10.00
Urea	20.00	20.00	20.00
TSP	45.00	45.00	45.00
Medicine	50.00	50.00	50.00
Operational cost	171.65	188.08	196.31
Total expenditures (Tk/dec.)	2460.40	2695.91	2813.84
Total expenditures (Tk/ha)	607718.80	665889.77	695018.48
Income			
Gross return (Tk/dec.)	3780.00	3287.70	3203.20
Net return (Tk/dec.)	1319.60	591.79	389.36
Net return (Tk/ha)	325941.40	146172.13	96171.92
BCR (Benefit Cost Ratio)	1.54	1.22	1.13

Sale price of koi = Taka 140.00/ kg. (100 g/Piece).
Sale price of koi = Taka 130.00/ kg. (75-85 g/Piece).
Commercial feed= Taka 45.00/ kg.
Leasing cost for pond is not included.
Operational cost is considered as 7.5% of total cost [1].

4. Discussion

In the present study water quality parameters like air temperature, water temperature, water pH, soil pH, DO (dissolve oxygen), ammonia, transparency and total alkalinity were maintained at suitable range as following the technique provided by [4, 22]. It was found that water temperature were T_1 (28.25±1.30 ^{0}C), T_2 (28.25±0.50 ^{0}C) and T_3 (29.5±1.41 ^{0}C) which report was similar [6, 24, 26, 27, 29]. The range of water temperature from 26.06 to 31.97°C is suitable for fish culture [5]. The water pH value of three treatments were T_1 (8.50±0.25), T_2 (8.45±0.20) and T_3 (7.70±0.25) respectively. The pH from 6.5 to 9.0 is suitable for pond fish culture and pH more than 9.5 is unsuitable [30]. Different authors have reported a wide variations in pH from 7.18 to 7.24 [24], 7.03 to 9.03 [29], 6.8 to 8.20 [6] and 7.50 to 8.20 [8] in fertilized fish ponds and found the ranges to be productive. The DO (dissolve oxygen) of three treatments were T_1 (4.90±0.60), T_2 (4.95±0.38) and T_3 (3.85±0.21) respectively which was similar [24, 27, 28, 32]. The amount of DO (dissolved oxygen) has been reduced in the morning hours in all treatments. This phenomenon may be attributed with suspension of photosynthetic activity in the night time as have been reported by [5, 9]. The variations in total alkalinity in all the treatments were found in productive range for aquaculture ponds [5, 23, 25, 33]. Transparency was comparatively higher in treatment T_3 (31.50±0.35) than T_2 (30±0.25) and T_1 (28.50±0.45) respectively due to the reduction of the plankton population by high density of fishes and use of lime [4, 5].

The growth rates of *A. testudineus* under different stocking densities are shown in Table 3. On the basis of mean final weight attained under T_1, T_2 and T_3 were 100.5±1.80, 85±2.10 and 77.5±2.83 g respectively. The highest growth was obtained in T_1 and lowest in T_2. Higher growth rate was attained at lower stocking densities and vice versa which has the similarity with the findings of some authors [19, 24]. Growth in terms weight, weight gain and SGR of koi, A. *testudineus* was significantly higher in T_1, where the stocking density was different compared to those of T_2 and T_3 and same food was supplied in all the treatments at an equal ratio, which is in agreement with the findings [12, 13]. SGR in treatment T_1 (2.01) was higher than T_2 (1.78) and T_3 (1.69). There was no significant difference (<0.01) among the different treatments. The average values of specific growth rate of Vietnamese koi were observed as 2.59%, 2.56% and 2.56% in treatments T_1, T_2 and T_3 respectively [3]. In the present study it was found that stocking densities directly affect the survival rate (%) of *A. testudineus*. The highest survival (90±.20) was obtained in T_1 where the density was 74,100 individuals/ha and the lowest (80±0.15) was obtained in T_3, the density was 98,800 individuals/ha (Table 3) (>0.05). It was more or less similar with the findings [24]. FCR value of T_1, T_2 and T_3 were 1.5±0.30, 1.75±0.35 and 1.85±0.14 respectively. FCR value of T_1 was obtained to be significantly lower than T_2 and T_3. It was more or less similar [10, 11, 20]. The production of *A. testudineus* for T_1, T_2 and T_3 were 6669.00, 6246.63 and 6086.08 kg/ha and which showed in significant difference among the treatments. The study was evaluated the production potentials of Koi in monoculture management at the density of 16,000/ha and obtained a production of 450 kg/ha in five moths rearing [2]. The highest production was observed to be 6175 Kg/dha/90 days in treatment T_3, 5434 Kg/ha/90 days in treatment T_2 and the lowest production was observed to be 4446 Kg/ha/90days in treatment T_1 at stocking densities 150, 250 and 350 fries/dec and designated as treatment T_1, T_2 and T_3 respectively [3]. The cost of production was higher in T_3 (695018.48 Tk/ha) lower than T_2 (665889.77 Tk/ha) and T_1 (607718.80 Tk/ha). The net profit generated from 120 days culture period was calculated as 325941.40 Tk/ha, 146172.13 Tk/ha and 96171.92 k/ha for T_1, T_2 and T_3

respectively. The highest net profit of BDT 325941.40 Tk/ha was obtained from T_1 where *A. testudineus* stocked in 74100 individuals/ha. It was found that the highest net profit was BDT 32,690 in T_1 followed by BDT 36,104 in T_2 and BDT 38,450 in T_3 [3]. The highest benefit or net return for T_1 Tk. 325941.40/ha and BCR of 1.54 followed by Tk. 146172.13/ha and BCR value of 1.22 in T_2 and Tk. 96171.92/ha and BCR value of 1.13 in T_3. The benefit cost ratio was 1.7, 1.63 and 1.56 in T_1, T_2 and T_3 respectively [3].

5. Conclusion

The present study indicated that comparatively highest production was found in treatment T_1 which received lower stocking density (300 fish/dec). From the research it might be suggested that the farmers should maintain stocking density. Because it is very important for any fish culture. The more study will be needed to optimizes stocking densities of Vietnamese koi at marginal farmer earthen ponds.

6. Acknowledgement

The authors express their sincere thanks to the fish farmers in Kotalipara Upazilla Mastho Shammobye Samithi and Upazilla Fisheries Officer for providing valuable information to accomplish this experiment successfully.

7. References

1. ADCP. Fish Feeds and Feeding in Developing Countries. Aquaculture Development and Co-Ordination Programme. ADCP/ REP/ 83/ 18. FAO. 1983, 97.
2. Akhteruzzaman M. A Study on the Production of Koi Fish (*Anabas Testudineus*) under Semi-Intensive Culture System. Journal of Zoology. 1988; 3:39-43.
3. Ahmed GU, Rahman MM, Alam MN, Alam MB, Sarker B. Impact of Stocking Density on Growth and Production Performance of Vietnamese Koi (A*nabas Testudineus*) In Semi Intensive Culture System at Muktaghasa Region of Mymensingh District. Research Agriculture Livestock and Fisheries. 2015; 2(2):335-341.
4. Boyd CE. Water Quality in Warm Water Fish Ponds, 369. Auburn: Alabassed Agricultural Experiment Station, 1979.
5. Boyd CE. Water Quality Management for Pond Fish Culture, 318. The Netherlands, Elsevier, 1982.
6. Begum M, Hossain MY, Wahab MA, Kohinoor AHM. Effects of Isophosphorus Fertilizers on Water Quality and Biological Productivity in Fish Pond. Journal of Aquaculture in the Tropic. 2003; 18(1):1-12.
7. Clesceri LS, Greenberg AE, Trussell RR. Standard Methods of the Examination of Water and Wastewater, 17th Ed, 10–203. Washington: American Public Health Association, American Water Works Association and Water Pollution Control Federation, 1989.
8. Chakraborty BK, Miah MI, Mirza MJA, Habib MAB. Growth, yield and returns to *Puntius sarana* (Hamilton) Sharpunti, in Bangladesh under semi intensive aquaculture. *Asian Fisheries Science,* 2005; 18:307-322.
9. Chakraborty BK. Status and Position of Aquatic Biodiversity of Four Beels and Its Floodplain Level of Northern Bangladesh with a Good Practice of Beel Nurseries and Community Based Co-Management Policy. In Advances in Environmental Research, Ed. Justin A. Daniels, 121–164. New York: Nova Science Publishers, 2010, 8.
10. Chakraborty BK, Haque SM. Growth, Yield and Returns to Koi, *Anabas testudineus* (Bloch, 1792) under Semi Intensive Aquaculture System Using Different Seed Types in Bangladesh. Journal of Fisheries and Livestock Production. 2014; 2:1.
11. Das I, Ray AK. Growth Performance of Indian Major Carps *Labeo rohita* (Ham.) on Duckweed Incorporate Pelleted Feed: A Preliminary Study. Journal of Inland Fisheries.1989; 21:1-6.
12. Diana JS, Lin CK, Jaiyen K. Supplementary Feeding of Tilapia in Fertilized Ponds. Journal of World Aquaculture Society.1994; 25(4):497-506.
13. Dan NC, Little DC. The Culture Performance of Monosex and Mix-Sex New-Season and Over Winter Fry in Three Strains of Nile Tilapia (*Oreochromis niloticus*) in Northern Vietnam. Aquaculture. 2000; 184:221-231.
14. DoF (Department of Fisheries). Fisheries Fortnight' 02 Compendium. Department of Fisheries, Ministry of Fisheries and Livestock, Government of the People's Republic Of Bangladesh, Dhaka, 2002, 87.
15. DoF. Fisheries Statistical Yearbook of Bangladesh (July 2011-June2012), Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh, 2012.
16. Habib MAB, Hasan MR. Evaluation of Dietary Protein and Lipid Requirements of Climbing Perch, *Anabas Testudineus*. Proc. BAU Research Progress, 1994; 8B:340-347.
17. Hussain MG, Mazid MA. Genetics Improvement and Conservation of Carp Species in Bangladesh. Mymensingh: Bangladesh Fisheries Research Institute, 2001, 56.
18. IUCN. Red Book of Threatened Fish of Bangladesh. The World Conservation Union Appendix 1, 2000, 61.
19. Islam MA, Chowdhury MY, Karim R. A Comparative Study of Some Chemical Factors and the Growth of Major Carps in Ponds. Bangladesh Journal of Aquaculture. 1978; 1:66-73.
20. Islam MS, Dewan S, Hussain MG, Hossain MA, Mazid MA. Feed Utilization and Wastage in Semi-Intensive Pond Culture of Mahseer, *Tor putitora* (Ham.). Bangladesh Journal of Fisheries Research. 2002; 6:1-9.
21. Kohinoor AHM, Akhteruzzaman M, Hussain MG, Shah MS. Observations on the Induced Breeding of Koi Fish, *Anabas Testudineus* (Bloch) in Bangladesh. Bangladesh Journal of Fisheries. 1991; 14(1-2):73-77.
22. Kohinoor AHM, Hossain MA, Hussain MG. Semiintensive Culture and Production Cost of Pabda (*Ompok pabda*) with Rajputi (*Puntius gonionotus*) and Mirror Carp (*Cyprinus carpio* var *specularis*) in Mini Ponds. Bangladesh Journal of Zoology. 1997; 25:129-133.
23. Kohinoor AHM, Islam ML, Wahab MA, Thilsted SH. Effect of Mola (*Amblypharyngodon mola* Hamilton) on the Growth and Production of Carps in Polyculture. Bangladesh Journal of Fisheries Research. 1998; 2(2):119-126.
24. Kohinoor AHM, Islam AKMS, Jahan DA, Zaher M, Hussain MG. Monoculture of Climbing Perch, Thai Koi, *Anabas testudineus* (Bloch) under Different Stocking Densities at On-Farm. Bangladesh Journal of Fisheries Research. 2007; 11:173-180.
25. Kohinoor AHM, Jahan DA, Khan MM, Ahmed SU, Hussain MG. Culture Potentials of Climbing Perch, *Anabas testudineus* (Bloch) under different Stocking Densities at Semi-Intensive Management. Bangladesh Journal of Fisheries Research. 2009; 13(2):115-120.
26. Moyle PL, Leidy RA. Loss of Biodiversity in Aquatic

Ecosystem: Evidence from Fish Fauna. In *Conservation of Biology: The Theory and Practice of Nature Conservation, Preservation and Management*, Ed. P.L. Fielder, And H.L. Jani, New York: Chapman and Hall, 1992, 562.

27. Mondal MN, Shahin J, Wahab MA, Asaduzzaman M, Yang Y. Comparison between Cage and Pond Production of Thai Climbing Perch (*Anabas testudineus*) and Tilapia (*Oreochromis niloticus*) under Three Management Systems. Journal of Bangladesh Agricultural University. 2010; 8(2):313-322.
28. Rahman MS, Chowdhury MY, Haque AKMA, Haq MS. Limnological Studies of Four Ponds. Bangladesh Journal of Fisheries. 1982; 2-5(1, 2):25-35.
29. Roy NC, Kohinoor AHM, Wahab MA, Thilsted SH. Evaluation of Performance of Carp-SIS Polyculture Technology in the Rural Farmer's Pond. Asian Fisheries Science. 2002; 15:41-50.
30. Swingle HS. Standardization of Chemical Analyses for Waters and Pond Muds. FAO Fish. 1967; 4(4):397-421.
31. Saha KC. Fisheries of West Bengal. West Bengal Government Press, Alipore, West Bengal, 1971.
32. Wahab MA, Ahmed ZF, Haq MS, Begum M. Compatibility of Silver Carp in the Poly Culture of Cyprinid Fishes. Progressive Agriculture. 1994; 5(2):221-227.
33. Wahab MA, Ahmed ZF, Islam MA, Rahmatullah SM. Effect of Introduction of Common Carp, *Cyprinus Carpio* (L), of the Pond Ecology and Growth of Fish in Polyculture. Aquaculture Research. 1995; 26:619-628.