Periphyton Based Climate Smart Aquaculture for the Farmers of Indian Rural Sunderban Areas

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ABSTRACT

Periphyton is the complex of sessile aquatic biota with associated detritus, attached to submerged substrates. A possibility of regular income generation through traditional farming is limited due to small land holding, soil salinity, frequent attacks of cyclones like 'Aila', floods, seawater inundation, agricultural practices without scientific knowledge and crop failures due to pests and diseases. The area is exposed to harsh agro-climatic situations leading to frustration, abandoning farming, migration of farming communities seeking better livelihood opportunities, shift to alternate income earning opportunities etc. In this backdrop, 'different approaches in fisheries modules are envisaged as an effective tool to create examples before the farmers so that they become able to tap their own resources for sustainable income generation and to enhance their livelihood security. The units may be of different types depending on the resources and capacity of the farmers. Considering superior periphyton growth on bamboo was used as the substrate. This material is too expensive in South-Asia for resource-poor farmers. Therefore, cheap alternatives for the bamboo substrate have opted like nylon nets. 37 species were identified from the periphyton patches and it showed that the water temperature also less fluctuating in periphyton cultured based ponds compared to the farmers' practice. The present study was mainly emphasis on tilapia culture at Sundarban water. Rearing management systems assessed were: fertilization alone (FA), combined fertilization-feeding (FF), fertilization periphyton (FP) and fertilization-compost application (FC) in triplicate ponds. Soaked mustard cake was used as a fertilizer @ 100 kg ha^{-1} at 15-day intervals in all the treatment ponds. Formulated crumble diet containing 29.7 per cent protein and 4.9 per cent lipid was used as a supplementary feed in FF. Bamboo poles were used as substrates (equivalent to 10% of pond surface area) to facilitate periphyton growth in FP and composted aquatic weed was applied @ 500 kg ha^{-1} in FC at monthly intervals. Ponds were stocked with grey mullet fry (3.36 ± 0.32 g/ 63.70 ± 4.61 mm) at 30,000 number ha^{-1}.Cost of cultivation was found to be significantly reduced in the case of periphyton technology and this reduction was 31.25 per cent to 37.09 per cent higher in comparison to the fertilizer and feed. The net return of periphyton technology was found to be 45 per cent to 58 per cent higher than fertilizer alone experiments.

Key words: *Periphyton; Tilapia; Climate change; Brackish water; Indigenous species;*

The effects of climate change on fish and fisheries are occurring perhaps most strongly in tropical coastal habitats. Climate change is affecting the fisheries and aquaculture sector by modulation of physiology, behaviour, distribution and migration pattern, reproductive capacity and mortality (*Ghosh, 2017*), The present study was conducted to examine the performance of the periphyton based climate-smart aquaculture in Indian Sundarban region. Utilizing different submerged substrates, development and utilization of periphyton which is a complex of microalgae, microscopic organisms and rubbish to change over into angle biomass have been widely assessed in freshwater aquaculture, especially in carps (*Wahab et al., 1999; Keshavanath et al., 2001; Azim et al., 2002*), tilapia (*Asaduzzaman et al., 2009*), catfish (*Amisah et al., 2008*) and monster freshwater prawn (*Asaduzzaman et al., 2008*). Essentially, periphyton usage was additionally tried for mullets, for occurrences, M. cephalus performed better in inland saline groundwater ponds (*Jana et al., 2004*). Notwithstanding the commitment of periphyton to angle biomass, the submerged substrates added to oceanic framework enhance water quality by catching suspended solids and accordingly upgrade nitrification *(Ramesh et al., 1999; Thompson et al., 2002*). In any case, with regards to expanding cost of fish feed, eutrophication because of natural load in angle ponds and supportability issue, the opportunity has already come and gone to investigate the technique that saddles common efficiency. For this reason, natural info based frameworks would be suitable eco-accommodating techniques. In such manner, treated the soil oceanic weed as ease cultivate made natural fertilizer could be a viable option as usually utilized as a part of customary aquaculture ponds in Indian Sundarbans. Another condition well-disposed and unusual normal feed supplementation framework, generation and use of periphyton are an ongoing idea in aquaculture. Albeit different works showed the advantages of periphyton or treatment framework in angle fingerling rising, there is a lack of data on the similar execution of periphyton framework with other option shabby natural information-based frameworks. In various cultivating situations, notwithstanding characteristic nourishment life forms, the majority of the fishes acknowledge supplementary feed (*Curian, 1975; Luzzana et al., 2005*). Use of various natural excrements and inorganic manures impacted the regular nourishment living beings and effectible affected development of this fish amid cultivating in the pond (*Bishara, 1978*). In this specific circumstance, the present investigation goes for looking at development, survival and life form condition pointers alongside hydro biological parameters and financial returns for various pond administration frameworks (treatment alone, joined preparation bolstering, treatment periphyton and preparation natural manure application) amid fingerling creation Indian Sundarban which is constantly influenced by the regular disasters like ocean level rising, high saline inefficient lands. The display shrewd innovation has the primary intend to lessen the cultivating input cost and increment the profitability through common sustaining.

METHODOLOGY

Experimental site and design: The analysis was directed for a time of 180 days in the Gosaba Island Sundarban, West Bengal, India. Twenty rectangular earthen ponds (600 m^2 each) were utilized. Five raising frameworks tried in this analysis shaped four medications: preparation alone (FA), consolidated treatment nourishing (FF) and preparation periphyton (FP). Every treatment had three duplicate ponds which were haphazardly doled out between medicines. The stocking thickness of each fish propelled sear 15,000 number ha-1.

Pre-stocking pond management : The ponds were sun-dried and after that farming lime (CaCO3) was connected to every pond base at 300 kg ha^{-1}(day 1). Following 3 long stretches of lime application, ponds were loaded with dyed water (300kg ha^{-1}). On day 5, every one of the ponds were prepared with mustard cake (4.84% aggregate nitrogen, N; 2.06% aggregate phosphorus, P; 1.32% aggregate potassium, K on dry weight premise), urea (46% accessible N) and single superphosphate (16% accessible P) at 200, 20 and 20 kg ha^{-1}, individually. At that point the ponds were left for 5 days to permit development of characteristic fish sustenance living beings and the water level was at long last expanded to 150 cm on day 10. On day 11, semi-dried bamboo shafts (2 m long; 10 cm dia) were raised vertically on the pond base in FP treatment ponds to go about as substrates for periphyton development. Submerged surface territory of bamboo shafts was ascertained and as needs be, 2650 number ha^{-1} were utilized to give an additional surface region proportional to 10 per cent of pond surface. Treated the soil amphibian weed (2.27% N, 0.16% P and 2.92% K) was connected at 500 kg ha^{-1} to all the reproduce ponds of FC treatment in five nylon net sacks set at four corners and center of ponds. The net packs were attached to vertically determined bamboo shafts to permit draining and managed arrival of supplements. For the readiness of fertilizer, sea-going weeds (*Chara* sp. what's more, *Enteromorpha* sp.) were gathered from KVK cultivate and treated the soil for multi month following the Indore technique (*Howard and Wad, 1931, Biswas, 2017*) with a slight change. An earthen pit (L×B×D:2×1.5× 1.5 m) was loaded with gathered crude weeds in layers of 25– 30 cm. Between two layers, beforehand arranged manure blend was connected at 5 cm thickness. A last layer of weed was kept to finish everything. The pit was secured with sodden gunny packs and water was sprinkled at 4-day interims. At an interim of 10 days, compost materials were flipped around to guarantee appropriate deterioration. On day 20, ponds were supplied with angles propelled sear pre-accustomed to cultivate conditions for 30 days in a pre-nursery pond.

Post-stocking pond management : In the wake of stocking, every one of the ponds under various medicines were prepared fortnightly with mustard cake at 100 kg ha^{-1}. This was done to wipe out the impact of preparation from different medicines and empower FR to go about as the control. The mustard cake was splashed medium-term and weakened with pond water before application. Horticultural lime at 100 kg $ha^{-1}$was connected multi day before mustard cake application all through the raising time frame to keep pH level inside an alluring extent. In FF treatment ponds, defined disintegrate eat less carbs (1 mm) was utilized as a supplementary feed gave in sustaining plate. Every day apportion was conveyed in two equivalent suppers early in the day (0900 h) and evening (1500 h). Proximate organization of feed decided (*AOAC, 1995*) as per cent dry issue was as per the following: natural issue (84.5), unrefined protein (CP: 29.7), lipid (L: 4.9), rough fiber (CF: 9.2), corrosive insoluble slag (4.1) and without nitrogen separate (45.3). Feed amount was balanced at 15-day interims in view of an expected biomass from arbitrary examples of 15 per cent loaded fish. Encouraging rate was kept at 10– 4 per cent of the evaluated angle biomass at a diminishing request. In FC treatment ponds, packs containing treated the soil oceanic weed were supplanted at 30-day interims. Pond water profundity was kept up at 150 cm in the wake of remunerating leakage and dissipation loss of water amid high tide at month to month interims.

Determination of water quality parameters : At 15-day interims, water temperature, saltiness, pH, broke up oxygen (DO), nitrate-nitrogen (NO_2-N), nitrate nitrogen (NO_3-N), add up to ammonia-nitrogen (TAN), phosphate-phosphorus (PO_4-P), net essential efficiency (GPP), net essential profitability (NPP) and chlorophyll-a were estimated from pond water tests gathered in the vicinity of 09:00 and 10:00 h following standard techniques (*APHA, 1998*), and saltiness were recorded utilizing a refract meter (ATAGO, Japan). Tiny fish tests were gathered month to month by separating 50 L of water through shooting silk microscopic fish net (work estimate 50ìm). Tiny fish concentrates were instantly safeguarded in 5 per cent cushioned formalin for assist subjective and quantitative investigation following direct evaluation strategy (*Jhingran et al., 1969*) utilizing a Sedgewick-Beam tallying cell.

Estimation of the chlorophyll-a content of water and periphyton biomass from a substrate: Estimation of chlorophyll-a (Chl-a) shade in water and periphyton in FP ponds was completed at fortnightly interims according to standard strategies (*APHA, 1998*). The periphyton biomass as dry issue (DM) and chlorophyll-a substance were resolved. From every pond, three bamboo posts were arbitrarily chosen, and 2×2 cm^2 tests of periphyton were gathered by rejecting (*Anand et al., 2013*). After example accumulation, the bamboo shafts were supplanted in their unique positions, checked and avoided from consequent samplings. The rejected material from every bamboo post was then moved into a pre-weighed and named pot, dried at 105°C and kept in desiccators until weighed.

Fish performance evaluation : Gravimetric data of fish were collected fortnightly throughout the experimental period. Total length (TL, mm) was recorded with a slide caliper, while body weight (W, g) was measured using a digital electronic balance. Daily weight gain (DWG) is a function of weight and time and was estimated for each replicate pond with the formula:

$$DWG = \frac{WF - Wi}{t}$$

Where, Wf and Wi are the average final and initial weight in time t.

Specific growth rate (SGR) was calculated using the conventional equation:

$$SGR = in\ Wf - \frac{in\ W}{t} \times 100$$

Where, Wf and Wi are the average final and initial weight in time t.

The mathematical relationship between length and weight was calculated using the conventional formula (*Pauly, 1984*):

$$W = {}_{a}TL^{b}$$

Where W is fish weight (g), TL is total length (mm), a is the proportionality constant and b is the isometric exponent. The parameters a and b were estimated by non-linear regression analysis.

Fulton's condition equation was used to find out the condition factor (*Chow and Sandifer, 1991*):

$$K = \frac{\overline{w}}{(TL)^3} \times 10^5$$

Where K is the condition factor, w is the average weight (g) and TL is the average total length (mm).

Final average body weight (ABW, g) and length (AVL, mm), survival (%) and total biomass produced (kg) were estimated after harvest by drag netting and dewatering the ponds finally.

Economic analysis: A financial examination to contrast the medicines was performed and estimation of the net return and advantage cost proportion (BCR) according to the techniques depicted by *Biswas et al., 2012.*

Statistical analysis: Contrasts in definite length, weight, DWG, SGR, survival, isometric type (b) of LWR and monetary returns among medicines were controlled by one-route ANOVA with the General Linear Model technique utilizing SPSS for Windows v.17.0 program (SPSS Inc., Chicago, IL, USA). Duncan's Multiple Range Test (*Duncan, 1955*) was utilized for examination of medicines. Measurable essentialness of b was broken down to assess the LWR in every treatment utilizing t-test (*Snedecor and Cochran, 1967*). All information are communicated as mean ± standard mistake (S.E.).

RESULTS AND DISCUSSION

Water quality parameters : Water quality parameters of the test ponds are exhibited in Table 1. All the deliberate parameters contrasted essentially ($P<0.05$) between the raising frameworks with the exception of temperature, pH and saltiness. Temperature shifted in the vicinity of 32.3 and 26.4°C, and saltiness extended in the vicinity of 9.3 and 3.17 ppt all through the investigation time frame. The most elevated estimation of temperature was recorded in August and the least was in November. In spite of the fact that, pH level was higher in FP (8.38 ± 0.31), it was not unique ($P>0.05$) from that of different medicines. Reconciliation of treatment with nourishing (FF) and fertilizer application (FC) fundamentally ($P<0.05$) lessened broke up oxygen (DO) focus, though a critical increment ($P<0.05$) was seen in fertilization periphyton framework (FP). Mean estimation of NO_2-N was fundamentally the most minimal ($P>0.05$) in FP (36.71 ± 6.63 μg L^{-1}) trailed by that in FR (43.75 ± 3.83 μg L^{-1}), FC (48.09 ± 6.07 μg L^{-1}) and FF (54.61 ± 10.62 μg L^{-1}). NO3-N remained essentially lower ($P<0.05$) in FP (175.77 ± 8.94 μgL^{-1}) and the most astounding quality was seen in FF (279.46 ± 11.14 μg L^{-1}), in any case, values in FC and FR were not fundamentally unique ($P>0.05$). Also, the most minimal estimation of TAN was seen in FP (174.89 ± 36.27 μg L^{-1}) which was altogether extraordinary ($P< 0.05$) from that of different medications and the highest mean esteem was recorded in FC (253.17 ± 66.52 μg L^{-1}). PO4-P fixation was lessened by 18.88 per cent in FP and expanded by 27.46 and 9.54 per cent in FF and FC, individually contrasted with that of FR. The most reduced estimations of GPP and NPP were recorded in FP (192.42 ± 12.90 and 111.34 ± 8.3 mg C $m^{-3}h^{-1}$) and

Table 1.Effects of fertilization (FR), combined fertilization-feeding (FF), fertilization-periphyton (FP) and fertilization-compost application (FC) systems on water quality parameters in grey mullet fingerling rearing ponds

Water parameter	FR	FF	FP	FC
Temperature (°C)	32.4 ± 1.6	32.9 ± 1.2	32.7 ± 1.9	31.8 ± 1.5
pH	8.1 ± 0.4	8.26 ± 0.3	8.38 ± 0.7	8.31 ± 0.3
DO (mg LŠ1)	5.6 ± 0.4b	5.86 ± 0.7b	6.06 ± 0.5c	5.47 ± 0.8a
Salinity (g L˜1)	11.3 ± 5.4	11.74 ± 5.4	11.89 ± 5.5	12.17 ± 5.5
NO_2-N (ìg L˜1)	41.8 ± 3.4b	52.61 ± 10.8d	35.71 ± 6.3a	47.09 ± 6.2c
NO_3-N (ìg L˜1)	195.4 ± 15.9ab	274.46 ± 11.5c	176.77 ± 8.2a	227.91 ± 30.3b
TAN (ìg LŠ1)	214.6 ± 44.7b	242.1 ± 52.1bc	174.8 ± 36.8a	252.17 ± 66.6c
PO_4-P (ìg L˜1)	131.3 ± 16.4b	168.11 ± 8.5d	106.62 ± 12.4a	145.33 ± 15.5c
GPP (mg C $m^{-3}h^{-1}$)	233.1 ± 14.3b	297.61 ± 19.9d	191.42 ± 12.5a	256.82 ± 22.7c
NPP (mg C$m^{-3}h^{-1}$)	175.7 ± 11.3b	193.66 ± 15.7d	111.34 ± 8.0a	184.27 ± 16.1c

Means bearing different superscripts indicate significant differences in a row ($P < 0.05$); DO, dissolved oxygen; TAN, total ammonia nitrogen; GPP, gross primary productivity; NPP, net primary productivity; Values are expressed as mean ± S.E. of three replicate ponds

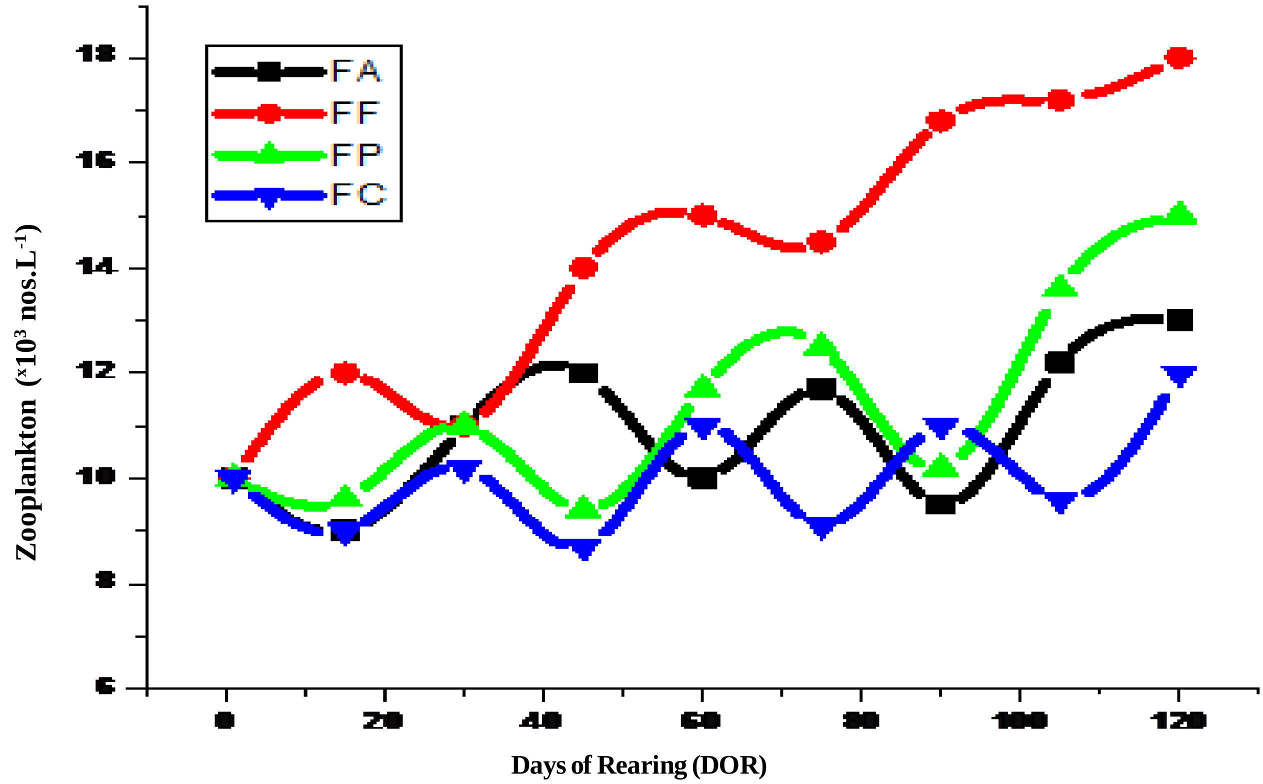

Fig. 1. Phytoplankton counts in pond water under fertilization Alone (FA), combined fertilization feeding (FF), fertilization-periphyton (FP) and fertilization-compost application (FC) systems during fish ûngerling rearing in ponds

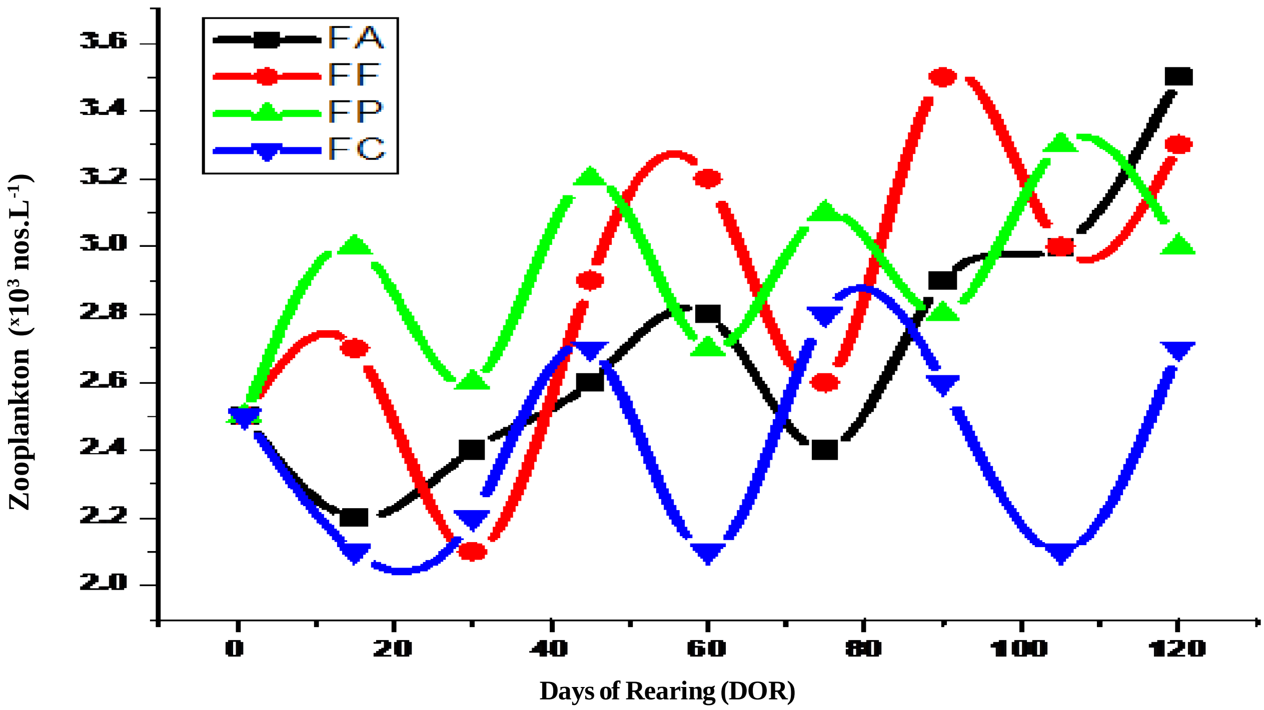

Fig. 2. Zooplankton (×10^3 nos.L^{-1}) counts in pond water under fertilization Alone (FA), combined fertilization feeding (FF), fertilization-periphyton (FP) and fertilization-compost application (FC) systems during fish ûngerling rearing in ponds

altogether higher mean qualities were recorded in every single other treatment with the most elevated qualities in FF (296.61 ± 19.54 and 193.66 ± 15.39 mg C $m^{-3}h^{-1}$).

Planktons, chlorophyll-a content of water and periphyton biomass : Mix of treatments with bolstering or periphyton affected tiny fish densities (Fig. 1& 2) and chlorophyll-a (Chl-a) content (Fig. 3) in pond water with higher qualities in FF and lower esteems in FP ponds. Tiny fish densities (phytoplankton and zooplankton) and Chl-a substance shifted altogether finished the trial time frame, and the mean qualities demonstrated an expanding pattern till the finish of raising period aside from in FP where mean qualities were unfaltering with marginally diminishing pattern toward the end. Periphyton biomass as dry issue (DM) and Chl-a substance for every unit surface zone over the era in FP ponds are exhibited in Fig. 4. DM and Chl-a were found to increment relentlessly finished the period till 75 long stretches of raising took after by a drop. Thereafter, those remained consistent till 120 days with unimportant variances. Mean estimations of DM and Chl-a were 15.06 ± 2.78 mg cm^{-2} and 30.25 ± 3.90 μg cm^{-2}, separately. Around 37 genera of plankton having a place with Bacillariophyceae (10 genera), Chlorophyceae (8), Cyanophyceae (4) and Euglenophyceae (2) and zooplankton having a place with protozoa, Annelida and Crustacea were recognized as periphytic networks developed on the substrate.

Fish growth and performance parameters: Development augmentation of fish fingerlings over the day and age is displayed in Fig. 5. All the development parameters were essentially (P<0.05) higher in FP contrasted with that of different medicines (Table 2). Mean development parameters, survival and aggregate biomass at harvest varied altogether (P<0.05) among medications. Highest DWG was found in FP and its qualities took after the request of FP>FF>FC>FA. Despite the fact that, SGR indicated comparable pattern, it didn't contrast fundamentally (P>0.05) amongst FP and FF. At the point when thought about to FA, mix of treatment with nourishing (FF) and periphyton (FP) increased survival by 8.6 and 12.8 per cent, separately, yet survival was reduced by 5.4 per cent when joined with compost application (FC). In spite of the fact that,

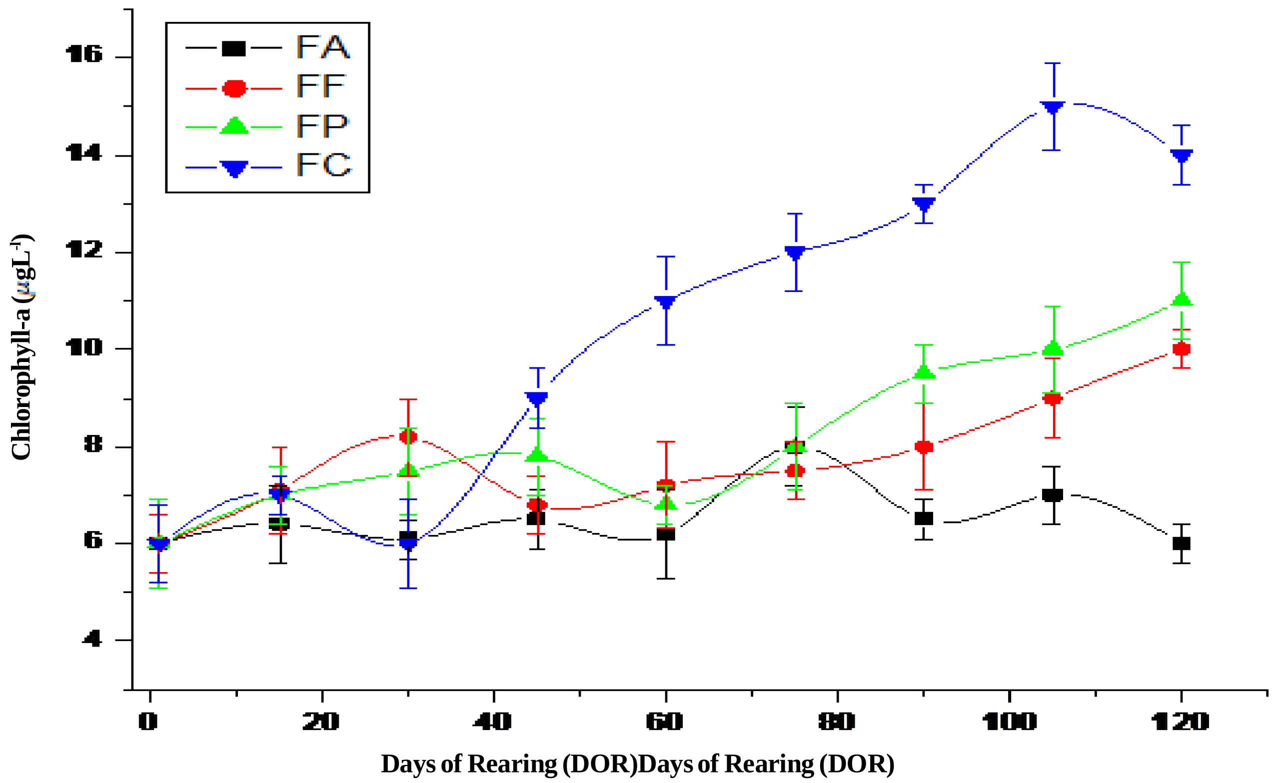

Fig. 3. Chlorophyll-a concentration in pond water under fertilization Alone (FA), combined fertilization-feeding (FF), fertilization-periphyton (FP) and fertilization-compost application (FC) systems during fish ûngerling rearing in ponds

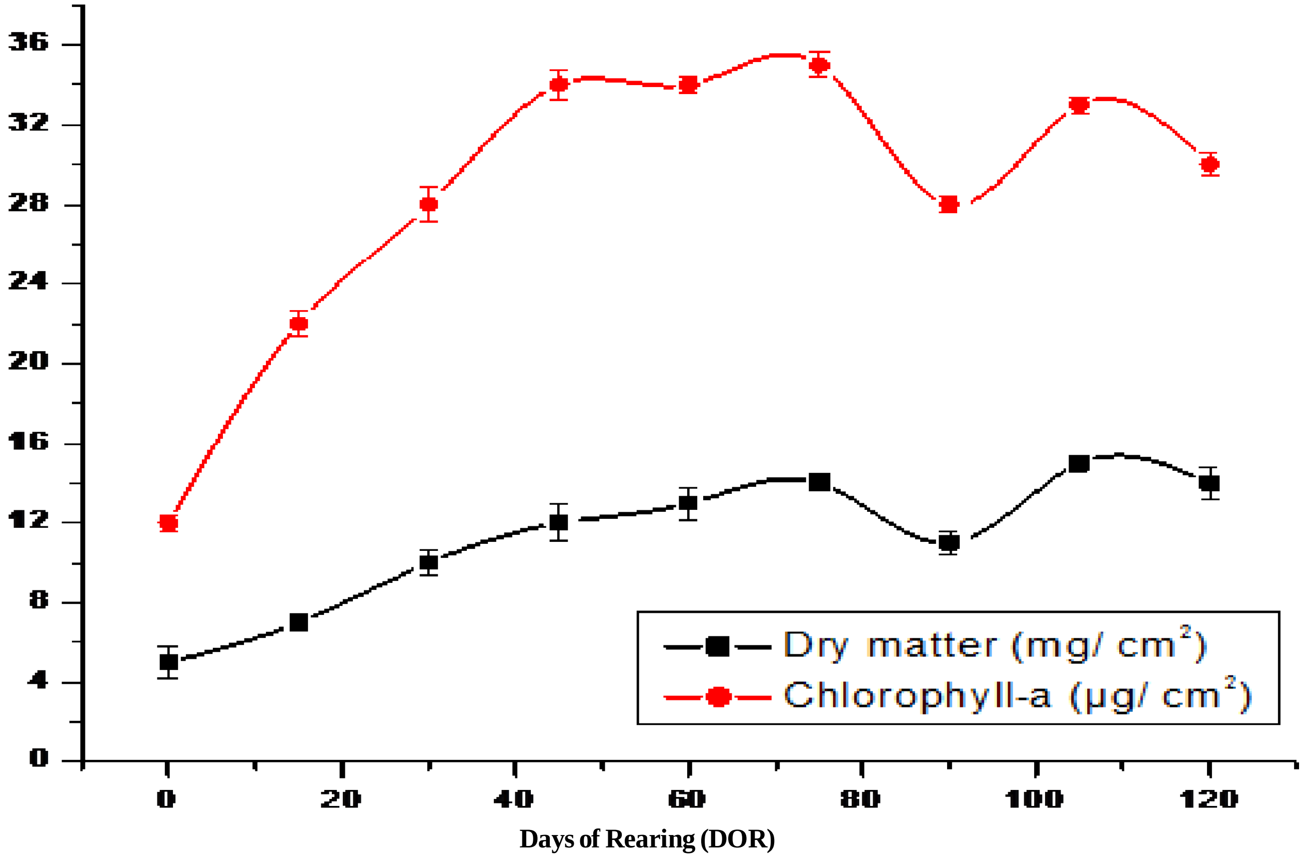

Fig. 4.Chlorophyll-a concentration and dry matter per unit surface area of periphyton in fertilization-periphyton (FP) treatment during fish ûngerling rearing in ponds

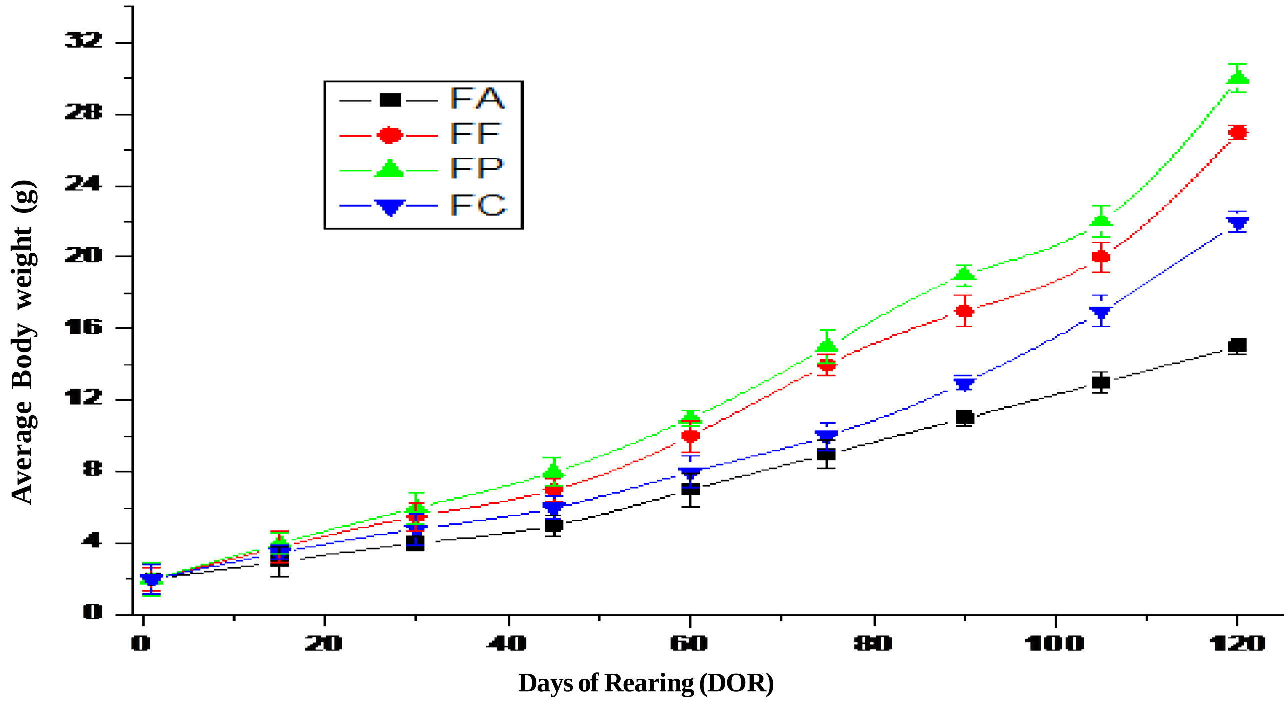

Fig. 5. Body weight increment of experimental fishes under fertilization (FA), combined fertilization-feeding (FF), fertilization-periphyton (FP) and fertilization-compost application (FC) systems during pond rearing

Table 2. Comparison of grey mullet performance parameters in fertilization (FR), combined fertilization-feeding (FF), fertilization-periphyton (FP) and fertilization-compost application (FC) systems

Parameter	FR	FF	FP	FC
Final weight (g)	14.8 ± 1.7a	24.80 ± 1.98c	28.39 ± 1.1d	21.38 ± 1.7b
Final total length (mm)	104.43 ± 4.5a	119.53 ± 3.4bc	123.59 ± 3.4c	115.2 ± 5.4b
DWG (g d^{-1})	0.09 ± 0.7a	0.19 ± 0.5c	0.21 ± 0.4d	0.15 ± 0.8b
SGR (% d^{-1})	1.22 ± 0.5a	1.73 ± 0.8c	1.78 ± 0.3c	1.54 ± 0.5b
Survival (%)	82.6 ± 7.1b	90.8 ± 5.7c	94.3 ± 4.2d	79.1 ± 6.5a
Total biomass (kg ha^{-1})	361 ± 4a	728 ± 37c	802 ± 29d	504 ± 32b
Condition factor (K)	1.16 ± 0.14a	1.7 ± 0.09b	1.32 ± 0.13c	1.21 ± 0.10b

Means bearing diûerent superscripts indicate significant diûerences in a row (P<0.05); DWG, daily weight gain; SGR, speciûc growth rate; Values are expressed as mean ± S.E. of three replicate ponds.

Table 3. Comparison of economic parameters among fertilization (FR), combined fertilization-feeding (FF), fertilization-periphyton (FP) and fertilization-compost application (FC) systems for Tilapia ûngerling production. Calculation was for 1ha water area and 120 days experimental duration. Currency mentioned is Indian Rupee (100 INR =1.55US$)

Items	Quantity	Price rate Rs.	FA	FF	FP	FC
Operational cost (OC)	Tilapia fry 30,000 no.	1 fry^{-1}	30,000	30,000	30,000	30,000
Organic manure	800 kg	25 kg^{-1}	20,000	20,000	20,000	20,000
Feed	1100 kg	40 kg^{-1}	–	50,000	–	–
Bamboopoles as substrate	600 no.	50 2m $bamboo^{-1}$	–	–	30,000	–
Aquatic weed collection	–	–	–	–	–	15,000
Lime	1000 kg	10 kg^{-1}	10000	10000	10000	10000
Man power	200, 240, 300 and 300 man-days in FA, FF, FP and FC, respectively	250 $man\text{-}day^{-1}$	50,000	60,000	75,000	75,000
Total OC			110,000	170,000	165,000	150,000
Economic return Fishes price	25000, 27000, 28300 and 23000 no. in FA, FF, FP and FC, respectively	10, 12, 14 and 11, $fingerling^{-1}$ from FA, FF, FP and FC, respectively	250000a	324000b	396200c	253000a
Net return			140000a	154000b	231200c	103000a

Means with diûerent super scripts diûer signiûcantly in a row (P < 0.05); values are means of three replicates.

the most reduced survival (79.1 ± 6.5%) was in FC, it produced significantly higher biomass because of substantially higher last body weight compared to FA. In any case, the most noteworthy biomass was created by FP (803 ± 29 kg ha^{-1}) and the least was in FA (362 ± 22 kg ha^{-1}). Fish in FP had the most elevated Fulton's condition factor (K) level 1.37 ± 0.13) which was altogether not the same as that of other treatments (P< 0.05) after the pattern like development parameters (Table 2). Additionally, exponential esteem (b) of length-weight relationship (LWR) varied fundamentally (P < 0.05) among treatments and took after the request of FP > FF > FC > FA. Agreeing to the slant esteem (b = 3.01), development in FP treatment was isometric, and based on t, it was not unique in relation to 3 (t = 0.96; P>0.05). The slopes for the FF, FC and FA medications varied from 3 (t=3.85, t=9.25 and t = 12.55, separately; P<0.05) and in this manner, showed algometric development.

Comparison of economic returns: Pond management system in FP significantly (P<0.05) increased the gross return, net return and BCR (Table 3). However, there were no significant differences in gross return, net return and BCR between FA and FC systems.

Water quality parameters stayed stable all through the test time frame and were inside the ideal reaches for pond water mixed finfish culture (*Ghosh, 2017, Ali et al., 1999; Bhowmik et al., 1992; Chakraborti et al., 2002; Jana et al., 2004*). Water temperature and salinity may represent an altogether more noteworthy impact on development in various cultivable sea-going life forms (*O'Brien, 1994; Tsuzuki et al., 2000*). However in our investigation, there was no distinction in temperature, pH and saltiness demonstrating that distinctions in weight pick up can be credited to the differed pond raising frameworks as it were. Fortnightly use of lime added to alluring water quality. The watched slight higher pH in ponds gave periphyton substrate might be ascribed to less or no supplement wastage and support of oxygen consuming condition in nearness of autotrophic living beings (*Azim and Little, 2006*). The treatment, where bamboo substrate was accommodated periphyton growth (FP) was more powerful in evacuation of lethal nitrogen metabolites compared to different medicines. In the substrate-based framework, notwithstanding phytoplankton, periphytic green growth created over the substrate utilized the accessible nitrate and phosphate mixes, and reducedtheir levels in water segment (*Ramesh et al., 1999; Ballester et al.,2007*). Inorganic nitrogenous (NO_2-N, NO_3-N and TAN) and phosphate-phosphorus focuses were higher in FA, FF and FC treatment ponds contrasted with that of FP ponds, however these qualities were underneath the desirable points of confinement of 0.25, 0.5, 1.0 and 1.0 mg L^{-1}, respectively (*Chakraborti et al., 2002*). These higher qualities in FA, FF and FC were due to the impact of mustard cake, feed and manure application. Again, use of supplements by phytoplankton maybe caused this circumstance that resulted in compound slopes which thus quicken snappy supply from the dirt, therefore expanding supplement focus in the water (*Boyd, 1979*). GPP and NPP indicated comparative pattern and those had a significant ($P<0.05$) positive connection with NO_3-N and PO_4-P. Comparative perceptions were accounted for by *Garg et al. (2006)* in inland saline groundwater ponds connected with various dosages of fertilization. In the present investigation, both phytoplankton and zooplankton populations were altogether higher in FF, FC and FA ponds compared to that of FP ponds. Chlorophyll-a substance likewise corresponded with the phytoplankton populace. This was essentially a direct result of intermittent pond fertilization that aided in persistent spread of phytoplankton population (*Mischke and Zimba, 2004*). Additional increment in plankton population was watched while at the same time joined with sustaining and compost application. Lower yet enduring microscopic fish include all through the trial time frame FP were because of rivalry for assets between phytoplankton and periphyton gatherings (*Havens et al., 1996*). Thus, results of this investigation recommend that utilization of bamboo substrate enhanced water quality by nitrification process including microbial and periphytic algal networks (*Anand et al., 2013*). Periphyton dry issue and chlorophyll-a substance for every unit surface area in the present examination demonstrated normal qualities of 14.95 ± 3.23 mg cm^{-2} and 29.47 ± 4.85 µg cm^{-2}, individually in FP treatment ponds. Our outcomes speak to substantially higher qualities contrasted with the periphyton dry issue levels detailed as 9.9 mg cmd^{-2} in marine framework (*Richard et al., 2010*), 0.8–1.4 mg cm^{-2} in inland saline ground water ponds (*Jana et al., 2004*) and 2.8–14.4 mg cm^{-2} in tank experiments at various carbon-nitrogen proportions (*Anand et al., 2013*). In general, the amount and nature of periphyton created on substrates vary as indicated by the sort of biological community, substrate and supplement accessibility (*Richard et al., 2009*). In the present investigation, periphyton dry matter and chlorophyll-a substance expanded relentlessly up to 75 days followed by an enduring state till the end. Expanding sum of periphyton biomass demonstrated low brushing weight on the periphyton by general low biomass of fish at first and consistent or low periphyton biomass was come about because of expanding or proper touching pressure after 75 days by developing fish with higher biomass at chose stocking density. This proposes assist examination on the control of fertilization/bolstering rate and stocking thickness of refined animals (*Asaduzzaman et al., 2008*). Periphytic green growth developed on bamboo substrates involved diatoms, filamentous green and blue green algae, and zooplankton bunches like scavengers, nematodes and ciliate protozoans. *Khatoon et al. (2009)* revealed comparable perceptions in marine shrimp ponds where diatoms were the predominant periphyton community. Growth parameters and survival in dark mullet fingerlings were affected by treatment alone, and blend of preparation with feeding, periphyton substrate and manure application. In any case, the combined preparation periphyton framework created greater fingerlings with better survival. This might be ascribed to the way that either combination of encouraging or fertilizer with preparation and fertilization alone couldn't get together the natural need of developing fish, where as combined treatment periphyton framework provided food the necessity more efficiently. The development of fishes recorded in preparation periphyton framework in this examination was higher than the perceptions of *Bishara(1978)* who announced that in 180 days, angle achieved 25 g in superphosphate treatment, 27 g in superphosphate + ammonium nitrate treatment, 12 g in nourishing with powdered blood + customary flour, 18 gin sustaining with rice bran + cotton seed cake, 12 g in rice grain feeding,13 g in natural fertilizer treatment and 11g in untreated and unfed ponds supplied at 10000 number ha^{-1}. Additionally, *Shofiquzzoha et al.(2001)* showed that *M. cephalus* accomplished 7.30– 10.91 g from the initial size of 1.22 g in a 85-day poly culture with *Liza Parsia* and *Penaeusmonodon*. Nonetheless, this fish accomplished higher development of 61– 91 g in90 days under various salinities (*Barman et al., 2005*) and 121– 264 gin 100 days under different measurements of dairy animal compost manuring (*Garg et al.,2006*) in inland saline groundwater. In the present examination, SGR of grey mullet was brought down contrasted and the report of *Jana et al. (2004),* who watched SGR of 2.5 ± 0.1 and $2.2 \pm 0.1\%$ d^{-1} in ponds with periphyton and without periphyton, individually. Higher SGR esteem of 3.12– 4.70% d^{-1} was recorded in this fish raised under different salinity levels of inland ground water (*Barman et al., 2005*). In this experiment, the most elevated survival ($94.3 \pm 4.2\%$) in consolidated preparation periphyton framework recommended its appropriateness for angle fingerling raising. The recorded survival of dark mullet in various pond management systems was higher contrasted and 43– 63 per cent of every a monoculture of 200-day term (*James et al., 1985*) and 56.67– 64.67 per cent out of a poly culture with tiger shrimp for 195 long periods of raising (*Shofiquzzoha et al., 2001*). Higher reaped ABW, DWG, SGR and lower survival were watched inthe same condition at a lower stocking thickness (7500 number ha^{-1})and longer culture span (150 days) in preparation, encouraging and combined treatment sustaining frameworks (*Biswas et al., 2012*). The highest add up to reaped biomass of dim mullet fingerlings was recorded in the treatment periphyton framework. This showed characteristic food in the type of periphyton, microscopic fish and benthos contributed altogether to higher fish biomass in fingerling raising stage. In natural habitat, dim mullet nourishes on all accessible sustenance, microalgae, benthic invertebrates, and rotting waste (*Bruslé, 1981; Lupatsch et al., 2003; Odum, 1970*). Our perceptions verify the discoveries of *Richard et al. (2010),* who detailed that survival; development and generation of mullets were preferred in periphyton-based frameworks over in fed systems. *Pruginin et al. (1975)* watched that regular sustenance in marine ponds was more proper contrasted with just pellet feed nourishing for rearing of mullet. Our discoveries were in the comparable line. Examination of the K esteem in FP demonstrated that dark mullet displayed more solid and vigorous condition indicating great compatibility with the earth. Condition factor is utilized to think about the 'condition', 'largeness' or 'prosperity' of fish and it additionally shows that heavier fish of a given length are in better condition (*Biswas et al., 2011*). Isometric type (b) esteem (3.01) in FP demonstrated that fish had ag ood LWR and were, in this manner, in great condition contrasted with other treatments. Development is viewed as isometric when the parameter b is equal to 3 and algometric when it is <or> 3 (*Enin, 1994*). All the more particularly, development is to be sure algometric when creature weight increases more than length ($b>3$), and negative algometric when length builds more than weight ($b < 3$) (*Wootton, 1992*). *Jana et al. (2004*) detailed comparable outcomes in inland saline groundwater. Our perception shows prevalence of periphyton bolstered framework over other fingerling raising frameworks of Tilapia. From financial examination, it is apparent that preparation periphyton system of pond administration essentially beat different three systems. In our past examination, joined treatment encouraging system was better contrasted with preparation or sustaining alone (*Biswas et al., 2012*).

CONCLUSION

The pond trial on grey mullet fingerling rearing under fertilization alone, and feeding, periphyton and compost application combined with fertilization revealed better performances in the fertilization-periphyton system. Bamboo-based substrate facilitated maintenance of better water quality by reducing toxic compounds like TAN and NO_2-N, and improved growth performance and survival of grey mullet fingerlings. Substrate favored growth of periphytic algal community that served as the natural food. This study infers that combined fertilization-periphyton system with a stocking density of 30,000 fry ha^{-1} would be appropriate for production of striped grey mullet fingerlings in sundarban saline pond. There is a scope for refinement of this practice by evaluating appropriate surface area of substrate to support the growingfish biomass. An understanding on the quantitative and qualitative utilization of periphytic algae by fish during different life stage and standardization of stocking density for optimum utilization of the developed periphyton biomass would help in further refining such system.

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