Bangladesh J. Fish. Res., 4(1), 1999: 63-68

Water quality management on the enhancement of shrimp (*Penaeus monodon* Fab.) production in the traditional and improved-traditional ghers of Bangladesh

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Abstract
On-farm research on enhancement of *P. monodon* production through water quality management was carried out in five ghers of Paikgacha, Khulna. Based on the prevailing condition of the ghers, lime in the form of $CaCO_3$, urea and TSP were used as the major inputs to minimize the soil-water acidity and to ensure the availability of natural food particles in the water bodies. Exchange of water at required level also practised for the qualitative improvement of culture water. Ghers of varying sizes showed that water quality management and fertilization have a positive impact on production performance of *P. monodon* (61.59% increment) that yielded an average production of 385.43kg/ha/crop against the present traditional rate of 238.50 kg/ha/year.

Key words: *P. monodon*, Water quality, Traditional farming

Introduction

The present shrimp farming area of Bangladesh covers an area of 130 000ha out of which approximately 80% area are under traditional and improved traditional farming system (Anonymous 1996). Traditional shrimp farming is characterized by low lying coastal water flooded areas that allows to enter shrimp, finfish and seeds of other species through tidal wave action and grows there up to marketable size. Though a significant development in the traditional shrimp gher operation through releasing of shrimp seed at a particular density (1.0-1.5/m^2) observed during the last few years in many ghers, where from an production of 175-250 kg/ha is obtainable, but due to the lack of proper management of soil-water of the gher and shortage of natural food particle in the gher water, culture species neither grows healthy nor attain a considerable size for marketing in the stipulated time. Among the soil-water parameters, low pH value and absence of natural food particles in the water body are mostly responsible for low growth performance. Other required factors like dissolve oxygen content, water salinity, water temperature, water depth etc. also plays significant role in shrimp production. But in the prevailing improved traditional shrimp culture system of the country these factors are not taken into consideration by the farmers. Many of these problems has arisen as result of undesirable farming practices. Despite the nature of the current problems, it is possible to increase profits and reduce environmental damage through the application of currently available shrimp farm management and production techniques (Chanratchakool *et al.* 1995). In this context, the present study was undertaken to find out the appropriate shrimp farm management techniques with a view to obtain higher production.

Materials and methods

Preparation of ghers

The study was carried out in five selected ghers of Paikgacha. Construction of dikes and gates were completed by the farmers as per instruction and then allowed to exposed the drain out wet field by sun light for about fifteen days. Based on the level of acid content gher bottom was flushed 3-5 times with tidal water to minimize the acidity. Lime were also applied depending upon the pH level of the soil. Cow dung and mustard oil cake (MOC) were applied at the rate of 500 kg and 100 kg/ha, respectively. Inorganic fertilizers, like, triple super phosphate (TSP) and urea were also applied at the rate of 30 kg/ha (TSP:U=3:1). After 4 to 5 days of fertilization, ghers were filled with water up to a depth of about 15-20 cm and then after one week, the depth of each gher was finally maintained at about 90 cm on an average.

Stocking of P. monodon seed

P. monodon postlarvae from local rivers of average 0.006g were stocked at a rate of 1.5 to 1.75/m^2. Depending upon the unavailability of local seeds farmers sometime used imported seeds from Thailand, India, Taiwan and Indonesia (Table 1). In all the cases, PL were screened before stocking by high rate of aeration in 100 ppm formalin solution for about thirty minutes.

Table 1. Culture management of experimental ghers

Farm no. & area (ha)	Culture period (days)	Water depth (m)	Stocking density (nos./ha)	Initial wt. (g)	Final wt. (g)	Gain in wt. (g)	Survival rate (%)	Production (kg/ha)
1. 46.7	150	1.2	17500*	0.006	43.5	43.49	52.2	399.66
2. 4.0	135	1.1	15000		44.7	44.69	59.7	400.29
3. 24.0	148	1.25	17500		44.0	43.99	58.3	448.91
4. 6.9	130	1.0	15000		45.0	44.99	49.6	334.80
5. 3.3	130	1.15	15000		44.9	44.89	51.0	343.49

* *Local seed 80% with imported seed 20%*

Water management

Water quality parameters such as dissolve oxygen (DO), pH, salinity, water temperature, transparency, un-ionized ammonia, hydrogen sulphide and alkalinity content were monitored weekly basis. Based on the prevailing soil-water condition and as per need, fortnight water exchange were done by tidal flushing during new and full moons followed by application of chemical fertilizers at a rate of 15kg/h (TSP:U=1:3). To keep the pH and alkalinity of water at a standard level, lime in the form of $CaCO_3$ was applied as per requirement (150-150 kg/ha).

Growth data recording

For the calculation of growth performance average weight of shrimp were recorded by fortnight sampling. The final growth and survival rate was calculated at the end of the culture period. Major portion of the shrimps were harvested after 120-150 days of rearing. But partial harvest of the marketable size shrimps before the stipulated period were encouraged to enhance the growth of smaller ones by increasing space and feed for the individuals of the remaining stock.

Results and discussion

Because of variation in water quality and management techniques of a shrimp farm, a great variation in production rate (238 kg/ha for improved traditional farms and 2500 kg/ha for semi-intensive farms) and survival rate (35-65%) can be observed (Anonymous 1994). It is beyond doubt that water quality management plays a vital role to promote the productivity of a shrimp farm directly. A healthy environmental condition and importance of entire management practice at different level from site selection to better production performance is crucial (Boyd 1995). As application of many production oriented management techniques require major. Among the important water quality parameters of gher, the major difference in pH, alkalinity and water transparency was recorded which were probably because of the direct effect of water management of the ghers under study (Table 2). The monthwise water quality parameters shows that temperature, salinity and dissolve oxygen content of the water of all the ghers are in good form which might also be similar for the traditional ghers, because these parameters are mostly controlled by natural environmental condition which indicates that management of a shrimp farm effectively require an understanding of the relationship between the shrimp and the environment. Interactions of some particular components, such as, oxygen, alkalinity, pH, dissolve nutrients and solid wastes are vitally responsible to produce such environment in a water body. Within a production pond, conditions which are less than perfect for culture are more commonly found than conditions which is directly responsible for shrimp death and cause low survival and poor production.

Table 2. Water quality parameters during 5 months culture period in experimental ghers

Parameters	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Temperature (^{0}C)	22.0-32.0	25.0-32.0	23.5-31.5	24.5-31.5	23.5-32.0
Transperancy (cm)	26.0-30.2	24.0-27.8	24.0-28.0	23.0-26.5	23.0-26.5
$_p$H	7.8-8.2	7.5-8.2	7.2-8.2	7.8-8.2	7.7-8.1
Salinity (ppt)	12.5-22.5	13.0-21.0	13.5-21.5	12.5-21.0	13.0-22.0
DO (ppm)	5.0-7.0	6.0-8.5	6.0-8.3	7.5-8.2	7.0-8.0
Alkalinity (ppm) (as $CaCO_3$)	100-325	125-300	156-330	100-350	122-320
Un-ionised Ammonia (ppm)	0.06-0.09	0.05-0.08	0.05-0.09	0.05-0.09	0.06-0.08
H_2S (ppm)	0.03-0.04	0.02-0.03	0.02-0.03	0.02-0.03	0.02-0.03

In the experimental ghers, this sorts of problems were overcame by occasional water exchange and lime application. As these treatments are not implied in the traditional ghers, as a result, this condition harm the shrimp, reduce the productivity and increase susceptibility to disease (Chanratchakool *et al.* 1998). Another cause of low production in the shrimp ghers of south east Asia is undesirable predator fishes. Because in the traditional shrimp farming system, most of the predators directly killed and feed on mullet and shrimp (Anonymous 1976).

The natural breakdown of toxic substances and wastes in shrimp ghers are performed by bacteria and plankton. This process are affected by the amount of oxygen present in water, temperature and water movement. If wastes are produced faster than the rate of breakdown, accumulation of waste substances will occur in the pond water. If the situation persists, this can lead to undesirable rearing condition (Chanratchakool *et al.* 1998) which is common in traditional and improved traditional shrimp farms of the country and which was minimized in the experimental ghers by required level of water exchange. Production data reveals that, considerable higher survival, growth and production of *P. monodon* can be achieved by keeping the environment of the gher suitable for shrimp farming (Table 1). Because in such a situation the main objective of the water management was stand to avoid lethal conditions and to provide adequate culture condition. As the traditional shrimp culture system in our country is a continuos process and in many cases extended up to 240 days or more, so there has been every possibilities of producing ammonia and hydrogen sulphide at toxic level in the bottom soil. In such case ammonia may produce by the excretion from the shrimp and decomposition of nitrogen containing organic materials, whereas, hydrogen sulphide produce under anaerobic conditions in sediments with high level of organic materials where reduced iron compounds are also present. Prior to culture, as the ghers under experiment were dewatered, exposed to sun light for several days and limed, and during culture operation, water exchange was done properly to a required level to keep the culture condition and water quality of the gher ideal, so in no case, unionised ammonia and hydrogen sulphide found to exceed to toxic level.

In traditional farming, in course of reducing the salinity level toward almost fresh (1-0 ppt) due to dilution by rain water at the end of the culture period (from later part of July to September), shrimp shell become soften because of low alkaline nature of the water where the presence of carbonates/bicarbonates are poor. Acid leached from the pond soil breaks down carbonates and bicarbonates reducing the water alkalinity and this process may continue until there is little or no carbonate or bicarbonate left in the gher water. Application of cabonate lime in the experimental ghers supplemented the level range 100 - 350 ppm (Table 2) against minimum required level of 80 ppm of carbonates and bicarbonates and helped to maintain the level of water alkalinity.

Production and water quality parameters of experimental and some traditional ghers shows that the low stocked traditional ghers with continuos long culture period has low survival and production compare to that of well managed shrimp ghers under study (Table 3). So management of water quality is vitally important for two basic reasons, such as, it will help to direct the farmer to maintain optimum environmental condition within the water body that will help to maximize growth and survival (Paul and Khondoker 1996) and the other is the maintenance of a good water quality that will eliminate most of the disease related problems of the particular water body (Tareen and Farmer 1983)

Table 3. Comparison of production performances and water quality management in the experimental and the traditional ghers

Culture practices and water management	Experimental gher (n= 5)	Traditional gher (n=10)
Culture period (days)	139	110-240
Farm area (ha)	3.9-46.7 (av. 16.98)	3.0-100 (av. 22.8)
Application of fertilizers, lime	Applied	Not applied
Stocking rates (PL/m^2)	1.7	1.0
Exchange of water	Done, as per required	Done, only during harvesting
Transparency (cm)	24-30	Above 30
$_{P}$H	7.5-8.0	5.5-7.0
Alkalinity (ppm)	100-350	60-225
Initial wt. (g)	0.006	0.006
Final wt. (g)	44.42	32
Survival rate (%)	54.16	38.0
Yield (kg/ha/crop)	385.43	238.50

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(Manuscript received 24 September 1998)