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Research Article

WATER QUALITY MANAGEMENT OF DIAMOND AQUA FARM, MALLIPATTINAM, THANJAVUR DISTRICT, TAMIL NADU, INDIA

S. Nizam Ali Khan[1], A. Mohamed Nazer and S. Raveendran[2]*
[1]Post Graduate and Research Department of Management Studies,
[2]Post Graduate and Research Zoology,
Khadir Mohideen College, Adirampattinam-614 701, Tamil Nadu, India

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ABSTRACT

The present study reported the water quality parameters in relation to growth of tiger shrimp, *Penaeus monodon* in culture pond at Diamond Aqua Farm, Mallipattinam, Thanjavur District for the period of 135 days from the introduction of fingerlings (10.04.2014) to the harvest day (22.08.2014).The results clearly indicate that almost all the physicochemical parameters like water temperature, pH, carbon dioxide, salinity, total hardness, calcium, magnesium, phosphate, ammonia and nitrite's average values were increased gradually from the month of April 2014 to August 2014 and remaining parameters like turbidity and dissolved oxygen were increased in the month of April 2014 to August 2014 in the cultured pond. However, they are within the normal range. The variations in the water quality parameters are due to seasonal changes, water exchange and shrimp culture.The growth of the shrimps was assessed from both length and weight parameters. The average length of the shrimp was gradually increased in culture ponds. The minimum and maximum lengths of the shrimp were 2.5 cm were observed in April 2014 and 14.9 cm in August 2014 in the culture pond. The weight of the shrimp was also gradually increased in culture pond from to August 2014. Based on the present investigation, it is concluded that to get the proper growth *P. monodon and* profit, proper water quality management and feed management is essential.

Keywords: Physical parameters, Chemical parameters, Management, Growth, *Penaeus monodon*.

INTRODUCTION

The shrimp farming in brackish water ponds are economically attractive and a rapidly growing industry in many tropical nations. Satisfactory techniques have been practiced for the successful culture of the shrimp in aqua farm. However, the successful production of shrimp in aqua farm is often limited by physicochemical factors of the water. Therefore, study of physicochemical and biological factors is the focal point of much research (Jana *et al*., 2000; and Adhikari *et al*., 2007). Asch and Seneca (1980) studied water quality management in aqua culture. Boyd and Pillai (1985) reported the importance of water quality management in commercial culture pond. The effects of water quality and production of *P. monodon* in earthen pond have been studied (Carpenter *et al.,* 1986). Uses of probiotics in water quality management of shrimp culture have also been studied by Prabu *et al* (1999). Saksena *et al.* (2006) reported the limnology of Kharland (saline) ponds of Ratnagiri, Maharashtra in relation to prawn culture potential. Pushparajanand Soundarapandian (2010) recorded the water quality parameters of the giant tiger shrimp, *P. monodon* culture pond at Mamallapuram, Devaneri, Tamil Nadu. Janakiram *et al.* (2011) reported the survival, growth and production of *P. monodon* in modified-extensive and semi intensive culture systems of Andhra Pradesh. Abu Hena *et al.* (2012) observed the chemical composition of water from tiger shrimp *P. monodon* culture ponds at Malacca, Malaysia. Shailender *et al.* (2013) reported the recent and sustainable culture methods of giant black tiger shrimp, *P. monodon* in Andhra Pradesh. Mude and Ravuru (2015) reported the growth of cultured white leg shrimp *Litopenaeus vannamei* of brackish water culture system in winter season with artificial diet.

A review of literature reveals that the study about the growth of tiger shrimp in relation to

*Corresponding author e-mail: drsr_kmc@rediffmail.com

water quality is still remaining inconsistent. Water quality is the most important limitation of the commercial viability of aquaculture operation, especially in semi-intensive culture condition. Impact of water quality on aquaculture pond environment needs to be assessed for the sustainability of aquaculture development. Therefore, the present work was aimed to analysis the water quality parameters in semi-intensive shrimp pond (*Penaeus monodon*) at Diamond Aqua Farm, Mallipattinam, Thanjavur District, Tamil Nadu, India.

MATERIAL AND METHODS

Description of the study area

The present investigation was carried out in a semi-intensive aquaculture pond at Diamond Aqua Farm, Mallipattinam, which is situated in the east coast of India in Thanjavur District. The area of Diamond Aqua Farm is 4.23 hectare. Total water spread area is 3.42. Pond 1 water spread area is 0.7 hectare. Water depth is 1.2 sm^2. It is semi-intensive culture pond, which was selected for the present study. The depth of the pond is 150 cm. The water was changed frequently to maintain the water quality. The present study was conducted from 10.04.2014 to 22.08.2014.

Description of the shrimp

The tiger shrimp *Penaeus monodon* (Fabricius) fingerlings L (18-20 stage) were selected as seed for the culture. The seeds were obtained from M/s Oceanic Aqua Hatchery, Marakonam, Pandicherry. They were transported in oxygenated polythene bags. Each bag consists of 3000 seeds. The total seeds introduced were 72000. They were introduced with stocking density of 4000. The observations were started from the stocking date 10.04.2014 to harvest day 22.08.2014 for the period of 135 days.

Feeding programmed was started from the first day. Bismi feed was used throughout the culture period. Feed was procured from Amazing Biotech, Marakonam. This feed has five numbers PL-1(crumble shape; 24-40 # mesh size), PL-2 (crumble shape; 14-24 # mesh size), starter (crumble shape; less than 2 mm size), grower (granule shape; less than 2x5 mm size) and finisher (rod shape; larger than 2.5x10 mm size). Above feed has the ingredient of protein 41%, Fat 6%, Fiber 8% and Ash 15%.

From the day 1st to day 30 two times feeding were given. From 31st day to 60th 3 time feeding and 60th to till harvest 4 time feeding were followed (7 am, 11 am, 2 pm and 9 pm). First day, 500 gm feed was given. 300 gram added daily up to 10 days. Then the feed amount was increased to their body size and biomass.

Analysis of water quality parameters

For the present investigations, the water quality parameters like temperature, pH, Turbidity, Dissolved oxygen, CO_2, Salinity, Total hardness, Calcium, Magnesium, Phosphate, Ammonia, Nitrite were analysed by the method of Strickland and Parson (1968). These parameters affect the growth of marine water prawn, *P. monondon*. Therefore, these parameters were observed for the period of 135 days.

Assessment of growth parameters

To assessment the growth, the prawns were collected from the pond using the check-tray to measure the body length by scale and the weight by digital pan balance.

RESULTS

Water quality parameters of shrimp culture pond

This study was carried out in Diamond Aqua Farm site located in the east coastal area at Mallipattinam, Thanjavur District for the period of 135 days from the introduction of fingerlings (10.04.2014) to the harvest day (22.08.2014). The physicochemical parameters and their influence on growth of *P. monodon* were observed (Table 1).

The results clearly indicate that almost all the physicochemical parameters like water temperature, pH, carbon dioxide, salinity, total hardness, calcium, magnesium, phosphate, ammonia and nitrite's average values were increased gradually from the month of April 2014 to August 2014 and remaining parameters like turbidity and dissolved oxygen were increased in the month of August 2014 to December 2014 in the cultured pond. However, they are within the normal range. The variations in the water quality parameters are due to seasonal changes, water exchange and shrimp culture.

Growth of shrimp

The length and weight of *P. monodon* are presented in the Figure 2.

Length: The length of the shrimp was gradually increased during the study period. The minimum and maximum lengths of the prawns were 1.2 cm in April 2014 and 15.5 cm in August 2014.

Weight: The weight of the shrimp was also gradually increased during the study period. The minimum and maximum weights of the shrimps were 2.2 gm in April 2014 and 35.3 gm in August 2014.

Correlation coefficient studies obviously indicate the positive correlation (+ 0.9) between body length and body weight in different days (month) of culture in pond.

Table 1. The data on physicochemical parameters of water quality parameters of *Penaeus monodon* culture pond at Diamond Aqua Farm.

Month	Tempera-ture (°C)	Turbitity (cm)	pH	Oxygen (mg/L)	Carbon dioxide (ppm)	Salinity (ppt)	Total Hardness (mg/L)	Calcium (mg/L)	Magne-sium (mg/L)	Phosph-aste (mg/L)	Ammonia (mg/l)	Nitrate (µg/l)
April 2014	29.1 ± 0.3	49.3 ± 2.2	7.2 ± 0.4	9.5 ± 0.9	23.2 ± 1.6	24.6 ± 2.2	61.5 ± 5.6	31.2 ± 1.3	53.7 ± 2.3	6.4 ± 0.3	0.21± 0.02	0.05 ± 0.01
May 2014	30.9 ± 0.4	48.4 ± 1.5	7.9 ± 0.2	9.4 ± 0.5	26.4 ± 1.7	26.2 ± 2.7	62.2 ± 4.4	32.3 ± 2.5	57.3 ± 3.5	6.6 ± 0.2	0.23± 0.06	0.06 ± 0.01
June 2014	30.7 ± 0.5	46.2 ± 1.3	7.5 ± 0.6	9.1 ± 0.7	28.3 ± 1.6	27.3 ± 2.7	64.7 ± 6.2	32.6 ± 2.2	52.5 ± 7.3	7.2 ± 0.2	0.26± 0.04	0.07 ± 0.02
July 2014	30.5 ± 0.6	42.1 ± 1.5	8.1 ± 0.4	8.8 ± 0.8	29.4 ± 1.7	28.3 ± 2.7	68.7 ± 2.5	33.5 ± 3.2	59.7 ± 2.4	7.4 ± 0.4	0.25± 0.07	0.08 ± 0.02
Aug 2014	30.2 ± 0.4	40.2 ±2.1	8.2 ± 0.3	8.7 ± 0.5	29.7 ± 2.2	28.5 ± 2.5	63.3 ± 3.6	36.3 ± 3.3	58.2 ± 7.5	8.4 ± 0.6	0.28± 0.04	0.09 ± 0.02

Each value is Mean ± SD of one month data.

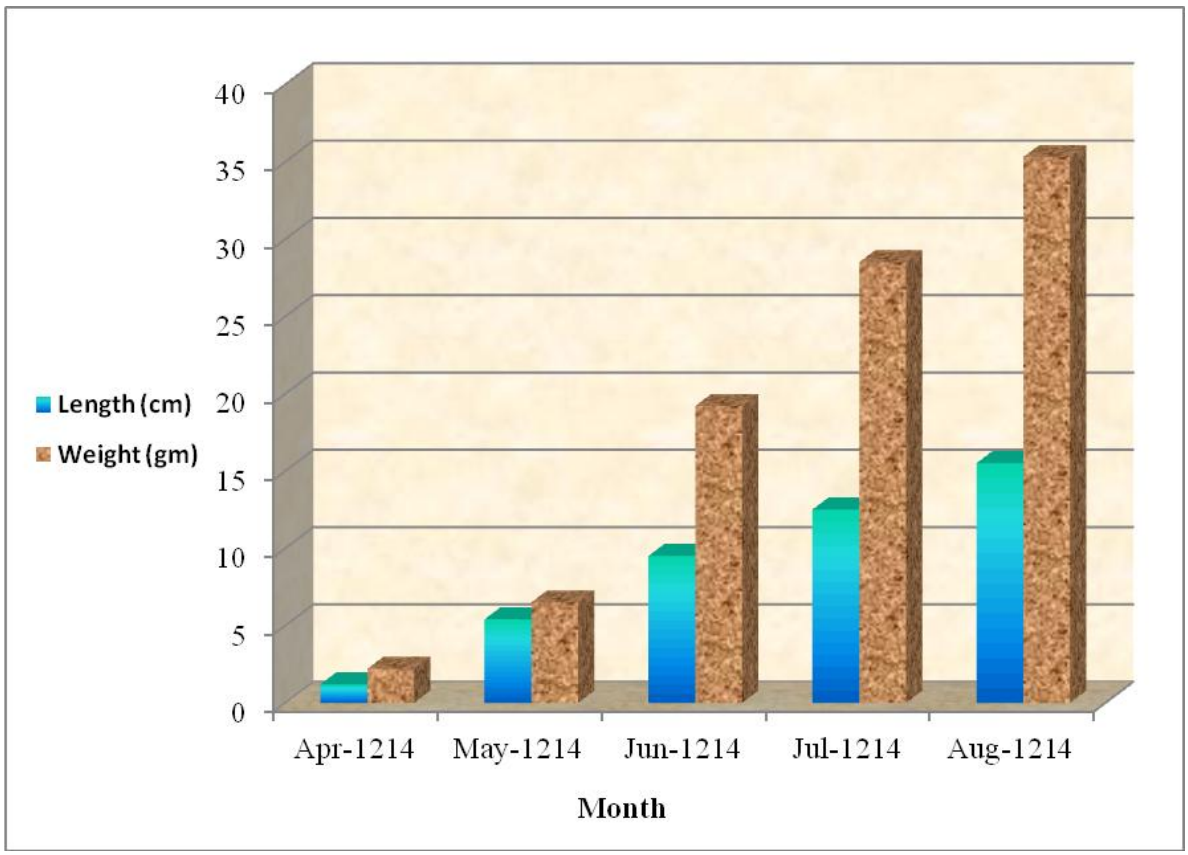

Figure 1. The histogram shows the growth of *Penaeus monodon* cultured at Diamond Aqua Farm, Mallipattinam.

DISCUSSION

The physicochemical factors of the culture pond and their individual or synergetic effects play an important role on shrimp production and pond ecology. The ecosystem and biota of the culture ponds may also influence the production performance of shrimp culture. The culture of shrimp received maximum importance due to its unique taste, high nutritive value and persistent demand in world market. The maintenance of good water quality is essential for optimum growth and survival of shrimps. The levels of physical, chemical and biological parameters control the quality of pond waters (Boyd, 1900). The level of metabolites in pond water can have an adverse effect on the growth. Good water quality is characterized by adequate oxygen and limited level of metabolites. Excess feed, faecal matter and metabolites will exert tremendous influence on the water oxygen in all the culture ponds in the present study was quality of the shrimp ponds. Hence critical water quality parameters are to be monitored carefully as adverse conditions may be disastrous effect on the growing shrimps (Ramanathan, 2005).

The temperature is an important ecological factor which influences the hydrological parameters, which are in turn influence the important role in metabolism, growth and biochemical processes. The optimum range for warm water species is 24-30° C. In the present study, the water temperature range varied from 29.1 to 30.9°C. The present findings show the similarity with earlier observation on *P. japonicus* (Hudinagam, 1952). Shrimps are cold-blood animals which can modify their body temperature to the environment in normal conditions. Verghese *et al.* (1975) reported that the temperature below 24° C has been associated with lower food intake in *P. monodon.* But in the present study, the higher values did not affect the growth. Such problem could be maintained by exchanging the surface water, maintaining the bottom water temperature and operating the wheel aerators safely.

In the present study, turbidity varied from 40.2 cm to 49.3 cm. Turbidity of the water in the culture pond depends on availability of zooplankton or phytoplankton and suspended solid particles. The high turbidity prevents the penetration of light into the water. This reduces photosynthesis. Turbidity may change the primary productivity of organisms (Carpenter *et al*., 1986). The turbidity of the culture pond gradually decreased from the day of stocking to the day of harvest respectively in cultured pond. The increase turbidity during the initial period may be due to less phytoplankton densities and decrease turbidity due to increase level of phytoplankton in the culture pond. The high turbidity clogs the gills and appendages. The high turbidity reduces the dissolved oxygen content. The high bacterial load may cause serious water quality problems and will lead bacterial infection (disease). Liming reduces the over turbidity. Having sedimentation pond (Reservoir) improves the clarity of water. Use of aluminum sulphate (alum) will be helpful in flocculating the suspended solids and there by accelerating the rate of settlement (Rajagopal, 1996).

The normal pH of brackish water pond should be between 7 and 9 for culturing prawns and less than pH often found harmful to prawns and higher pH (more than 9) is also detrimental to the health of the prawns (Muthu, 1980). In the present study, the pH concentration was ranged from 7.2 to 8.2 in cultured pond. This alkaline range of pH is considered as more suitable for the prawn culture. The maintenance of normal level pH in the culture pond was due to the application of liming.

Oxygen is the most critical water quality parameter. The dissolved oxygen is produced by photosynthesis of aquatic plants is consumed by invertebrates and prawns. It is variable in aquaculture pond. The reduction of oxygen content affects the growth of the shrimp. The oxygen dissolved in the culture medium is an important factor not only for the respiration of aquatic organisms but also to maintain favourable chemical and hygienic environment of the water body. It controls many of the oxidation reactions and maintains aerobic conditions in water. When oxygen level is very low and anaerobic conditions exist, nitrate is reduced by denitrifiers into ammonia which will be toxic. This also increases the pH. The oxygen level in the culture medium can be maintained in the desired range by aeration. Muthu (1980) stated that the dissolved oxygen content should not be lower than 3.5 ml/lit in shrimp culture pond. In the present investigation, the oxygen content was ranged from 8.7 to 9.5 ml/lit in cultured pond. Continuous aeration was done during the present study and therefore the oxygen level exceeds the limit. This is similar to the

finding of Chakrabarti *et al* (1985). The maintenance of the normal oxygen level in the culture pond was due to the water exchange, use of aerator and drainage of organic matter which undergoes decomposition flushed out from the ponds. The dissolved oxygen promotes prawn production in maximum level (Maguire and Allan, 1992).

Dissolved carbon dioxide is an important factor which influences the metabolic activities the aquatic organism. It also involves the photochemical reaction of phytoplankton. In the present observation dissolved carbon dioxide level slightly increased during the culture period in cultured pond. The increased level of carbon dioxide at the end of the culture period is mainly due to respiration of aquatic organisms. The increase level of dissolved carbon dioxide in the culture ponds causes stress to the prawns. The present study agrees with earlier observation (Carpenter *et al.,* 1986; Allan and Maguire, 1992 and Prabu *et al.,* 1999).

Salinity is the most important factor influencing many functional responses of organisms as metabolism, growth, migration, osmotic behaviour, reproduction etc. Marine organisms maintain their internal salt concentration of blood and body fluids by osmoregulation. Sudden increase or decrease in salinity will affect the osmoregulatory functions of growing organisms and lead to mortality. Gopalkrishnan (1973) reported that low salinity of water is more favourable for *P. monodon* during earlier stages, while medium range of salinity is conducive to faster growth in the later stages. They need considerable energy for osmoregulation to maintain their internal salt balance in relation to range of salinity for *P. monodon* is 20 - 35 ppt (Muthu, 1980). According to the Maguire and Allan (1992) fluctuation in salinity in brackish water influence the survival rate of *P. monodon l*arvae. The low value salinity had a highly significant influence the growth rate *P. monodon.* Marichamy and Motha (1987) reported that better production of *P. indicus* from salt pans in Tuticorin was obtained when the salinity was recorded around 35 ppt during most of the culture days. In the present study marine water was used and the salinity was in the desired range from 24.6 to 28.5 ppt in the cultured ponds as reported by Zein Eldin and Griffith (1966).

In the present study, the total hardness, calcium and magnesium values were not greatly varied in the cultured ponds. The role of phosphate content is considered as a major factor on the regulation of biological growth in marine water. In the present study the phosphate level of the pond was varied between 6.4 and 8.4 mg/l. The seasonal fluctuation of phosphate in the marine water environment agrees with earlier workers (Moraj and Nakar, 1983; Boyd, 1987 and Prabu *et al.,* 1999). Microorganisms such as phosphate enzyme producing bacteria are useful since they release the essential phosphate into the water.

In the present study, ammonia varied from 0.21 mg/l to 0.28 mg/l. Ammonia is the principal end product of protein catabolism organisms and it is excreted through gills. Under anaerobic conditions, sulphate is also reduced to ammonia. Collapse of cyanobacteria bloom also leads to increase in ammonia. When the ammonia concentration in the culture medium increases, excretion of ammonia by cultured organisms decreases. As a result ammonia level in blood and other tissues increases. It leads to elevation in blood pH and adverse effects on enzyme catalysed reactions and membrane stability. Ammonia also increases oxygen consumption by tissue, damages gills and reduces the ability of blood transport oxygen. Exposure of organism to sublethal concentrations ammonia increases susceptibility of organisms to diseases. Under farm conditions, the ammonia level should be less than 1 mg/l. In the present study ammonia level in the cultured pond was well below this mark that is favourable for the shrimp's growth.

In the present study, the growth of tiger shrimp *P. monodon was* gradually increased in cultured pond. The weight of the animal gradually increased after 30 days with increased length of animal. There was a direct relationship between weight and length of the animal. Similar observations were reported by earlier workers. According to Saldanha and Chetterji (1997) the weight increased always correlated with length of shrimp *P. monodon.* The result indicates that the shrimp *P. monodon* grow well in low salinity and optimum temperature (Rajyalakshmi *et al.,* 1981; Zhang *et al*., 1989; Shaylaja and Rengarajan, 1993 and Janakiram *et al.* 2011).

CONCLUSION

To get the profit in shrimp culture, proper water quality management and feed management is

essential. The present investigation reveals the better growth of *P. monodon* in cultured pond. It was achieved by good maintenance of water quality parameters and feed management.

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