American Journal of Agricultural Science Engineering and Technology

ISSN: 2158-8104 (Online), 2164-0920 (Print)
Volume: 5, Issue: 1

Published by: e-Palli,
Florida, USA

The American Journal of Agricultural Science, Engineering and Technology (AJASET) is blind peer reviewed international journal publishing articles that emphasize research, development and application within the fields of agricultural science, engineering and technology. The AJASET covers all areas of Agricultural Science, Engineering and Technology, publishing original research articles. The AJASET reviews article within approximately two weeks of submission and publishes accepted articles online immediately upon receiving the final versions.

Published Media: ISSN: 2158-8104 (Online), 2164-0920 (Print).

Frequency: 2 issues per year (January, July)

Area of publication: Agricultural Science, Engineering and Technology. The subjects covered by the journal includes but not limited to:

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Agricultural Engineering
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EFFECT OF COMMERCIAL FEEDS ON GROWTH AND PRODUCTION PERFORMANCE OF SHRIMP *(PENAEUS MONODON)* IN BAGERHAT COASTAL PONDS OF BANGLADESH

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DOI: http://doi.org/10.5281/zenodo.4716476

ABSTRACT

The experiment was conducted over 120 days from March to June 2019 in Bagerhat sadar upazila, Bagerhat. The study was categorized into four treatments indicated as T_1 (ACI feed), T_2 (Quality feed), T_3 (Mega feed) and T_4 (control) with three replicates. The experimental ponds were stocked with shrimp PL at same density of 4 nos./m^2. Ponds were treated with agricultural lime based on soil and water pH and fertilized with urea and Triple Super Phosphate depending on water transparency and depth. Different water quality parameters were determined at ten-day intervals. Parameters of water were within acceptable ranges of shrimp culture. Higher growth (30.36 g) of shrimp was achieved in T_2 compared to T_1 (28.53 g), T_3 (27.43 g) and T_4 (22.85 g). Growth and survival rate of shrimp were comparatively lower in T_4 at the same stocking density. Significantly ($p<0.05$) higher production of shrimp was obtained in T_2 (971.52 kg/ha) than those of T_1 (855.90 kg/ha), T_3 (757.07 kg/ha) and T_4 (566.68 kg/ha). Highest net profit (US$ 2570.2/ha) of shrimp farming was found in T_2 than that of T_1 (US$ 2105.7), T_3 (US$ 1786.6) and T_4 (US$ 1298.1). Results of the study indicate that among different commercial feeds Quality feed (T_2) is better than other feeds in respect of survival rate, growth, production and net profit. So, farmers may be encouraged to use Quality feed for getting higher production and significant return in a short period of time.

Keywords: *Penaeus monodon*, growth, production, water quality parameters, net profit.

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INTRODUCTION

Bangladesh is considered one of the most suitable country in the world for shrimp and prawn farming, because of its resources and favorable agro–climatic conditions. A sub-tropical climate and a vast area of shallow waterbodies provide a unique opportunity for shrimp and prawn production (Islam *et al.*, 2008). The culture of shrimp and prawn in the coastal zone is a major export earning activity for Bangladesh. Total shrimp and prawn production including capture has been increased from 1.60 lakh MT in 2002-03 to 2.39 lakh MT in 2018-19 (DoF, 2020). This culture is ongoing in the coastal belt during the early 1980s to supply international markets and earning foreign currencies (Islam *et al.,* 2001).

The giant tiger shrimp, *Penaeus monodon* is the largest brackish water shrimp, which is widely distributed throughout the Indo-Pacific region. It has been harvested from the sea and cultured in many countries of the world. The most important characteristic is its fast growth. It is a euryhaline and grow well in salinities from 5 ppt to 25 ppt. Survival rate is usually between 70-80% and it adapts well to intensified culture system (Liao, 1987). Bailey-Brock and Moss (1992) described shrimp as omnivorous scavengers, opportunistic omnivores, detritus feeders, carnivores and predators. They consume detrital aggregates including bacteria, meiofauna, protozoa, micro-algae, zooplankton, macrobenthos and other items (Dall, 1968; Chong and Sasekumar, 1997; Moriarty, 1997). The widely diverse feeding behaviors offer possibility to culture shrimp in polyculture as either the main species or a secondary species.

The nutrients in artificial feeds are well balanced to meet the nutritional needs of the cultured shrimp. The nutrients that should be included in shrimp feeds include protein for body building, fat for normal functioning of the body and for energy, carbohydrates for energy, mineral salts for bone structure and body functions and vitamins for good health. Regular supply of artificial feeds in shrimp culture pond generally increases shrimp production two times than that without artificial feeding (Shofiquzzoha and Alam, 2008).

Locally available ingredients such as fish meal, soya, maize and wheat are some ingredients that provide the nutrients listed above. The cost of feeds is the highest cost of production in commercial shrimp/fish farming. It ranges from 40% to 60% of the total cost of production. Use of formulated low-cost feed with locally available feed ingredients instead of expensive commercial feed may be a means to reduce feed cost as well as production cost. In many times, all ingredients of balanced feed are not available at local level round the year. Easily available low-cost commercial feeds such as Quality feed, ACI feed, Maisa feed, Mega feed and Nourish feed may be used instead of locally made low quality feed for increasing shrimp production as well as for higher net return.

Considering the growth, production potential, feeding behavior and economic benefit, shrimp *(P. monodon)* culture is practicing in many countries of the world. In maximum time, shrimp farmers of this country could not properly harvest shrimp due to viral diseases. Most of the shrimp farmers of Bangladesh do not use any type of feed for shrimp. Natural foodstuffs present in the shrimp pond are not sufficient to fulfill the demand of the growing biomass. Growth and production of farmed shrimp is largely dependent upon the supply and intake of dietary nutrient inputs and feed. So, economic loss due to low growth of shrimp might be partially minimized using commercial feed. Production and profitability of shrimp depend on several factors. Use of commercial feed is one of the most imperative factors among them. Some sporadic works on effects of commercial feed on growth and production of shrimp have been done in Bangladesh. Keeping the above facts in mind, the present study was undertaken to assess the effects of different commercial feeds on survival, production and economic return of shrimp culture at brackish water earthen ponds in Bagerhat region.

METERIALS AND METHODS

Experimental area and design

The experiment was conducted in twelve brackish water earthen ponds situated at Bagerhat sadar *upazila* of Bagerhat district (Fig. 1). Average area of the pond was 400 m^2 and average depth of water was 0.8-1.6 m each. The experiment was performed for a period of 120 days from March to June 2019. The experiment was designated as four treatments having three replications each. The treatments were T_1, T_2, T_3 and T_4. Selected ponds were randomly allocated under each treatment. Stocking density of shrimp was same each of the treatment.

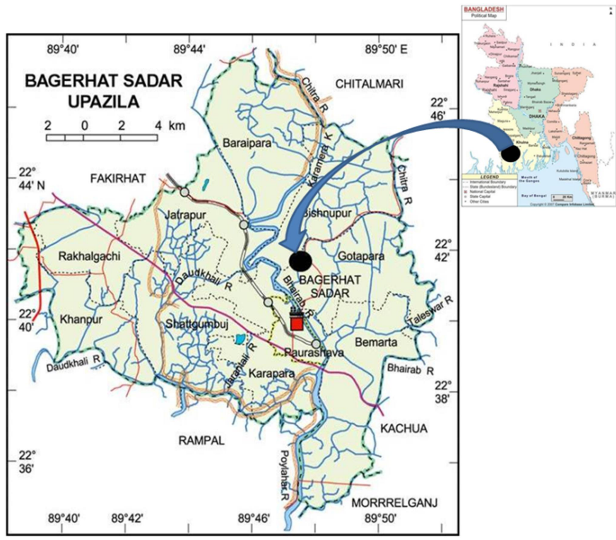

Fig. 1. Map of Bagerhat sadar *upazila* showing the experimental area.

Pond preparation and management

All selected ponds were drained out and were fully exposed to sunlight. Ponds were prepared by repairing the embankments and by removing all types of weeds. Before the trial, ponds were treated with agricultural lime ($CaCO_3$) at a rate of 250 kg/ha based on soil pH. Ponds were then filled with tidal water gradually up to a depth of 0.9 m from the nearby tidal canal through screen net. All unwanted organisms were eliminated using rotenone at a rate of 3 ppm and then lime ($CaCO_3$) was applied at a rate of 125 kg/ha for neutralizing its action. After 5 days of cleaning, ponds were fertilized with urea and TSP at a rate of 50 and 100 kg/ha, respectively. After 4-5 days of fertilization, the color of water turned into green. Fine meshed nylon net was used as fence on the dikes around ponds to prohibit the potential disease carrier's fauna such as snail, snake and others from outside.

Collection, stocking and feeding of shrimp

After collection of shrimp PL from local market of Rampal in Bagerhat, the polythene bags were kept in the experimental ponds for about 40 minutes and water was exchanged between bags and ponds to acclimatize with pond water temperature. After conditions, PL were released in all ponds. Commercial shrimp feed as Quality feed (29.0% protein, 11.0% moisture, 6.0% crude lipid and 5.0% crude fiber), ACI feed (33% protein, 10.0% moisture, 6.0% crude lipid and 7.0% crude fiber) and Mega feed (35.0% protein, 11.0% moisture, 6.0% crude lipid and 5.0% crude fiber) procured from local market was applied 6 days in a week to ponds at a rate of 10% of total shrimp biomass for first month, 6% for 2nd month and gradually decreased up to 3% until the end of the study.

Water quality determination

Water quality parameters of ponds like temperature, salinity, transparency, dissolved oxygen (DO) concentration, pH, total alkalinity and ammonia were measured between 9.00-10.00 am after 10-day intervals. Salinity of water was measured using a portable refractometer (ATAGO, Hand Refractometer). Surface water temperature was determined *in situ* using a standard centigrade thermometer. Transparency was recorded using Secchi disc. Dissolved oxygen was determined using a portable DO meter (YSI 58 digital DO meter, HANNA, Yellow Springs, Ohio 45387 USA). pH of water was recorded using pH meter (HANNA, USA). Total alkalinity was measured by titrimetric method (APHA, 2000). Ammonia nitrogen was measured using ammonia test kit (Biosol, A.A. Biotech PVT Ltd., Fishtech BD Ltd).

Sampling of shrimp

Fortnightly sampling of 15-20% stocked shrimp to estimate the biomass and to adjust the feeding rations and also to observe the physical conditions of stocked shrimp. Shrimp were sampled using cast net. Weight and length of 40 individuals of shrimp were recorded for growth assessment. Weight (g) was measured using a portable balance and length (cm) by measuring scale. Sampling was continued until harvest.

Estimation of growth, survival and production of shrimp

After 120 days of culture, bamboo poles and leaves were removed, water was drained out of ponds and all shrimp were harvested by repeated netting (cast net and surrounding net). All shrimp harvested from each pond were counted, measured and weighted individually to determine survival rate, growth and production. Specific growth rate (SGR), feed conversion ratio (FCR) and survival rate (%) were calculated following the equation as cited by Pechsiri and Yakupitiyage (2005). The equations are as follows:

Weight gain (g) = Mean final weight (g) - mean initial weight (g).

Specific growth rate (SGR) (%/day) = {Ln (final body weight) - Ln (initial body weight) × 100}/cultured period (days).

Feed conversion ratio (FCR) = Feed consumed (g dry weight)/live weight gain (g wet weight) of shrimp.

Survival rate (%) = (Number of shrimps harvested ÷ total number of shrimps stocked) × 100.

Production of shrimp= No. of shrimp caught × average final weight of shrimp.

Yield and economic analysis

The following equations were used to calculate production and profitability (Chowdhury *et al.,* 2020; Dillon and Hardaker, 1993). The currency was converted from BDT to US$ (BDT 84 = US$ 1).

$Gross\ return\ (GRi) = \Sigma i\ PiQi$

$Net\ return\ (\pi) = \Sigma i\ (PiQi) - TFC - TVC$

$Benefit\ cost\ ratio\ (BCR) = GRi/TC$

Here, Pi = market value of harvested shrimp in US$, Qi = production (kg/ha), i = treatments (T_1, T_2, T_3 and T_4), TFC = total fixed cost, TVC = total variable cost, TC = total cost (TFC + TVC).

Statistical analysis

The data were expressed as mean with their standard error mean (*SE*). All data were analyzed using IBM SPSS Statistics version 23. Data were initially tested for normality (Shapiro-Wilk test) and homogeneity of variance (Levene's test for equality of variance) before conducting one-way analysis of variance (ANOVA). All data were normally distributed and variances were approximately equal. As both conditions were fulfilled, growth and economic data were tested through ANOVA. Significant difference among means was compared with Tukey's HSD test at $P<0.05$. Linear regression was conducted to examine how well feed could predict growth parameters.

RESULTS AND DISCUSSION

Growth, production and profit of shrimp farming

Growth, survival rate and production of shrimp *(P. monodon)* in four treatments are depicted in Table 1. Average body weight (ABW) of PL of *P. monodon* during stocking was same (0.006 g) in all shrimp ponds. Mean final weight of shrimp was the highest in T_2 (30.36 g) followed by T_1 (28.53 g), T_3 (27.43 g) and T_4 (22.85 g), respectively (Fig. 2). Khanam *et al. (*2018) reported the final weight of shrimp as 23.40-31.76 g at different stocking densities (3-5 pcs/m^2) for 120 days at farmer's level, which supports the findings of the present study. Ghosh *et al.* (2013) recorded the final weight of shrimp as 40 g at a stocking density of 5 pcs/m^2 for 150 days in Pranti Shrimp Farming (PSF), Koira, Khulna, which is higher than the findings of the present study. Masud *et al.* (1997) demonstrated that final weight of shrimp as 15.5 to 26 g at different stocking density for 120 days in Elite Aquaculture Farm Ltd. in Teknaf of Cox´s Bazar, which is lower than the findings of the present work. Hossain *et al.* (1992) reported that shrimp attained an average weight of 21.65 g after rearing of 120 days with a stocking density of 5 PL/m^2 in earthen ponds, which is also lower than the present findings.

Table 1. Growth, survival rate and production (Mean±sd) of *Penaeus monodon* in different treatments.

Parameters	Treatments			
	T_1 (ACI feed)	T_2 (Quality feed)	T_3 (Mega feed)	T_4 (control)
Stocking density (nos./m^2)	4	4	4	4
Average initial weight (g)	0.006±0.002	0.006±0.001	0.006±0.002	0.006±0.001
Average final weight (g)	28.53^b ±1.05	30.36^a ±2.23	27.43^c±1.53	22.85^d ±1.38
Daily weight gain (g)	0.24^b ±.09	0.25^a±0.05	0.23^c±0.04	0.19^d±0.07
FCR	3.1^b±0.10	2.5^c±0.15	3.3^a±0.19	3.5^a±0.20
Specific growth rate (%/day)	7.06^b±1.02	7.11^a±1.01	7.02^c±1.02	6.87^d±0.22
Survival rate (%)	75.00^b±6.06	80.00^a ±5.49	69.00^c±7.91	62.00^d±2.00
Production (kg/ha)	855.9^b±15.33	971.52^a±27.83	757.07^c±32.96	566.68^d±9.68

Mean values in the same row with same superscript letters are not significantly different (p>0.05)

In present study, daily weight gain of shrimp was recorded as 0.24, 0.25, 0.23 and 0.19 g, respectively in T_1, T_2, T_3 and T_4 for 120 days. Khanam *et al.* (2018) reported the daily weight gain of shrimp as 0.19 to 0.26 g for 120 days at 3-5 pcs/m^2, which is in agreement with the present findings. Ghosh *et al.* (2013) measured the daily weight of shrimp as 0.20 to 0.28.5 g of 150 days at 5 to 15 pcs/m^2 density at PSF, Koira, Khulna, which is coincided with the present finding. Masud *et al.* (1997) reported that the daily weight of shrimp was 0.128 to 0.216 g at different stocking density for 120 days in Cox´s Bazar, which is slightly lower than the findings of the present study.

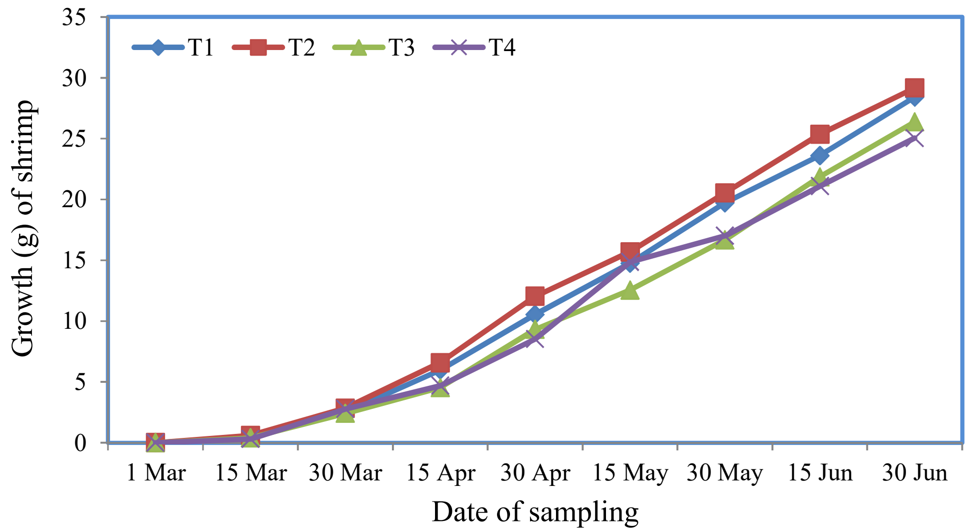

Fig. 2. Growth (g) of *P. monodon* in four treatments.

Specific growth rate (SGR) of shrimp varied from 6.87 to 7.11%, which is consistent with the findings of Khanam *et al.* (2018), who recorded the SGR of shrimp as 6.89-7.14%. Islam *et al.* (2008) found the SGR of shrimp as 6.79-6.91% in farmers´ shrimp farms of Bagerhat, which is in agreement with the findings of the present experiment. Sharma and Reddy (1996) reported SGR of shrimp as 2.01% using commercially available feed, which is lower than the present findings.

Feed conversion ratio (FCR) of *P. monodon* in the present study ranged between 2.5-3.5%, which is close to the findings of Khanam *et al.* (2018), who found the FCR of shrimp as 2.45 to 3.00. The findings of the present study are higher than the findings of Masud *et al.* (1997), who recorded FCR of shrimp as 1.78 to 2.02. Chekait *et al.* (1995) observed the FCR ranged from 1.5 to 1.55 using microencapsulated diets, which is lower than present findings of the study. Wyban and Sweeney (1989) found that shrimp as 2.0 to 2.5, which is slightly lower than the findings of the present study. Chanratchakool *et al.* (1995) stated that FCR varies with the stocking density, quality of feed, depth of water, quality of PL and the size at which shrimp were harvested.

Survival rate of shrimp in this study was 62.00 to 80.00%. Higher survival rate of shrimp was found in T_2 (80.00%) followed by T_1 (75.00%), T_3 (69.00%) and T_4 (62.00%), respectively. Khanam *et al.* (2018) obtained survival rate of shrimp as 76.00-85.00%, which is slightly higher than the findings of this study. Ghosh *et al.* (2013) found survival rate of shrimp as 58-76%, which is lower than the present findings. Islam and Mahmud (2010) and Islam *et al.* (2008) recorded survival rate of shrimp as 58-72.5 and 64.5-71.0%, respectively in shrimp farms of Bagerhat, which are lower than the present findings. Masud *et al.* (1997) obtained the survival rate of shrimp as 49 to 70%, which is also lower than the present study.

Production of shrimp in all treatments ranged from 566.68 to 971.52 kg/ha with the highest production (971.52 /ha) in T_2 and the lowest production (566.68 kg/ha) in T_4 for 120 days culture period. This finding is close to the findings of Khanam *et al.* (2018), who found production of shrimp as 809.88 to 990.00 kg/ha for 120 days in farmer's pond. Ghosh *et al.* (2013) obtained production of shrimp as 1498 to 2058 kg/ha in the stocking densities of 5 to 15 pcs/m^2, which is higher than the production of the present study. The findings of present study are higher than the findings obtained by Islam and Mahmud (2010) and Islam *et al.* (2008), who recorded shrimp production as 416.9-641.7 and 404.0-509.0 kg/ha in shrimp ponds of Bagerhat stocked with 3 PL/m^2 for 120 days fed with different feeds. Chen *et al.* (1989) found that production of shrimp as 848-1550 kg/ ha, which is higher than the findings of present study.

Profit of shrimp farming in present study obtained the highest (US$ 2570.1/ha) in T_2 followed by T_1 (US$ 2105.7/ha), T_3 (US$ 1786.6/ha) and T_4 (US$ 1298.1/ha). Benefit cost ratio (BCR) was also highest in T_2 (1.56) than those of T_1 (1.50), T_3 (1.47) and T_4 (1.45) (Fig. 3). The findings of this study are higher than the findings of Khanam *et al.* (2018), who obtained the profit from shrimp farming as US$ 1615.9 to 2336.2/ha for 120 days at a density of 3-5 pcs/m^2. Observed profit was higher than the findings of Ghosh *et al.* (2013), who recorded the net profit as US$ 1892.9/ha at a stocking density of 10 pcs/m^2. So, it is indicated that the highest net profit and BCR were obtained from the treatment of Quality feed (T_2) than others.

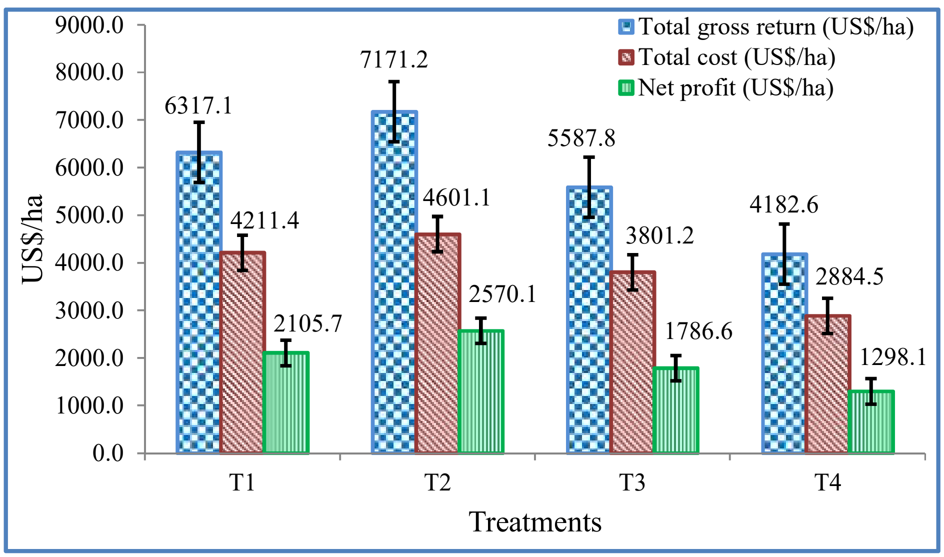

Fig. 3. Cost and economic return of *P. monodon* farming during study period.

Water quality parameters

Values of water temperature varied from 28.23 °C to 33.20°C, which is in agreement with the findings of Khanam *et al.* (2018) and Ghosh *et al.* (2013), who found water temperature ranges from 26.17 to 32.93°C and 25 to 32°C, respectively in farmer's shrimp pond of Bagerhat and Khulna (Fig. 4a). Dissolved oxygen (DO) concentration ranged from 4.10 to 5.33 mg/l, which supports the findings of Khanam *et al.* (2018) and Ghosh *et al.* (2013) who found the DO ranges from 4.02 to 5.01 mg/l and 4.0 to 6.0 mg/l, respectively (Fig. 4b). Salinity of water varied from 3.44 to 6.97 ppt. Ghosh *et al.* (2013) reported that the ranges of salinity for shrimp was 12 to 26 ppt, which is higher than the findings of present study (Fig.

4c). Islam and Mahmud (2010) reported the salinity ranged from 1.2-11.0 ppt in shrimp ponds, which are slightly higher than the present findings. Concentrations of ammonia nitrogen (NH_3-N) varied from 0.004 to 0.089 mg/l, which is similar with the findings of Khanam *et al.* (2018), Islam and Mahmud (2012) and Islam *et al.* (2008) who recorded ammonia nitrogen ranged from 0.003-0.008mg/l and 0.028-0.029 mg/l, respectively (Fig. 4d).

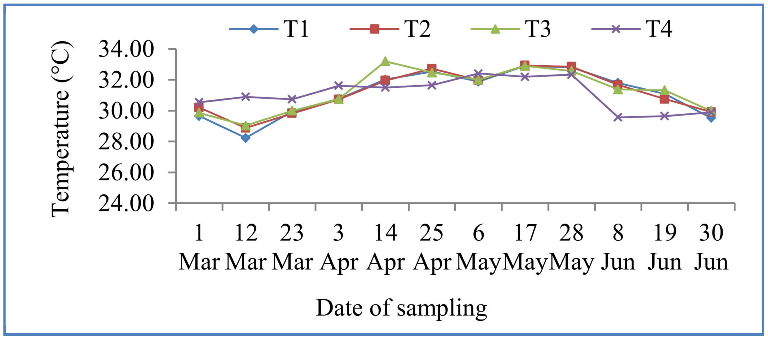

Fig. 4a. Variation of water temperature (°C) during study period.

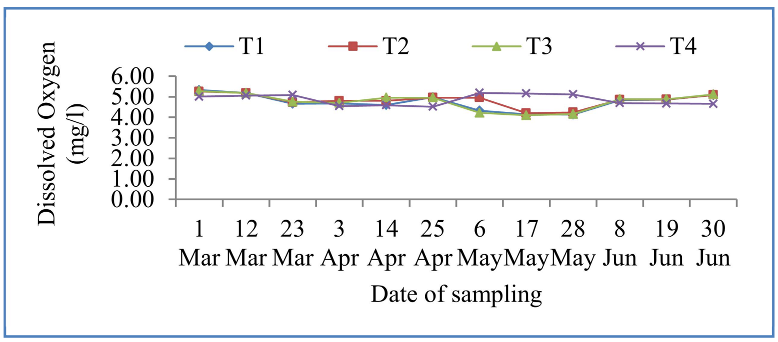

Fig. 4b. Variation of dissolved oxygen (mg/l) during study period.

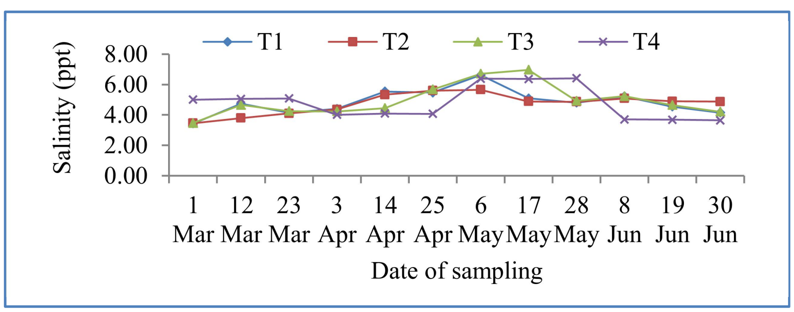

Fig. 4c. Variation of salinity (ppt) during study period.

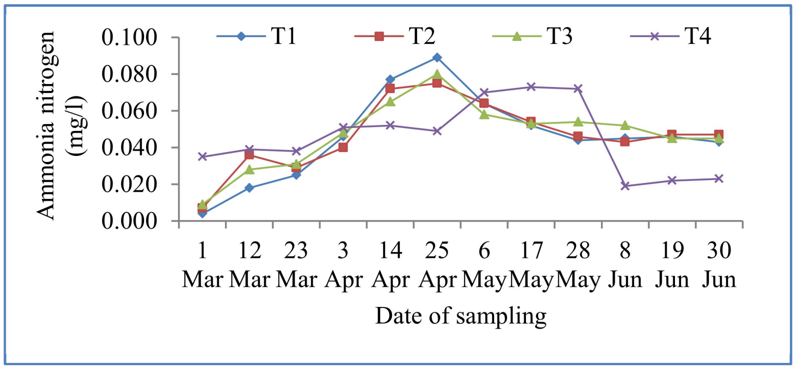

Fig. 4d. Variation of ammonia nitrogen (mg/l) during study period.

CONCLUSIONS

Sustainable of shrimp culture is dependent on various factors. Effect of commercial feeds is one of the most important among these factors. Most of the shrimp farmers are not aware of application of commercial shrimp feeds. But it is utmost imperative to know the quality, application and management of feeds for more production and more income. Based on the findings of the present study, it can be concluded that treatment 2 (Quality feed) is the best among all treatments in respect of survival, growth, production and net profit. Therefore, this commercial feed may be used in shrimp culture system in the coastal area for boost up shrimp production with a significant return.

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