IDENTIFICATION OF PHYSICO-CHEMICAL FACTORS AFFECTING THE GROWTH OF *Macrobrachium rosenbergii* IN PONDS

A Project Thesis

By

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Examination Roll No: MS 050609

Session: 2004-05

A project thesis submitted in partial fulfillment of the requirements for the Degree of

Master of Science

In

Fisheries and Marine Resource Technology

August 2007

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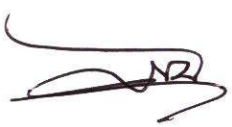
Approved as to style and content by



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Declaration

Identification of physico-chemical factors affecting the growth of *Macrobrachium rosenbergii* in ponds

The results presented in the thesis with the above mentioned title are entirely of the candidate's own investigations and no part of the results has been accepted for any degree nor is it being concurrently submitted for any degree.

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August, 2007

Dedicated
to

My Beloved Parents

Acknowledgement

All praises are to the Supreme Being, creator and ruler of the Universe God, whose mercy keeps me alive and enables me to pursue my education in Fisheries & Marine Resource Technology Discipline and to complete my project thesis for the degree of MS in Fisheries.

First, I would like to express my utmost indebtedness and gratitude to my supervisor **Mohammad Sayadur Rahaman,** Assistant Professor, Fisheries & Marine Resource Technology Discipline, for his careful supervision and guidance in completing this project thesis and for providing the opportunity.

I would like to give thank my respective and honorable teacher Professor Dr. Saifuddin Shah, Fisheries and Marine Resource Technology Discipline Khulna University for his constant encouragement and providence of all necessary facilities.

I, appreciate the efforts of all teachers who carefully and constructively gave their all out support, and valuable suggestions to do the research work.

I am delighted to avail myself to express my sincerest thanks to researcher Md. Moksedur Rahman (Anik) for cooperation during my research work.

I am thankful to the name SK. Omar Ali, lab technician of Water Chemistry Research Lab, Fisheries and Marine Resource Technology Discipline, Khulna University for acknowledgement of his hearty co-operation.

Amitosh Mallick

August 2007.

Abstract

This project thesis deals with the study of identification of physico-chemical factors of habitat which effect on the growth of *Macrobrachium rosenbergii* in ponds. The experiment was conducted into the research ponds located at the Khulna University premises during August to November of 2006. Twelve ponds were selected and they were stocked with three replications having densities of 500 PL/dec., 800 PL/ dec. 1000 PL/dec. and 958 PL/ dec. which were attributed as T_1, T_2 and T_3 and T_c respectively. Physico-chemical parameters of the pond habitat and as well as growth of post larvae (in wt) were recorded at an interval of fifteen days during the experimental period. Among the various parameters eg pH, alkalinity, DO, hardness, sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^-), phosphate (PO_4^{-3}), ammonia (NH_3^+), some such as DO, Ca^{2+}, Phosphate and alkalinity were identified as effective factors, which made a significant effect on the growth of *M. rosenbergii.* In T_c better growth was recorded at 7.27 pH, 0.71mg/L phosphate, 0.07 mg/L ammonia, 19.04 mg/L Mg^{2+}, 63.42 mg/L Ca^{2+}, 190 mg/L hardness, 179.2 mg/L alkalinity, 38.32 mg/L chloride, 2.07 mg/L K^+, 3.77p mg/L Na^+ and 6 mg/L DO. In T_1 better growth was recorded at 7.16 pH, 0.77 mg/L phosphate, 0.07 mg/L ammonia, 15.8 mg/L Mg^{2+}, 57.43 mg/L Ca^{2+}, 185 mg/L hardness, 183.33 mg/L alkalinity, 39.15 mg/L chloride, 1.76 mg/L K^+, 3.56 mg/L Na^+ and 6.16 mg/L DO. In T_2 better growth was recorded at 7.23 pH, 0.82 mg/L phosphate, 0.05 mg/L ammonia, 21.06 mg/L Mg^{2+}, 60.08 mg/L Ca^{2+}, 196 mg/L hardness, 170.8 mg/L alkalinity, 46.65 mg/L chloride, 1.6 mg/L K^+, 3.56 mg/L Na^+ and 5.83 mg/L DO. In T_3 better growth was recorded at 7.26 pH, 0.73 mg/L phosphate, 0.07 mg/L ammonia, 19.44 mg/L Mg^{2+}, 59.43 mg/L Ca^{2+}, 203 mg/L hardness, 156.66 mg/L alkalinity, 43.48 mg/L chloride, 1.8 mg/L K^+, 3.7 mg/L Na^+ and 5.8 mg/L DO. In case of aquaculture it is very important to record physico-chemical parameters for better management.

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Introduction

1.1Background of the study

In fish culture, water quality is usually defined as the suitability of water for the survival and growth of fish, and it is normally governed by only a few variables. Most fish culturists are aware of these variables and are acquainted with relationships between them and fish production. Water quality is somewhat nebulous and often used term that is seldom defined adequately. Any characteristics of water in production system that effects survival, reproduction, growth and production of aquaculture species, influences management decision, causes environmental impacts or reduces product quality and safety can be considered a water quality variable (Boyd 1979a). Other factors being equal, aquaculture species will be healthier, production will be more efficient, environmental impacts less and product quality better in culture systems with "good" water quality than in those with "poor" water quality. Knowledge of water quality principles will help aquaculturists determine the potential of a body of water to produce aquaculture species, to maintain or to improve water quality in the culture system, to minimize problem of fish stress and fish health, to produce higher quality aquacultural products, to reduce environmental impacts of effluents and to realize more efficient production and greater profits (Chatson 1984).

Aquaculture is a very old endeavor whose roots can be traced back for more than 2000 years in China. However, water quality did not become a major issue until more intensive production systems were developed during the second half of the 20th century. Most of the research and practical experience in water quality and its management have resulted from attempts to reduce risk and improve the efficiency of commercial production system during the past 20-25 years.

There are basically four levels of water quality restrains in aquaculture. When one is selecting a site for an aquaculture project, the quality of the source of water should be carefully evaluated. Natural water quality may not be adequate and treatment may be necessary to correct water quality problems. For example, if ponds are built on highly acidic soils, water in ponds may be so acidic that heavy liming is required. Water sources also may be highly polluted from anthropogenic sources and this pollution can have

serious effect on production. Investor should consider water quality limitations at a prospective site and estimate the cost of overcoming these limitations. If the cost is too great, the site should not be developed for aquaculture. It is better to never become an aquaculturist than to become a failed aquaculturist.

Once it is decided to start an aquaculture project at a given site, the next problem with water quality arises from water quality deterioration caused by management inputs to enhance production. The most common and problematic inputs are manures, fertilizers and feeds needed to increase production. These nutrient sources result in greater production, but they also lead to dense phytoplankton blooms, dissolved oxygen depletion and increased concentrations of toxic metabolites. As the production level increases and water quality deteriorates, water treatment methods such as aeration, water circulation and water exchange must be used to maintain tolerable culture conditions. Even with water quality management inputs, the efficiency of production cannot be maintained at a constant level as production rises. Thus the cost of production normally increases as production increases and the most profitable production level are well below maximum production. The objective in aquaculture, as in other business, should be to optimize profits and reduce risk instead of maximizing production. Unfortunately many aquaculturists seem to equate high production with good profits. Whereas this is true within a certain range of production, because of increasing costs in maintaining water quality as production increases, many aquaculturists go beyond the plateau in profit.

The effluents from aquaculture ponds can result in eutrophication, sedimentation and other environmental perturbations in receiving waters. Good water quality management in ponds can be a powerful tool in reducing the volume and enhancing the quality of pond effluents to minimize adverse environmental effects. Treatment methods also are available for improving the quality of effluents before their final discharge from aquacultural operations. Unfortunately, some researchers are attempting to develop very complex solutions to this rather simple problem. This phenomenon is driven by the quest for research funds rather than by a sincere desire to develop simple, cost effective waste management procedures for the benefits of the aquacultural industry. Many areas of aquaculture too much emphasis is placed on novel ideas and high-tech solutions rather than on well-conceived, realistic solutions. In fact, granting agencies usually fail to fund

projects that suggest a simple, low-tech solution in favor of necessary, novel, complex approaches. It should be remembered that pond aquaculture is rather low-tech endeavor and we should first seek simple solutions to problems.

Finally, certain substances that are applied to ponds in management inputs, produced by pond biota, or admitted to ponds in the water supply may enter the flesh of fish and other aquaculture species. Examples are antibiotics used in feeds, water quality amendments applied to ponds, toxins and flavor compounds produced by algae and pesticides and heavy metals. Accumulation of certain compounds in aquatic animals may impart discoloration or off flavor to the flesh, making it unacceptable to the consumer. Accumulation of microbial toxins, antibiotics, pesticides or heavy metals in aquacultural products may even pose a food safety hazard to the consumer (Boyd 1990).

Hundreds of water quality variables may affect the well being of fish or crustaceans, but, fortunately, only a few normally play a decisive role (Boyd 1990). Some variables, such as salinity and water temperature, are important when assessing the suitability of a site for the culture of a particular species. Other properties, such as alkalinity, turbidity, and compounds of phosphorus and nitrogen are important because they affect plant productivity, which, in turn, may influence aquaculture production. Dissolved oxygen, carbon dioxide, ammonia, and other factors come into play during the grow-out period because they are potential stressors of the animal under culture.

1.2 Statement of the problem

Fish farmers often have a poor understanding of monetary benefits of a given management procedure. In waters used for fish culture, using either fertilizer or fish feeds, occasionally both, increases production. The proper grade and application rate for fertilization or chemical treatment must be selected through out the culture period. From the preparation of pond to end of harvesting, the water quality management should be considered with close observation during the nursery of the products. Research regarding the selection of suitable water environment for best out put must be carefully considered with cost effectiveness of management procedure.

1.3 Objectives of the study

- To record the physicochemical characteristics of pond habitat in different stocking density of *Macrobrachium rosenbergii* during their nursery in ponds.
- To identity the physicochemical factors of pond habitat which can affect on growth of *M. rosenbergii* during their development in different stages.
- To identify the suitable water quality criteria for culture of *M. rosenbergii* in their development stages.

Literature review

Enough research reports on water quality of shrimp culture are not available. Some authors have given several reports on water quality of shrimp culture, which are cited below.

Law (1988) reported that shrimp post larvae could tolerate pH as low as 6.5.he recommended the pH range from 7.5 to 8.5 for the shrimp culture

Environmental stresses including a variety of factors such as the presence of a large number of bacteria associated with larvae, temperature, pH, DO, salinity, over crowding, physical handling etc were considered by different workers (Nash *et al.*, 1987 and Hameed, 1993).

Hoq *et al.* (1996) measured a few water quality parameters in five prawn farmers' ponds in Kolaroa thana under Satkhira district. They recorded that temperature ranged from 27.5-30.5^{0}C, pH from 7.5 – 8.0 and DO from 4.0-5.9mg/ l.

Apud *et al.* (1981) stated that growth of PL's in the nursery is highly dependent on water management and depth as well as on quantity of supplementary feed or formulated diet used. On the other hand, he also mentioned that stocking densities for intensive nursing systems range from 100,000 to 400,000 PL/ha with the optimum of 150,000 to 250,000 PL/ha as practiced by most intensive growers where the survival vary from 60-80%.

Raanan *et al.* (1984) stated the minimum required ambient temperature for rearing of freshwater prawn is 22^{0}C.

Apud *et al.* (1985) reported that the minimum dissolved oxygen level of prawn is 3-4 mg/L. However, below 2 mg/l of oxygen prawn exhibit an initial period of hyperactivity with swimming at the surface and jumping followed by morality.

Sandifer and Smith (1985) reported that satisfactory temperature for prawn culture ranged from 26 ^{0}C to 31 ^{0}C and optimum temperature was 28 ^{0}C to 30 ^{0}C.

Estilo (1988) mentioned that mortality of shrimp would occur at low (1 ppm) dissolved oxygen levels for prolonged period. He also noted that the levels of dissolved oxygen should not below 4 mg/l for shrimp culture.

Jia- Mo *et al.* (1988a) conducted a monoculture experiment on *M. rosenbergii* in earthen ponds and found the total yield was 547.7 kg/ ha with average yield 91.28 kg for 142 days culture period when the survival rate was 57.68% and the average size of the prawn was 17.58 g. They also reported that the food conversion rate was 3:1 with "Camaronina" (35% protein) , the water temperature fluctuated from 28.5^0 C to 33^{0}C, the pH from 7.5 to 8.5 and the dissolved oxygen was 4.5 ppm.

Thai *M. rosenbergii* hatchery management results in a stocking density of 30-50/l (New, 1990) and Hawaiian hatcheries expect 50-70 % survival to achieve a post-larval production of 30/l. For *M. rosenbergii* larval rearing, a salinity range of 10-15 ppt is generally practiced. Optimum temperature range of 26-31^{0}C or above 35^{0}C cause retarded development or mortality. Newly hatched brine shrimp nauplii (artemia), fish flesh, mussel flesh, squid flesh and egg custard are frequently used. Artemia nauplii are maintained at 1 nauplii/ml and increased to about 5 nauplii/ml while feeding in Thailand but Hawaiian hatcheries trend to use5-15 nauplii/ml (New, 1990). Modify the fatty acid content of artemia nauplii have proved effective (Sorgeloos *et al.,* 1996). Post larval production rates have been reported as 10-20 /l nauplii/ml in Thailand, 30/1 in Hawaii, (New, 1990) and by using intensive antibiotic aided techniques in France hatcheries production of up to 50/1 has been achieved (AQUACOP, 1997).

Freshwater prawns (*M. rosenbergii*) have been grown to market size in a variety of conditions, both by scientists and farmers in up to 25 ppt salinity in pens and cages and in ponds. Ang *et al* (1992) concluded that when PL_{32} *M. rosenbergii* were reared in cages for 24 weeks, a stocking density of 10/m^2 gave better growth and survival than 2/m^2 although final biomass was the highest and the greatest stocking density

Kanit *et al* (1992) conducted research work on variation physico-chemical properties of water and phytoplankton in intensive shrimp pond at Amphoe Ronot, Songkhla in

Thailand and reported that the major genus of *Trichodesmium* which increased from 5,665 cells/l to 1,28,541 cells/l and 11.94 million cells /l from the 6th and 12th week, respectively. After the 12th week, it had decreased to 203,262 cells/l. They also stated that the second most abundant species was *Spirogyra* and the number increased from 38 cells/l in the second week to 2.19-million cells/ l in the 18th week.

Sadek and El-Gayar (1993) evaluated the effect of used agricultural drainage water with salinity from 4-6 ppt, total hardness from 900-1500 ppm and total alkalinity from 170-180 ppm on the growth rate of *M. rosenbergii* in earthen ponds at different stocking densities (1 or 2 prawns /m^2) and observed an average weight of 52.8±0.7 g and 50.8±2 g for the two densities 1 and 2 prawns / m^2, respectively with individual daily increments of 318±0.5 and 319±5.5 mg /day after 155 days culture period. They also reported that the survival rates varied from 62 to 80 % at stocking densities between 1 or 2 prawns /m^2 and no difference was observed in feed conversion rate, calculated as 4.1±0.2 and 4.6±0.3 for the two densities of 1 and 2 prawns /m^2, respectively.

Chen and Chen (2003) investigated the effects of pH on survival, growth, moulting and feeding of giant freshwater prawn and found that 24-, 48-, 72-, and 96- h LC 50s (median lethal concentrations) of pH of juveniles (0.13± 0.01 g) were 4.00, 4.05, 4.07 and 4.08, respectively. Survival rates of juveniles (2.65±0.06g) following 56 days exposure to pH 8.2, 7.4, 6.8, 6.2 and 5.6 were 100%, 88.9%, 94.4%, 94.4% and 94.4%, respectively. The body weight, total length, feeding rate and moulting frequency of prawns were significantly lower ($P<0.05$) in acidic pH. Finally they concluded that the minimum acceptable pH levels were 6.2 and 7.4 based on growth and feeding, respectively.

Asaduzzaman, *et al.* (2006) conducted an experiment to evaluate the effect of control of Carbon/Nitrogen ratio by addition of low cost carbohydrate to the water column on water quality and pond ecology in fresh water prawn *M. rosenbergii* post-larvae nursing system. According to the results of this experiment control of C/N ratio by the addition of low cost carbohydrate to the pond water column benefited the freshwater prawn nursing practices in three ways; increased heterotrophic bacterial growth supplying bacterial protein augment the prawn post-larvae growth performances,

reduced demand for supplemental feed protein and subsequent reduction in feed cost and reduced toxic NH_3-N and NO_2-N levels in pond nursing system

Materials and Methods

3.1 Site selections

Twelve ponds, 1.25 decimal (0.50 square meter) each, located at the Khulna University premises were selected for conducted the research during the period August to November 2006. Ponds were stocked with three replications at densities 500 PL/dec., 800 PL/ dec. 1000 PL/dec. and at 958 PL/ dec. as control group attributed as T_1, T_2 and T_3 and T_c respectively. The selected ponds were with adequate aquaculture facilities, such as necessary water depth (1.25-1.5m), well constructed dikes, free from flood or water logging, sunny, available sources of water supplies, easy to access etc. The ponds were more or less equal in depth, basin, configuration and pattern.

3.2 Analytical Methods Set-up

Before starting the project works, important analytical methods regarding the pertinent water quality parameters were carried out for standard by following procedures into the Water Chemistry Research Laboratory of Fisheries and Marine Resources Technology Discipline.

Experiment name: Determination of **pH** by electrometric method.

Procedure

By using a pH meter (Hanna Instrument Model: ISO 9001) the pH of the experimental ponds was measured on site. Calibration of the instrument was done immediately before measurement by using standard buffer of pH 7.0 and 9.10.

Experiment Name: Determination of the **alkalinity** of the water sample by the neutralization titration.

Principle

Water samples containing measurable OH^- and or CO_3^{2-} ions turn pink to phenolphthalein indicator. This water becomes colorless at pH below 8.4, when titrated with acid to covert theses ions to HCO_3^- form. Again, water sample with only HCO_3^- can be titrated to the critical pH level of 5.3 with acid by using yellow to faint

orange color change of methyl orange indicator. Both of the indicators are used for determining total alkalinity, expressed as ppm of calcium carbonate ($CaCO_3$) and also the concentrations of OH^-, CO_3^{2-} and HCO_3^- ions in water samples.

Materials

- Burette (25ml), Pipette (10ml), Funnel, Conical flask (250), Measuring flask (100ml), Beaker (250ml), Spatula, Burette stands etc.

Reagent

- H_2SO_4, Na_2CO_3, Phenolphthalein indicator, Methyl orange indicator.

Reagent Preparation

- 0.1N H_2SO_4 solution: 2.8ml H_2SO_4 (95-98%, sp gravity=1.84) was taken into 1 litter volumetric flask and diluted it to 1000ml mark of the flask.
- 0.1N Na_2CO_3 solution: 2.65gm Na_2CO_3 was taken into 500ml volumetric flask and diluted it to 500ml mark of the flask.
- Phenolphthalein indicator solution: 2.5gm Phenolphthalein was dissolved into 250ml 95% ethyl alcohol and added 250ml of distilled water.
- Methyl orange indicator solution: 500gm methyl orange free acid powder was dissolved in distilled water and diluted it to 1 liter.

Procedure

- The burette was rinsed with distilled water and then rinsed with 0.1N H_2SO_4 by pipette.
- The burette was clamped and filled with 0.1N H_2SO_4 solution up to mark.
- The H_2SO_4 was standardized by $NaCO_3$ solution.
- The sample (10ml) was taken into 250ml of conical flask and added 5 drops of methyl orange indicator solution into it and titrated with 0.1N H_2SO_4 to a light pink (pH 4.5) color as required by the sample composition.

Calculation

Alkalinity, $mgCaCO_3 / L = \frac{A \times N \times 50000}{ml\ Sample}$

A = ml standard acid used and N = normality of standard acid.

Experiment Name: Determination of the **dissolved oxygen (DO)** of the water sample by the Winkler method.

Principle

Manganous (Mn^{2+}) ions form manganous hydroxide ($MnOH_2$) under highly alkaline condition. This $MnOH_2$ reacts with DO of water and an equivalent amount of Mn^{+2} is oxidized to higher valency states. On acidification, in presence of iodide, the oxidized manganous (Mn^{+4}) again reverts to divalent Mn^{+2} and iodide is liberated in equivalent amount of DO. This I_2 estimated by titration with sodium thiosulphate ($Na_2S_2O_3$) indicates the amount of DO in water sample.

Materials

- Manganous sulfate ($MnSO_4.4H_2O$), KOH, KI and NaN_3, Starch and Sodium thiosulfate ($Na_2S_2O_3$)

Procedure

Laboratory Preparation:

- Manganous sulfate solution: 120gm $MnSO_4.4H_2O$ (or 100gm $MnSO_4.2H_2O$ or 91gm $MnSO_4.H_2O$) was dissolved in distilled water and diluted to 250ml.
- Alkali-iodide-acid reagent: For a saturated or less than saturated sample; 700gm KOH and 150gm KI were dissolved in distilled water and diluted to 1L. 10gm NaN_3 was added into it dissolved in 40ml distilled water.
- Starch solution: 2gm laboratory grade soluble starch and 0.2gm salicylic acid were dissolved as a preservative, in 100ml hot distilled water.
- Standard sodium thiosulfate titrant: 6.205gm $Na_2S_2O_3.5H_2O$ was dissolved in distilled water and 0.4gm NaOH was added and diluted to 100ml.

Field Work:

- 1ml $MnSO_4$ solution was added followed by 1ml alkali-iodide-azide reagent to the sample collected in a 250 to 300ml BOD bottle.
- The bottle was stoppered carefully to exclude air bubbles and mixed by inverting bottle a few times.
- When precipitate had settled sufficiently to leave clear superannuate above the manganese hydroxide floc, 1.0ml conc. H_2SO_4 was added.
- The bottle was restoppered and mixed by inverting several times until dissolution was completed

- The sample (10ml) was titrated with 0.025 $Na_2S_2O_3$ solutions to pale straw color by adding a few drops of starch solution and continued titration to first disappearance of blue color.

Calculation

$$\text{DO in } mg/L = \frac{y \times 200}{x}$$

Here y = ml of the titrant and x = ml of the sample.

Experiment Name: Determination of **Hardness** of the water sample complexometric titration (EDTA titration).

Principle

For determining hardness of waters, concentration of Ca and Mg in water are first determined. The values are then converted to respective equivalents of $CaCO_3$and added to get total hardness of water.

Materials

Glassware, volumetric flask, burette, pipette, conical flask etc.

Reagents

0.01N calcium solution, ammonium purpurate (murexide) indicator, erichrome black T indicator, 4N sodium hydroxide, ammonium chloride, 0.01N EDTA solution.

Procedure

(a)Standardization of EDTA solution:

- 5ml 0.01N Ca solution was taken in a 100ml conical flask and dilutes it to about 25ml with distilled water.
- Then 5ml 4N NaOH solution was added and about 25mg of murexide indicator was added.
- The content was mixed well to get a orange red coloration.
- Then it was titrated with 0.01N EDTA solution against a white background until the color changes to purple.
- The color changes were not very distinct and hence the titration during end point was carried out cautiously.
- The strength of EDTA solution was determined by using the following relationship.

  Strength factor = S/V

  Where, V = volume of EDTA solution.

Titration

- 10ml of water sample was taken in a 100ml conical flask.
- Then 1ml of NH_4Cl-NH_4OH buffer solution and 1drop of eriochrome black T indicator was added to get a wine red color.
- It was then titrated against0.01N EDTA solution until the color change to blue.

Calculation

Hardness = (AxBx1000)/ml sample.

Where, A = ml of titrant and B = 1.0

Experiment Name: Determination of **Sodium (Na^+)** by photometric method.

Reagents

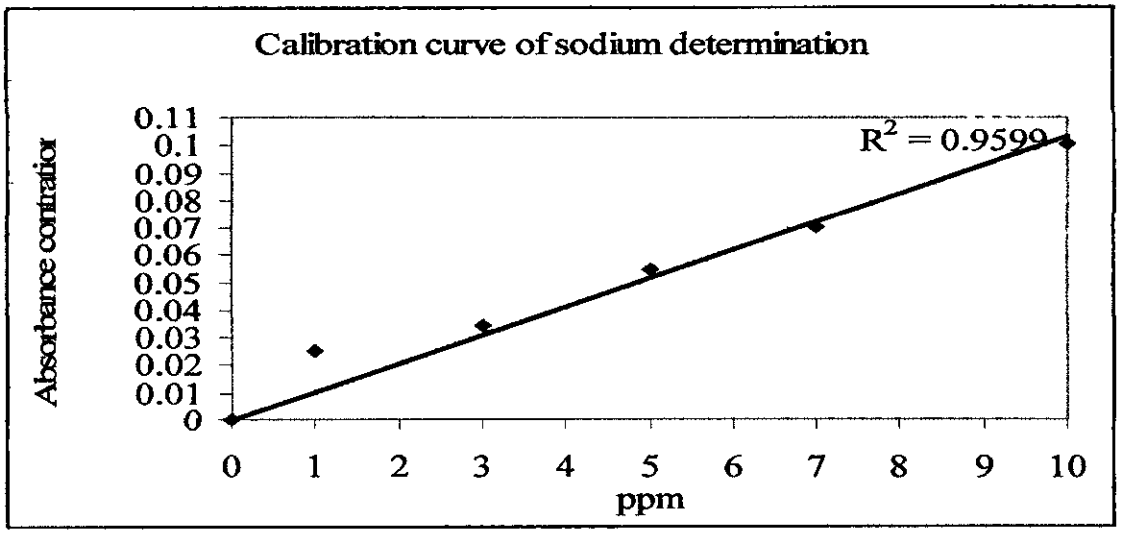
Stock sodium solution: 0.25419 g sodium chloride (NaCl) was dissolved in distilled water and making up to 100 ml and its concentration was 1000 ppm.

Sodium (Na^+) standards

1, 3, 5, 7and 10ppm sodium standard solution was prepared from stock solution.

Procedure

- At first flame photometer was standardized by standard solutions and set the digital reading at 100 by means of the sensitivity knob.
- Next standard solutions were analyzed by flame photometer and the absorbance was recorded and in the same way unknown samples were analyzed by flame photometer and absorbance was recorded.
- Blank sample absorbance was always zero.
- Then a calibration curve was prepared by standard sodium samples.



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X	0	1	3	5	7	10
Y	0	0.025	0.034	0.055	0.07	0.1

Calculation

Sodium concentration of water samples was calculated from the calibration curve, which was prepared by standard sodium samples.

Experiment Name: Determination of **Potassium (K^+)** by photometric method.

Reagent

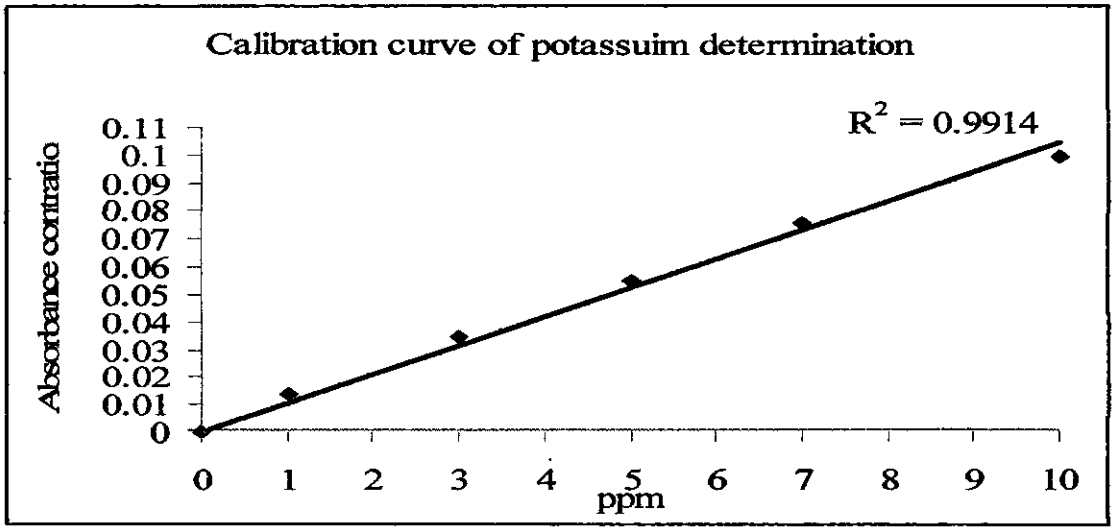
Stock potassium solution: 0.1907 g potassium chloride (KCl) was dissolved in distilled water and making up to 100 ml and its concentration was 1000ppm.

Potassium (K^+) standards

1, 3, 5, 7 and 10ppm potassium standard solution was prepared from stock solutions.

Procedure

- At first flame photometer was standardized by standard solutions and set the digital reading at 100 by means of the sensitivity knob.
- Next standard solutions were analyzed by flame photometer and the absorbance was recorded and in the same way water samples were analyzed by flame photometer and absorbance was recorded.
- Blank sample absorbance was always zero.
- Then a calibration curve was prepared by standard potassium samples



Here,

X	0	1	3	5	7	10
Y	0	0.014	0.035	0.055	0.076	0.1

Calculation

Potassium concentration of water samples was calculated from the calibration curve, which was prepared by standard potassium solutions.

Experiment Name: Determination of the **calcium** of the water sample by the neutralization titration.

Principle

When EDTA (ethylenediaminetetraacetic acid or its salts) is added to water containing both calcium and magnesium, it combines first with calcium. Calcium can be determined directly with EDTA, when the pH is made sufficiently high that the magnesium is largely precipitated as the hydroxide and an indicator is used that combines with calcium only. Several indicators give a color change when all of the calcium has been complexed by the EDTA at a pH of 12 to 13.

Reagent

- Sodium hydroxide (NaOH) 1N,
- Murexide (ammonium perpetrate) indicator: This indicator changed from pink to purple at the end point.
- Standard EDTA titrant, 0.01M: 3.723g analytical reagent-grade disodium ethylenediaminetetraacetate dehydrate, was dissolved in distilled water and diluted to 1000 mL.

Procedure

2.0 mL NaOH solution or a volume sufficient to produce a pH of 12 to 13 was added to the sample and stirred. Then 0.1 to 0.2 g indicator was added and then EDTA titrant was slowly added with continuous stirring to the proper end point.

Calculation

$$mgCa/L = \frac{A \times B \times 400.8}{ml\ Sample}$$

Experiment Name: Determination of the **magnesium** of the water sample by the calculation method

Procedure

Magnesium may be estimated as the difference between hardness and calcium as $CaCO_3$ if interfering metals are present in noninterfering concentrations in the calcium titration and suitable inhibitors are used in the hardness titration.

Calculation

Mg Mg/L= [total hardness (as $CaCO_3$/L) - calcium hardness (as mg $CaCO_3$/L)] × 0.243 (Greenberg *et al* 1992)

Experiment Name: Determination of phosphorus by vanodomolybdophosphoric acid colorimetric method.

Principle

In a dilute orthophosphate solution, ammonium molybdate reacts under acid conditions to for a heteropoly acid, molybdophosphoric acid. In the presence of vanadium yellow vanadomolybdophosphiric acid is formed. The intensity of the yellow color is proportional to phosphate concentration.

Apparatus

a. Colorimetric equipment: It included the following
1. Spectrophotometer, for use at 400 to 490 nm.
2. Filter paper, provided with a blue or violet filter exhibiting maximum transmittance between 400 and 470nm.

b. Acid-washed glassware.

c. Filtration apparatus and filter paper.

Reagent

a. Phenolphthalein indicator aqueous solution.

b. Hydrochloric acid, HCl, 1+1. H_2SO_4, $HClO_3$ or HNO_3 may be substituted for HCl. The acid concentration in the determination is not critical but a final sample concentration of 0.5N was recommended.

c. Activated carbon: Final precipitate was removed by rising with distilled water.

d. Vanadate- molybdate reagent:

1) Solution A: 25gm ammonium molybdate $(NH4)_6Mo_7O_{24}.4H_2O$) was dissolved in 300 ml distilled water.

2) Solution B: 1.25 gm ammonium metavanadate, NH_4VO_3, was dissolved in 300 ml distilled water by heating to boiling. The solution was cooled and 330 ml conc. HCl was added. Then solution B was cooled to room temperature and solution A was poured into solution B. Finally it was mixed and diluted to 1mL.

3) Standard phosphate solution: 219.5 mg anhydrous KH_2PO_4 was dissolved in distilled water and diluted to 1000mL; 1.00 mL = 50 μg $PO_4^{3-}P$.

Procedure

- Sample adjustment: 0.5 mL (1 drop) phenolphthalein indicator was added to 50 mL sample when sample pH was greater than 10 and the red color was discharged with 1+1 HCl before diluting to 100 mL.
- Color removal from sample: Excess color in the sample was removed by shaking about 50 mL with 200 mg activated carbon in an Erlenmeyer flask for 5 minutes and was filtered to remove carbon. Each batch of carbon for phosphate because some batches produced high reagent blanks.
- Color development sample: 35 mL or less of sample was placed in 50 mL volumetric flask containing 0.05 to 1.0 mg P.10 mL venadate- molybdate reagent was added and diluted to the mark with distilled water. A blank was prepared in which 35 mL distilled water was substituted for the sample. After 10 minutes or more, absorbance of sample was measured versus a blank at a wavelength of 430nm (400 to 490) depending on sensitivity desired. The color was stable for days and its intensity was unaffected by variation in room temperature.
- Preparation of a calibration curve: A calibration curve was prepared by using suitable volumes of standard phosphate solution and proceeding as in c.

Apparatus

- Erlenmeyer flask,

3.4 Sampling of prawn PL and growth measurement

A push net (*thala jal*) was used to collect sample of prawn PL from each pond. The stocking weight of the PL was recorded before releasing into the ponds. Data on growth of the PL in weight was recorded once in every fifteen days and the physico-chemical parameters were also recorded in the same time. A total of 20 PL from each pond was collected and taken to the laboratory and then they were anesthesized by bathing the PL in a solution of 1 ppt benzocane of 10% alcohol (Shah 1984). After that individual weight of the PL was measured in gram up to 3 digits after the decimal point by using an electric balance and then was returned to the respective ponds. The sampled PL of golda was handled very carefully to avoid the handling stress. Experimental data collected were used to measure growth by following way:

Weight gain (g) = Mean prawn weight at certain record - Mean prawn weight of the previous record

3.5 Water quality parameters analysis

Water quality parameters were analyzed according to the procedures that described above.

Results and Discussions

Successful aquaculture depends on providing animals with a satisfactory environment in which to grow. Good initial conditions for aquaculture can be assured by selecting a site with suitable soils and high-quality water supply. There is a difference between tolerance levels, in which the fish will survive, and optimal levels of water quality, in which fish will achieve the best health and growth. Optimal water quality criteria are dependent upon species of fish, age/size of the fish and prior exposure of the fish. Growth of fish and prawn are normally governed by few environmental factors (Fry, 1971). A number of water quality parameters which are important for characterization of habitat such as pH, total alkalinity, dissolved oxygen and hardness and important water constituents such as sodium (Na^{+}), potassium (K^{+}), calcium (Ca^{2+}), and magnesium (Mg^{3-}), phosphate (PO_4^{-3}) and ammonia (NH_3^{-}) which can effect on growth of *M. rosenbergii* were measured at fifteen days interval during the period of experiment in different stocking density with replication. Data on growth of the PL in weight was recorded once in every fifteen days during the estimation of water quality parameters. These were given in table. 4.1

Table: Water quality parameters of pond habitat and growth (in gm) of PL.

	Sampling	pH	Alkalinity (mg/L)	DO (mg/L)	Hardness (mg/L)	Na^+ (mg/L)	K^+ (mg/L)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	PO_4^{3-} (mg/L)	Cl^- (mg/L)	NH_3^- (mg/L)	Growth (in gm)
T_c	1st	6.77	127.78	3.5	180	4.17	2.67	24.09	17.01	0.31	56.65	0.06	0.191
	2nd	6.87	150.00	4	178	4.07	2.27	33.42	17.01	0.54	35.80	0.06	0.223
	3rd	7.17	174.83	4.50	186	4.00	2.27	45.43	17.82	0.77	35.82	0.07	0.448
	4th	7.27	179.17	6.00	190	3.77	2.07	63.42	19.04	-	38.32	-	1.063
	5th	7.33	183.33	6.33	183	3.77	2.03	43.42	18.23	-	36.65	-	0.874
T_1	1st	6.9	141.66	3	186	3.7	2	25.09	18.5	0.59	63.31	0.09	0.139
	2nd	6.9	129.16	3.5	186	3.63	1.83	44.08	18.63	0.71	39.14	0.09	0.798
	3rd	7.16	183.33	6.16	185	3.56	1.76	57.43	15.8	0.66	39.15	0.07	1.805
	4th	7.13	158.33	6	190	3.4	1.63	44.76	19.04	-	41.65	-	1.384
	5th	7.33	179.16	5.33	186	3.36	1.53	45.42	17.82	-	39.98	-	1.09
T_2	1st	7.3	127.77	3.5	206	3.9	1.76	27.43	21.46	0.36	63.87	0.06	0.09
	2nd	7.53	150	4.33	210	3.76	1.7	46.76	22.68	0.58	40.82	0.06	0.210
	3rd	7.33	190	5.16	200	3.63	1.7	44.75	21.46	0.82	44.15	0.05	0.597
	4th	7.23	170.83	5.83	196	3.56	1.6	60.08	21.06	-	46.65	-	0.915
	5th	7.43	175	5	200	3.56	1.46	44.75	20.25	-	42.48	-	0.708
T_3	1st	7.36	127.77	4	200	3.86	1.93	30.76	19.04	0.65	66.09	0.09	0.070
	2nd	7.33	146.66	3.5	200	3.8	1.9	49.43	18.63	0.73	51.37	0.07	0.071
	3rd	7.26	156.66	5.8	203	3.7	1.8	59.43	19.44	0.68	43.48	0.07	0.978
	4th	7.46	200	5.83	190	3.7	1.7	49.43	16.2	-	45.81	-	0.583
	5th	7.46	154.16	5	190	3.66	1.66	47.43	17.41	-	44.15	-	0.769

Characterization of pond habitat and its effect on growth

Pond fish will not survive in waters with pH less than 5. In waters with pH values of 5 to 6, fish will survive, but they will not grow and reproduce normally. There are many bodies of water where pH is adequate for normal growth and survival of fish. The optimum pH for growth and health of most freshwater aquatic animals is in the range 6.5-9.0 (Boyd 1990). The same processes as in natural waters regulate the pH of waters in aquaculture ponds but biological activity usually has a greater effect on pH in aquaculture ponds in most natural waters. The initial pH of pond waters is a function of total alkalinity of the water. After ponds are put into culture, the activities of plants, bacteria, and animals cause the pH to cycle diurnally. Hence pH is considered as an important factor in fish culture. It is also called the productivity index of a water body. Rapid fluctuation of pH level of a culture pond cause to hinder the growth of golda PL. In this study, experimental ponds were treated with chemical in usual practice. The pH values were recorded in different stages of Galda PL in different stocking density with replication. But close observations were made; there is any effect on the growth of PL and correlation with other physico-chemical characteristics of pond habitat, which can influence on growth of the species.

The pH value observed in the experimental ponds to be near neutral to slightly alkaline. The pH value ranged from 6.1 to 7.70, which were suitable for culture of *M rosenbergii* in earthen ponds (Jia-Mo *et al.*, 1988a). Hoq *et al.* (1996) reported that pH ranged from 7.5 to 8.0 in five prawn farmers ponds. Hossain *et al.* (2000) reported that pH ranged from 6.8 to 8.4 was suitable for M *rosenbergii.* The suitable range of pH for prawn culture is 7.0 to 8.5. If pH decreases below 4, acidity increases and no fish and shrimp can live. On the other hand if pH increases over 9.5 fish shows abnormality and it further increases over 11 all fishes die (Das B 1998). Relation between growth performance and pH obtained from experiment has been shown in the following figure.

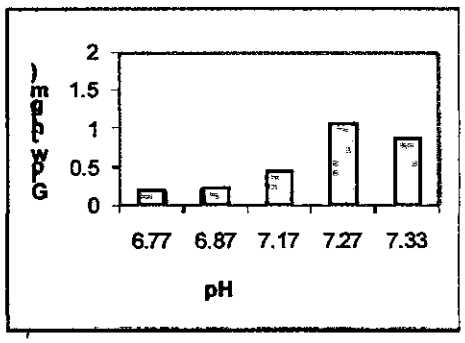


Fig. 4.1: Relation bet^{n} growth & pH in T_c

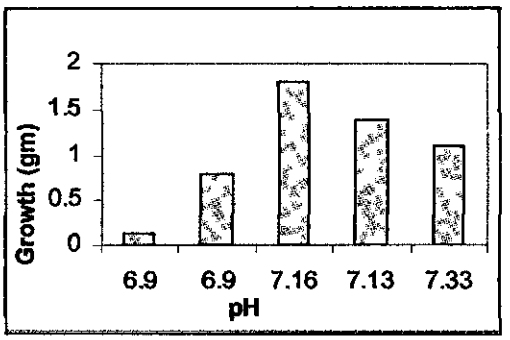


Fig. 4.2: Relation bet^{n} growth & pH in T_1

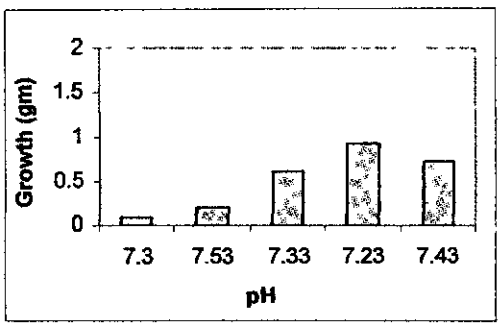


Fig. 4.3: Relation bet^{n} growth & pH in T_2

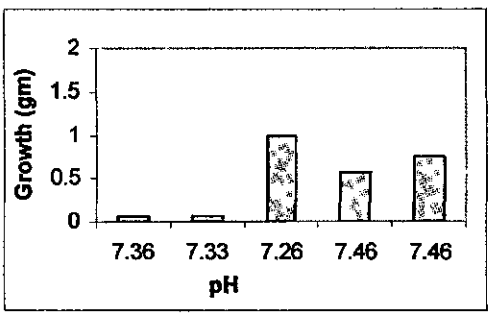


Fig. 4.4: Relation bet^{n} growth & pH in T_3

From the above figures, it is clear that slight variation of pH values (from 6.77 to 7.46) were recorded in all ponds. In pond T_c lower growth was recorded at pH 6.77 and higher growth was recorded at pH 7.27. In pond T_1 the lower growth was recorded at pH 6.9 and higher growth was recorded at pH 7.16. In pond T_2 lower growth was recorded the pH 7.3 and higher growth was recorded at pH 7.23. In pond T_3 lower growth was recorded at pH 7.33 and higher growth was recorded at pH 7.26. Again among T_c, T_1, T_2, and T_3 higher growth was recorded at pH 7.16 in T_1 (500PL/dec). The highest pH 7.46 was recorded in maximum stocking density because of biological activity. Growth performance was also lower in this pH. Although fish eat most of the feed applied, a great percentage of the dietary intake was excreted into the water as metabolic wastes such as ammonia. Ammonia is directly toxic to fish, and some of the ammonia may serve as a substrate for the production of nitrate that is also highly toxic. The gills of aquatic animals are the primary targets of elevated hydrogen ion concentrations in the environment, which is not surprising considering the structural delicacy of gills and their intimate contact with external environment (Heath, 2000). A drastic fall of pH below 7 causes to happen the following, as stated by Ali and Mazid (2005). The sodium chloride content of the body of the prawn PL extruded resulting death of the PL; most of the

microorganisms reproduce rapidly and cause diseases if pH falls consequently the disease resistance power and appetite for food is lost gradually.

Total alkalinity has little direct effect on fishes but indirectly the well being of fish may be affected by total alkalinity, because ponds of low values of alkalinity are generally biologically less productive than those with high values. Total alkalinity may be several hundred ppm in natural water bodies. According to Alikunhi (1957) total alkalinity more than 100 mg/L should be present in, highly productive water bodies. According to Boyd (1990) total alkalinity should be more than 20 ppm in fertilized ponds as fish production increases with the increase of total alkalinity.

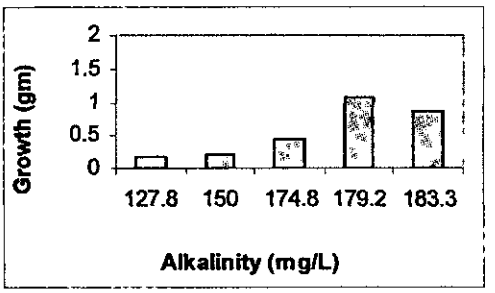


Fig. 4.5: Relation bet^{n} growth & alkalinity in T_c

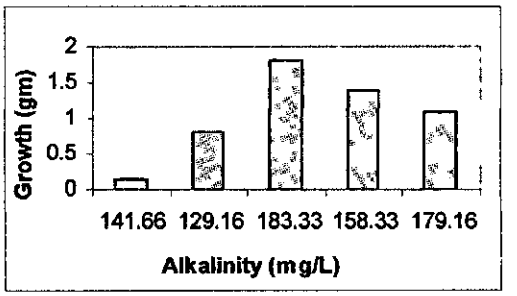


Fig. 4.6: Relation bet^{n} growth & alkalinity in T_1

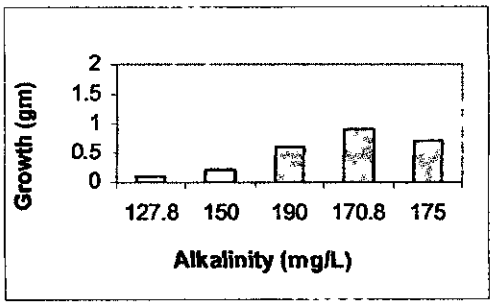


Fig. 4.7: Relation bet^{n} growth & alkalinity in T_2

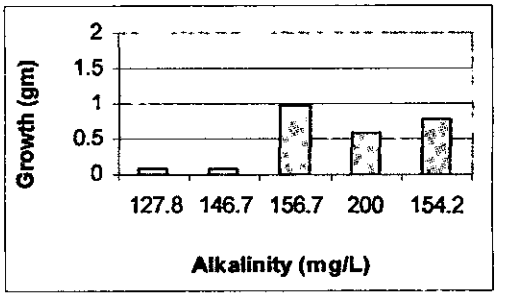


Fig. 4.8: Relation bet^{n} growth & alkalinity in T_3

From the above Figures, it is clear that some variation of alkalinity values (from 127.77 to 190 mg/L) were recorded in all ponds. In pond T_c lower growth was recorded at 127.8mg/L and higher growth was recorded at 179.2mg/L. In pond T_1 the lower growth was recorded at 141.6mg/L and higher growth was recorded at 183.33mg/L. In pond T_2 lower growth was recorded at 127.8mg/L and higher growth was recorded at 170.8mg/L. In pond T_3 lower growth was recorded at 127.77mg/L and higher growth was recorded at 156.66mg/L. Again among T_c, T_1, T_2, and T_3 higher growth was recorded at 183.33mg/L in T_1. Natural waters that contain 40 mg/L or more total alkalinity are considered more productive that waters of lower alkalinity

(Moyle, 1945; Mairs, 1966). According to Moyle (1946), the greater productivity of waters of higher alkalinity does not result directly from alkalinity, but rather from phosphorus and other nutrients that increase along with total alkalinity. Ponds with total alkalinities of 200-300 mg/L have been successfully used for fish culture. However, there is sometimes a shortage of carbon dioxide in lakes with high concentration of calcium carbonate in mud or on watersheds, resulting in low productivity. So maintaining of alkalinity of pond habitat is related of pH and the concentration of calcium in dissolved state. The values of alkalinity at different stages had some significant difference. So in the study alkalinity had made a significant effect on growth of *M. rosengergii.*

Hardness is a measure of the concentrations of calcium and magnesium particularly as divalent cation in the water. Most fresh water aquatic animals grow well over a wide range of total hardness values but they may be more susceptible to adverse water quality conditions when hardness values (particularly calcium concentration) are low. Harder water (above 150 mg/L) is better for fish health, because it provides needed calcium and reduces the need for osmoregulation (Boyd 1998). It is thought that fish in hard water are less likely to suffer from bacterial kidney disease and other health problems. Total hardness values are also generally correlated with the native fertility of freshwater system.

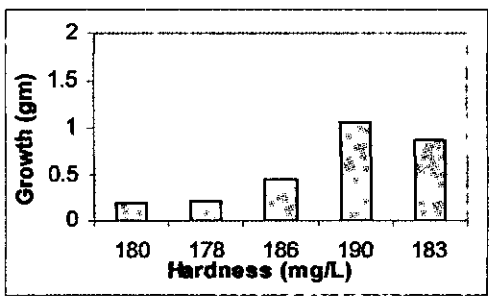


Fig. 4.9: Relation bet^{n} growth & hardness in T_c

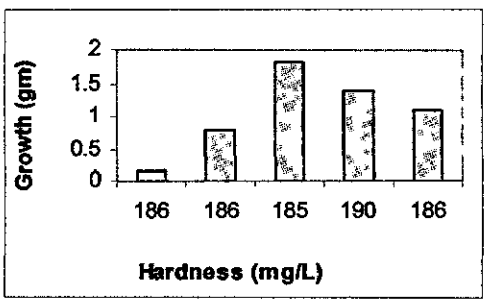


Fig. 4.10: Relation bet^{n} growth & hardness in T_1

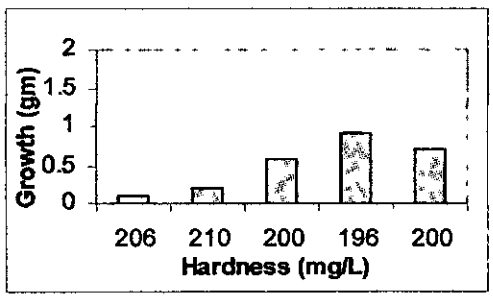


Fig 4.11: Relation bet^{n} growth and hardness in T_2

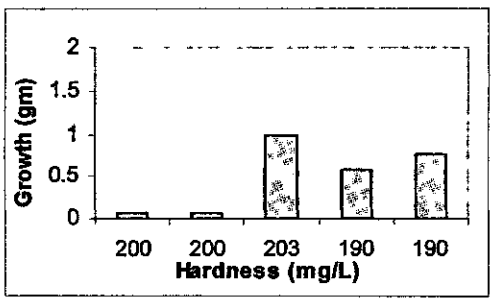


Fig. 4.12: Relation bet^{n} growth & hardness in T_3

From the above figure, it is clear that slight variation of hardness values (from 180 to 210 mg/L) were recorded in all ponds. In pond T_c lower growth was recorded at 180mg/L and higher growth was recorded at 190mg/L. In pond T_1 the lower growth was recorded at 186mg/L and higher growth was recorded at 185mg/L. In pond T_2 lower growth was recorded at 206mg/L and higher growth was recorded at 196mg/L. In pond T_3 lower growth was recorded at 200mg/Land higher growth was recorded at 203mg/L. Again among T_c, T_1, T_2, and T_3 higher growth was recorded at 185mg/L in T_1. The values of hardness at different stages were more or less similar. So in this study hardness of pond habitat shows no significant effect on growth performance of *M. rosengergii.*

Successful fish and shrimp culture depends on the careful management of dissolved oxygen at optimum level. Hoq *et al* (1996) recorded DO ranging from 4.0 to 5.9 mg/l in five prawn farms, which were suitable for fish culture. Jia-Mo *et al.* (1998b) reported that the dissolved oxygen was 4.5 mg/l, where *M rosenbergii* were cultured in earthen ponds. Jaruvat and Somnuk (1987) reported that shrimp would normally die if dissolved oxygen is less than 0.7 mg/I. Hossain *et al.* (2000) reported the dissolved oxygen content was 3.0 to 6.1 mg/l in earthen ponds in *M rosenbergii* monoculture. Ali and Mazid (2005) stated that 5-7 mg/l DO is favorable for prawn PL and if the DO level fall to 2 ppm or less gold PL stopped taking food and farther, if the DO level fall below 1 ppm the PL will die immediately. Relation between growth performance and dissolve oxygen concentration obtained from experiment has been shown in the following figure.

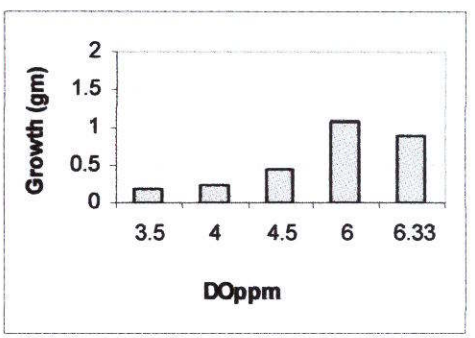


Fig. 4.13: Relation bet^n growth & DO in T_c

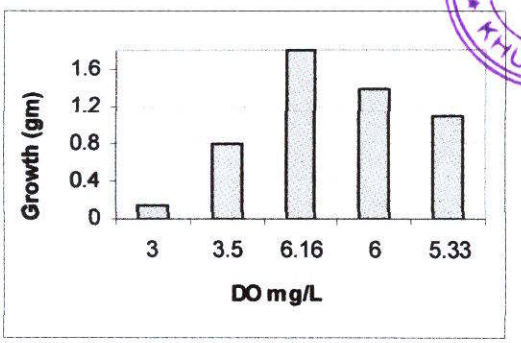


Fig. 4.14: Relation bet^n growth & DO in T_1

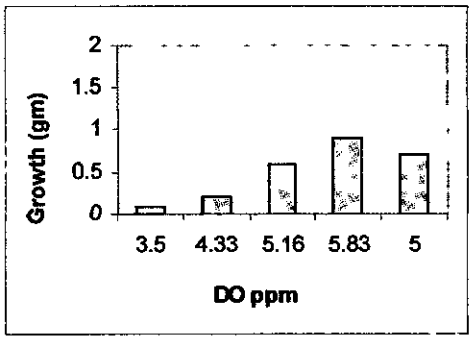


Fig. 4.15: Relation bet^{n} growth & DO in T_2

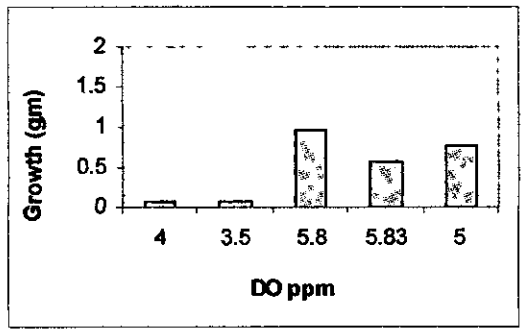


Fig. 4.16: Relation bet^{n} growth & DO in T_3

From the above figure, it is clear that some variation of DO values (from 3 to 6.33 mg/L) were recorded in all ponds. In pond T_c lower growth was recorded at 3.5ppm and higher growth was recorded at 6ppm. In pond T_1 the lower growth was recorded at 3ppm and higher growth was recorded at 6.16ppm. In pond T_2 lower growth was recorded at 3.5ppm and higher growth was recorded at 5.83ppm. In pond T_3 lower growth was recorded at 4ppm and higher growth was recorded at 5.8ppm. Again among T_c, T_1, T_2, and T_3 higher growth was recorded at 16.16ppm in T_1. The values of DO at different stages had some significant difference. So in the study DO have made a significant effect on growth of *M. rosengergii.*

Effect of major ions on growth

Sodium (Na^+)

The presence of sodium (Na) in water environment influences on the life of animal greatly. Sodium in suitable range increases the productivity of the pond. It affects adversely if the range becomes more or less than its range. The suitable range of sodium for shrimp culture should be 0.26 to 30mg/L. Relation between growth performance and sodium concentration obtained from experiment has been shown in the following figure.

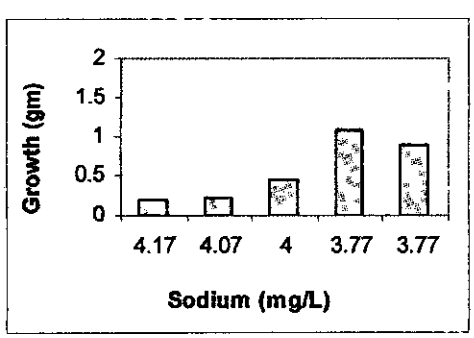


Fig. 4.17: Relation bet^{n} growth & Na^+ in T_c

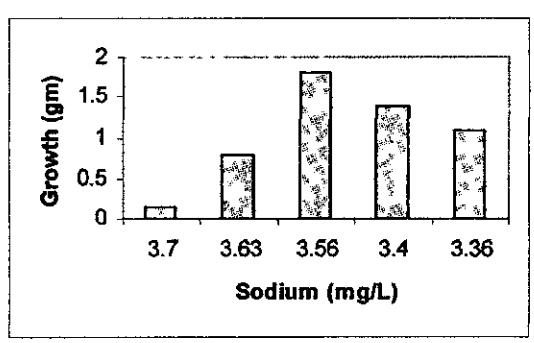


Fig. 4.18: Relation bet^{n} growth & Na^+ in T_1

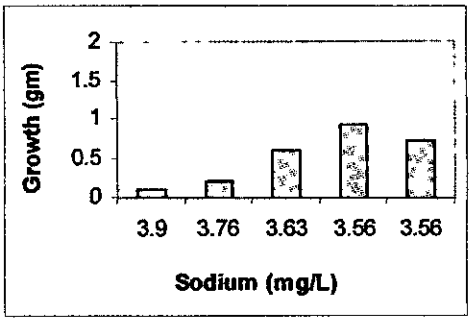


Fig. 4.19: Relation bet^{n} growth & Na^{+} in T_2

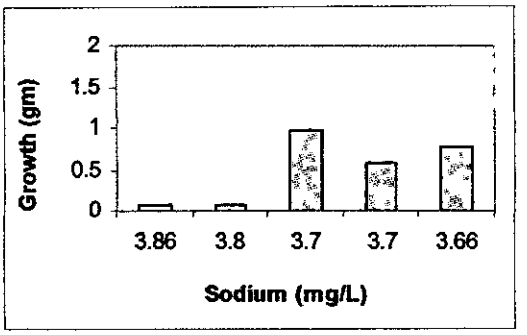


Fig. 4.20: Relation bet^{n} growth & Na^{+} in T_3

Here, it is clear that slight variation of sodium values (3.56 to 4.17 mg/L) were recorded in all ponds. In pond T_c lower growth was recorded at 4.17mg/L and higher growth was recorded at 3.77mg/L. In pond T_1 the lower growth was recorded at 3.7mg/L and higher growth was recorded at 3.56mg/L. In pond T_2 lower growth was recorded at 3.9mg/L and higher growth was recorded at 3.56mg/L. In pond T_3 lower growth was recorded at 3.86mg/L and higher growth was recorded at 3.7mg/L. Again among T_c, T_1, T_2, and T_3 higher growth was recorded at 3.56mg/L in T_1. The values of sodium at different stages were more or less similar. So in the study sodium had no significant effect on growth of *M. rosengergii.*

Potassium (K^{+})

Potassium dissolved water plays a great role as a catalyst in the metabolism of phytoplankton. It helps to produce carbohydrate in phytoplankton. Beside this, it helps to increase antibody in phytoplankton. The suitable range of potassium for fish and shrimp culture should at least 0.5 to 1.0 mg/L (Das B 1998). Relation between growth performance and potassium concentration obtained from experiment has been shown in the following figure.

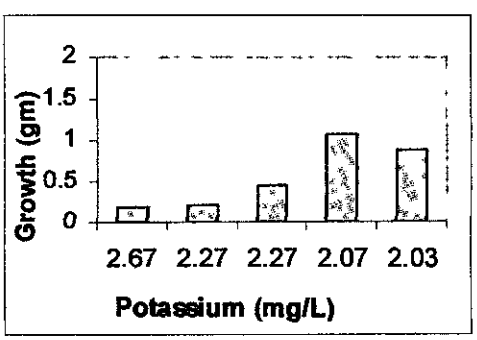


Fig. 4.21: Relation bet^{n} growth & K^{+} in T_c

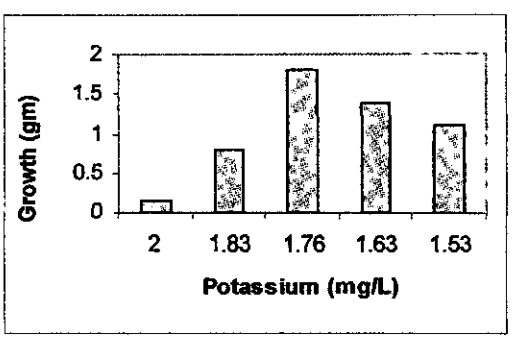


Fig.4.22: Relation bet^{n} growth & K^{+} in T_1

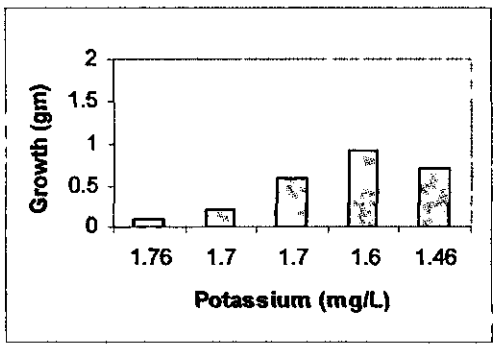


Fig. 4.23: Relation bet^{n} growth & K^{+} in T_2

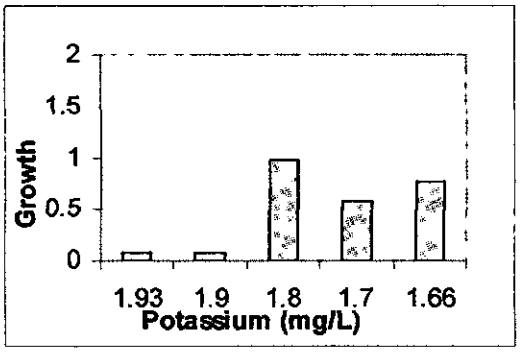


Fig. 4.24: Relation bet^{n} growth & K^{+} in T_3

From the above figure, it is clear that slight variation of potassium values (from 1.46 to 2.67 mg/L) were recorded in all ponds. In pond T_c lower growth was recorded at 2.67mg/L and higher growth was recorded at 2.07mg/L. In pond T_1 the lower growth was recorded at 2mg/L and higher growth was recorded at 1.76mg/L. In pond T_2 lower growth was recorded at 1.76mg/L and higher growth was recorded at 1.6mg/L. In pond T_3 lower growth was recorded at 1.93mg/L and higher growth was recorded at 1.8mg/L. Again among T_c, T_1, T_2, and T_3 higher growth was recorded at 1.76mg/L in T_1. The values of potassium at different stages were more or less similar. So in the study potassium had no significant effect on growth of *M. rosengergii.*

Calcium (Ca^{2+})

Environmental calcium influences the permeability of gill membranes to water and ions. A membrane tends to become much more permeable to ions and water when waterborne calcium concentrations are low. Animals may, therefore, have difficulty osmoregulation in low calcium waters, especially when animals are exposed to other environmental factors that affect osmoregulation. The effects of these factors on animal health are worse when inadequate calcium is present in the environment. Based on the relatively few studies that have been conducted, it appears that fresh fish exposed to stressful condition perform best when calcium concentrations are greater than 10-20 mg Ca^{2+}/L. Again it was demonstrated by Seals *et al.* (1994) who showed that environmental calcium concentrations over the range 5-80 mg Ca^{2+}/Ldid not affect growth, feed conversion, condition factor or blood chemistry of fish. Relation between growth performance and calcium obtained from experiment has been shown in the following figure.

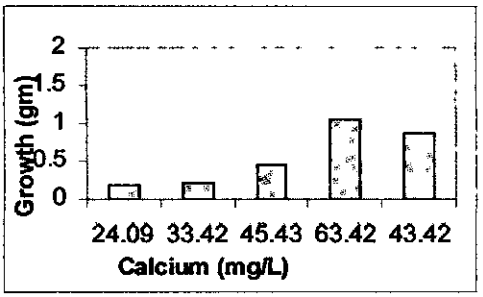


Fig. 4.25: Relation bet^{n} growth & Ca^{2+} in T_c

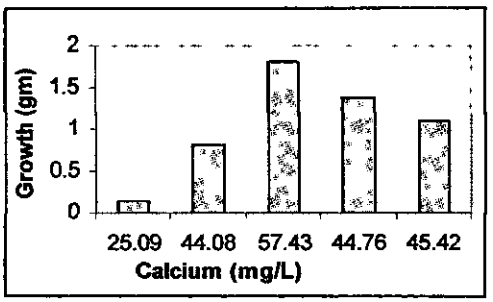


Fig. 4.26: Relation bet^{n} growth & Ca^{2+} in T_1

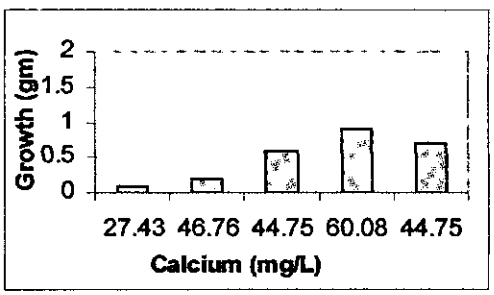


Fig. 4.27: Relation bet^{n} growth & Ca^{2+} in T_2

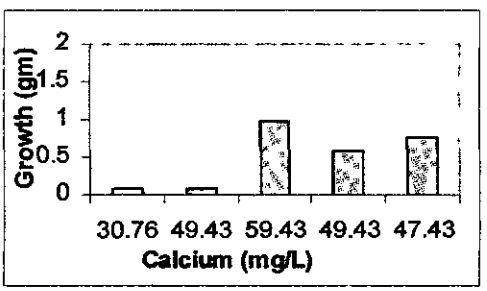


Fig.4.28: Relation bet^{n} growth & Ca^{2+} in T_3

From the above figure, it is clear that some variation of Ca^{2+} values (24.09 to 63.42 mg/L) were recorded in all ponds. In pond T_c lower growth was recorded at 24.09 mg/L and higher growth was recorded at 63.42 mg/L. In pond T_1 the lower growth was recorded at 25.09 mg/L and higher growth was recorded at 57.43 mg/L. In pond T_2 lower growth was recorded at 27.43 mg/L and higher growth was recorded at 60.08 mg/L. In pond T_3 lower growth was recorded at 30.73 mg/L and higher growth was recorded at 59.43 mg/L. Again among T_c, T_1, T_2, and T_3 higher growth was recorded at 57.43 mg/L in T_1. The values of Ca^{2+} at different stages had some significant difference. So in the study Ca^{2+} made significant effect on growth of *M. rosengergii.*

Magnesium (Mg^{2+})

Magnesium has also some importance in aquaculture. Shrimp and Cray fish have a highly mineralized exoskeleton and require relatively large amounts of calcium and magnesium to replace the minerals lost during molting. Crustaceans absorb calcium and magnesium from the water during molting, and concentrations in the water should be great enough to supply this requirement (Fieber and Lutz 1982). Relation between growth performance and magnesium obtained from experiment has been shown in the following figure.

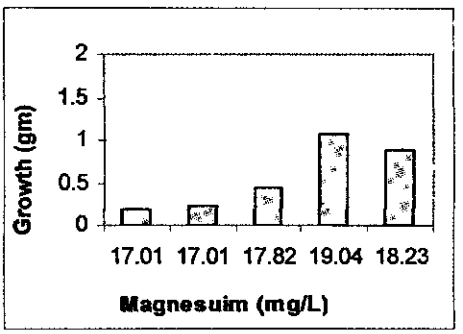


Fig. 4.29: Relation bet^{n} growth & Mg^{2+} in T_c

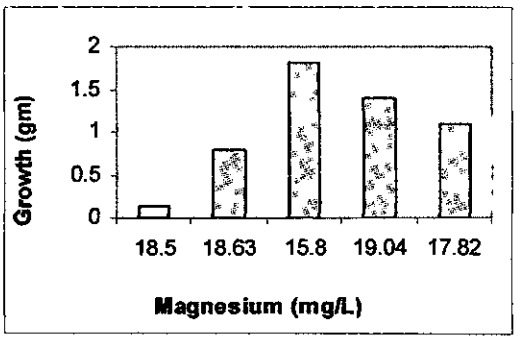


Fig. 4.30: Relation bet^{n} growth & Mg^{2+} in T_1

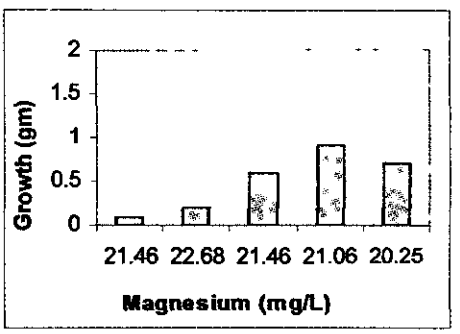


Fig. 4.31: Relation bet^{n} growth & Mg^{2+} in T_2

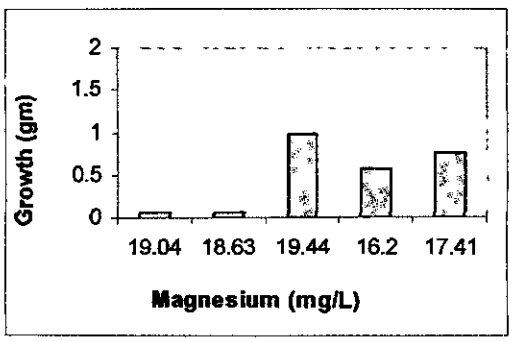


Fig. 4.32: Relation bet^{n} growth & Mg^{2+} in T_3

It is clear from the above figure that in pond T_c lower growth was recorded at the magnesium concentration of 17.01 mg/L and higher growth was recorded at 19.04 mg/L. In pond T_1 the lower growth was recorded at 18.5 mg/L and higher growth was recorded at 15.8 mg/L. In pond T_2 lower growth was recorded at 21.46 mg/L and higher growth was recorded at 21.06 mg/L. In pond T_3 lower growth was recorded at 19.04 mg/L and higher growth was recorded at 19.44 mg/L. Again among T_c, T_1, T_2, and T_3 higher growth was recorded at 15.8 mg/L in T_1. The values of magnesium at different stages were almost similar. There was no significant difference in the data. So in the study magnesium had no significant effect on growth of *M. rosengergii.*

Chloride (Cl^-)

Detail studies on optimum concentration Cl^- ions in freshwater aquaculture were lacking but it has great impacts on salinity. Chloride content of freshwater ponds usually varies between almost 260 mg/L to 537 mg/L (.05 to1.0ppt salinity) (Boyd 1990). Most of fresh water fishes usually grow well under water chloride up to about 1645ppm (3.0ppt salinity). Relation between growth performance and chloride concentration obtained from experiment has been shown in the following figure.

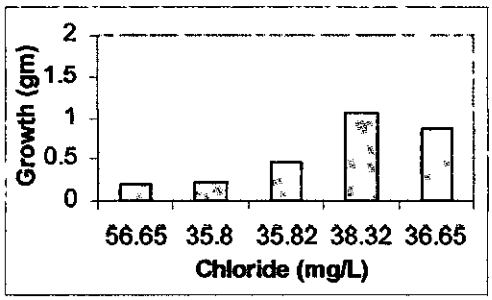


Fig. 4.33: Relation bet^n growth & Cl^- in T_c

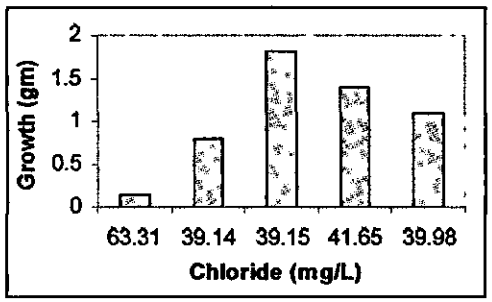


Fig. 4.34: Relation bet^n growth & Cl^- in T_1

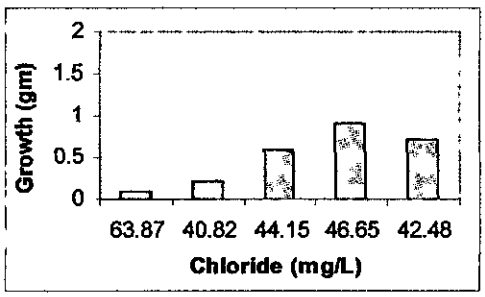


Fig. 4.35: Relation bet^n growth & Cl^- in T_2

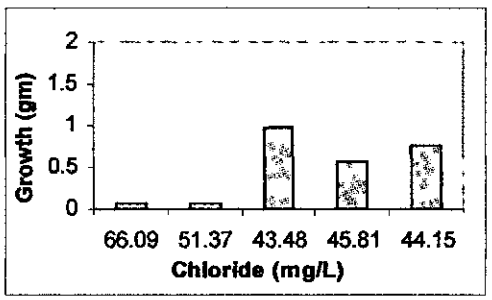


Fig.4.36: Relation bet^n growth & Cl^- in T_3

From the above figure, it is clear that slight variation of chloride values (from 35.8 to 66.09 mg/L) were recorded in all ponds. In pond T_c lower growth was recorded at 56.65 mg/L (0.102ppt salinity) and higher growth was recorded at 38.32 mg/L (0.069ppt salinity). In pond T_1 the lower growth was recorded at 63.31 mg/L (0.114ppt salinity) and higher growth was recorded at 39.15 mg/L (0.07ppt salinity). In pond T_2 lower growth was recorded at 63.87 mg/L (0.115ppt salinity) and higher growth was recorded at 46.65 mg/L (0.084ppt salinity). In pond T_3 lower growth was recorded at 66.09 mg/L (0.119ppt salinity) and higher growth was recorded at 43.48 mg/L (0.078ppt salinity). Again among T_c, T_1, T_2, and T_3 higher growth was recorded at 39.15 mg/L (0.07ppt salinity) in T_1. The values of chloride at different stages were more or less similar. So in the study chloride had no significant effect on growth of *M. rosengergii*

Effect of phosphate and ammonia

Phosphorus in cultural ponds is important because they affect plant productivity, which, in turn, may influence aquaculture production. Therefore, the measurement of phosphate is assumed considerable importance (Chapman 1992). In fact, Hutchinson (1957) and Lee (1970) indicated that most natural waters respond to addition of phosphorus with greater plant production. Experience with pond fertilization also suggests that addition of phosphate fertilizers will increase fish production in most

ponds (Mortimer1954; Hickling1962). Usually phosphorus in pond water exists in little amount. If phosphorus increases in excess in pond water plankton cannot grow as usual. For fish or shrimp culture the suitable range of PO_4 should be 0.5 to 1ppm (Das B.1998) in pond water. Relation between growth and phosphate obtained from experiment has been shown in the following figure.

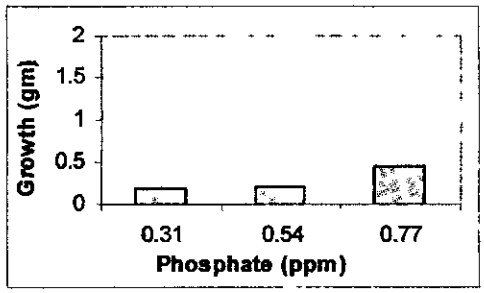


Fig. 4.37: Relation bet^n growth & PO_4 in T_c

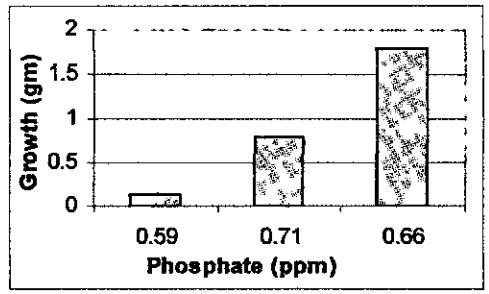


Fig. 4.38: Relation bet^n growth & PO_4 in T_1

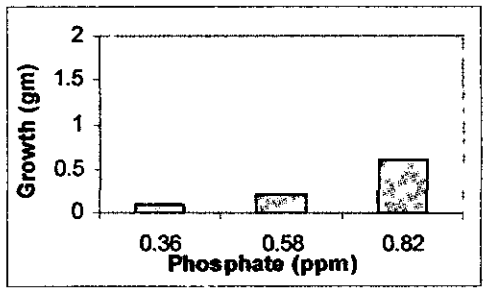


Fig. 4.39: Relation bet^n growth & PO_4 in T_2

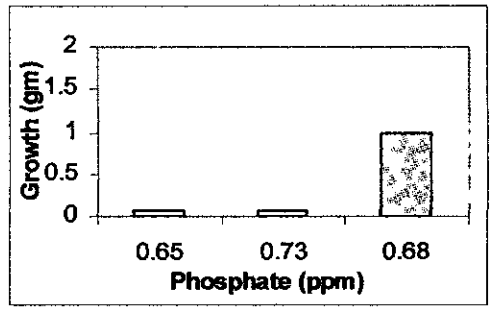


Fig. 4.40: Relation bet^n growth & PO_4 in T_3

From the above figure, it is clear that some variation of phosphate values (from 0.31 to 0.82 mg/L) were recorded in all ponds. In pond T_c lower growth was recorded at 0.31 mg/L and higher growth was recorded at 0.77p mg/L phosphate. In pond T_1 the lower growth was recorded at 0.59 mg/L and higher growth was recorded at 0.71 mg/L. In pond T_2 lower growth was recorded at 0.36 mg/L and higher growth was recorded at 0.82 mg/L. In pond T_3 lower growth was recorded at 0.65 mg/L and higher growth was recorded at 0.73 mg/L. Again among T_c, T_1, T_2, and T_3 higher growth was recorded at 0.71 mg/L in

T_1. The values of phosphate at different stages had some significant differences. So in the study phosphate had some effect on growth of *M. rosengergii.*

Ammonia-containing inorganic fertilizers or organic manures (which decompose to release ammonia and other nutrients) are often added to stimulate plant growth in ponds in relying upon natural foods to support aquaculture production. But it is also a toxic gas, which is very much harmful for the growth and survival of the PL of *M. rosenbergii.* Waste material of the PL, excess feed etc produces this toxic gas after

decomposition if excess feed is delivered to the ponds. If the ammonia level of the pond crosses its tolerable limit the ammonia level in the blood is increased and the PL stopped food intake and consequently leads to death due to malfunctioning of blood of the PL (Ali and Mazid , 2005). According to Das B.(19898), for fish or shrimp culture total ammonia of pond should be 1ppm or less than 1ppm and free ammonia of water should be less than 0.25ppm. If ammonia increases to 2.5 or more then it becomes too much harmful for shrimp culture. Ammonia toxicity increases with increasing pH and temperature and decreasing salinity. Clinical symptoms of fish exposed to high levels of ammonia include increased slime secretion, hyperemia of the gills and skin, anemia, and non-directional swimming. Relation between growth performance and ammonia obtained from experiment has been shown in the following figure.

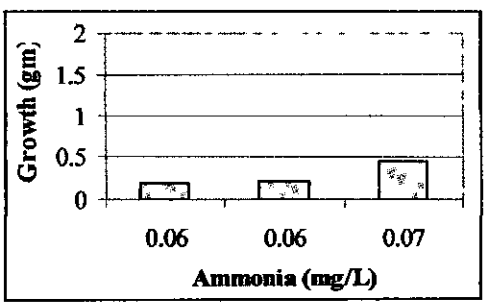


Fig. 4.41: Relation bet^n growth & NH_3 in T_c

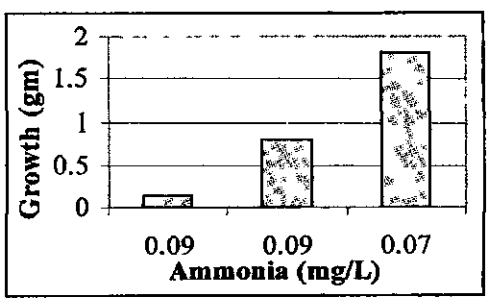


Fig. 4.42: Relation bet^n growth & NH_3 in T_1

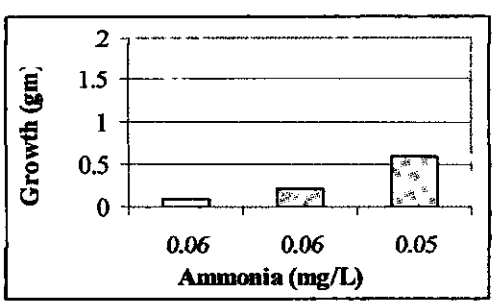


Fig. 4.43: Relation bet^n growth & NH_3 in T_2

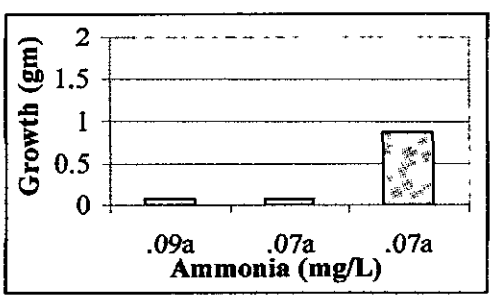


Fig. 4.44: Relation bet^n growth & NH_3 in T_3

From the above figure, it is clear that in pond T_c lower growth was recorded at the ammonium concentration of 0.06mg/L and higher growth was recorded at 0.07 mg/L. In pond T_1 the lower growth was recorded at 0.09 mg/L and higher growth was recorded at 0.07 mg/L. In pond T_2 lower growth was recorded at 0.06 mg/L and higher growth was recorded at 0.05 mg/L. In pond T_3 lower growth was recorded at 0.79 mg/L and higher growth was recorded at 0.07 mg/L. Again among T_c, T_1, T_2, and T_3 higher growth was recorded at 0.07 mg/L in T_1. The values of ammonia at different

stages were almost similar. So in the study ammonia had no significant effect on growth of *M. rosengergii.*

Finally the criteria of water quality parameters were shown in the following table, which was recorded among the treatments when the growth was better.

Table. 4.4: Water quality parameters during better growth

Water quality parameter	T_c (958PL/dec)	T_1 (500PL/dec)	T_2 (800PL/dec)	T_3 (1000PL/dec)
PH	7.27	7.16	7.23	7.26
Alkalinity (mg/L)	179.2	183.33	170.8	156.66
DO (mg/L)	6	6.16	5.83	5.8
Hardness (mg/L)	190	185	196	203
Sodium (mg/L)	3.77	3.56	3.56	3.7
Potassium (mg/L)	2.07	1.76	1.6	1.8
Calcium (mg/L)	63.42	57.43	60.08	59.43
Magnesium (mg/L)	19.08	15.8	21.06	19.44
Phosphate (mg/L)	0.77	0.71	0.82	0.73
Chloride (mg/L)	38.32	39.15	45.65	43.48
Ammonia (mg/L)	0.07	0.07	0.05	0.07

Conclusion

In water quality management, the environmental conditions are regulated so that they are within a desirable range for survival and growth of fish. Each management involved in shrimp culture has an effect of cost. Fertilizers or chemicals may be used to increase fish yields, but they are costly. Obviously, the value of the increase in yield resulting from fertilization must exceed the cost of the fertilizer or fertilization is not economically feasible. In addition, all sorts of activities should be environment friendly.

The result of the present study reveals that among the four treatments better growth was recorded at 7.1 pH, 185 mg/L hardness, 183.33 mg/L alkalinity, 6.16 mg/L DO. These parameters play an important role in aquaculture. pH is the productivity index of a water body. Rapid fluctuation of pH level of a culture pond cause to hinder the growth of golda PL (Das B 1998). Total alkalinity has little direct effect on fishes but indirectly the well being of fish may be affected by total alkalinity, because ponds of low values of alkalinity are generally biologically less productive than those with high values. Harder water (above 150 mg/L) is better for fish health, because it provides needed calcium and reduces the need for osmoregulation. It is thought that fish in hard water are less likely to suffer from bacterial kidney disease and other health problems and the availability of dissolved oxygen frequently limits the activities and growth of aquatic animals (Boyd 1990). So it is very necessary to maintain these parameters as in the above values in the culture period. On the other hand water constituent such as sodium, potassium, calcium, magnesium, chloride, phosphate and ammonia are also important for aquaculture. Phosphorus and sodium in suitable range affect plant productivity of the pond, which, in turn, may influence aquaculture production. Potassium dissolved water plays a great role as a catalyst in the metabolism of phytoplankton. It helps to produce carbohydrate in phytoplankton. Beside this, it helps to increase antibody in phytoplankton (Das B 1998). Calcium and magnesium has also some importance in aquaculture. Shrimp and Cray fish have a highly mineralized exoskeleton and require relatively large amounts of calcium and magnesium to replace the minerals lost during molting. Ammonia is also important for aquaculture because they are potential stressor of the animals under culture (Boyd

1990). In the present study better growth was recorded at 3.56 mg/L Na^+, 1.76 mg/L K^+, 57.43 mg/L Ca^{2+}, 15.8 mg/L Mg^{2+}, 39.15 mg/L chloride, 0.77 mg/L phosphate, 0.07mg/L ammonia. So in case aquaculture it is very important to maintain these values of these parameters in order to get maximum production.

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