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Research Article

STUDY ON WATER QUALITY PARAMETERS OF SHRIMP FARMS IN THREE DIFFERENT LOCATIONS IN NELLORE DISTRICT OF COASTAL ANDHRA PRADESH, INDIA

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ABSTRACT

The study was conducted to analyze the water quality parameters on 15, 30, 45, 60, 75, 90,105 and 120 days of culture in Pennaeus vannamei shrimp farms in three different locations (L1 : Kavali- Allur; L2: Nellore; L3: Gudur-Kota) of Nellore district shrimp farming areas during four crops (two summers and two winter) C1(Crop-1), C2 (Crop-2), C3 (Crop-3) and C4 (Crop-4) during where shrimp culture is prominent in the Nellore district. The two way ANOVA results show that there are significant differences in water temperature, transparency, Dissolved Oxygen, alkalinity, hardness and total ammonia nitrogen and there is no significance difference for Salinity and pH, hardness at different time intervals of culture. The results are also Significant for transparency, Dissolved oxygen, Salinity, alkalinity, hardness and total ammonia nitrogen and are not significant for temperature and pH among the three locations. Based on the present study, it is concluded that the water quality parameters will vary from location to location within region, during days of culture and also during summer and winter crops.

Keywords: Pennaeus vannamei; Shrimp farm; Water quality parameters; Aquaculture

1. INTRODUCTION

Aquaculture and fisheries sectors remain important sources of food, nutrition, income and livelihoods for hundreds of millions [1]. Though the aqua culture can be traced back to 15th century, industrial shrimp farming can be traced to the 1930's, when Japanese agrarians spawned and cultivated Kuruma shrimp (*Penaeus japonicus*) for the first time. The commercial shrimp farming began to grow rapidly in the late 1960s and early 1970s and the production grew steeply and today over 50 countries export framed shrimp. Global shrimp production in aquaculture crossed 5.1 million tonnes in 2015 with 3.9% growth. Globally Shrimp culture expanded at very faster rate due to short culture period, quality availability of seed and feed, high export value in international market besides domestic markets. 70% of shrimp is exported from developing countries to developed countries and is a significant contributor to the income and employment in developing countries.

According to FAO, farmed *L.vannamei* in Asia increased from 2300 metric tonnes in 2002 and 31, 56,948 metric tonnes in 2015. This represents nearly 136% increase in vannamei production during 16 year period.

Currently more than 80% of the Penaeid shrimp formed in Asia are *L.vannamei* [2]. Shrimp farming provides a major source of income for small farmer's and plays a potential role in the poverty alleviation in developing countries including that in small coastal villages [3, 4].

Shrimp culture in India evolved from a more subsistence industry in 1980 to one of the world's leading commercial industry by the mid-day 1990s. India has 1.24 million Ha of brackish water aquaculture area spread over all maritime States / Union Territories (UTs), but hardly 15% of the brackish water areas are developed for commercial farming [5]. The black tiger shrimp *Pennaeus monodon* culture was introduced in late 1990s and reached peak in 1994 and thereafter the culture was started decreasing due to the onset of the white spot syndrome virus (WSSV) disease and other problems which led to the shattering of the shrimp culture in India. In 1999, the culture of the fresh water prawn, *Macrobrachium rosenbergii* (Scampi) was introduced which had been on a rise up to 2005. Later, the problems in scampi culture in the farming led to its decline in culture. By 2005, the farmers were again in search of alternative species for tiger shrimp *P. monodon,* and the White leg shrimp *Pennaeus vannamei* was found to be a

right candidate species. The Government of India permitted the culture of *P.vannamei* in 2009 after experimental trails in Indian environment After introduction of P vannamei in 2009, the area under culture and production for *P. monodon* is slowly decreased and P.*vannamei* culture and production is increased.

The state of Andhra Pradesh ranks first in the brackish water aquaculture and fresh water aquaculture in the country. At present, the fisheries sector contribution to the Gross State Domestic Product (GSDP) is about 7.4% and will increase in near future. Nellore region, being the aqua capital of India is a major district where the shrimp production and culture area is significant. Inspite of its prominence, very few studies have been carried out on the water quality analysis issues related to *P.vannamei* culture in a comparative perspective within a region across a longer period. In the light of the above, the present study has been undertaken to determine water quality parameters of shrimp ponds in three different locations within a district for two years to understand the nature of changes take place in water quality over time and space.

2. MATERIALS AND METHODS

2.1. Study area

Nellore district is having a coast line of 169 Kms and is known as Aqua capital of India. The district lies between 13-30' and 15-6'. of the North latitude and 70-5' and 80-15' of the East Longitude and extending over an area of 13076 Sq.Kms. The district consists of 46 mandals. The study was made in three locations namely Kavali - Allur, Gudur- Kota and Nellore covering 9 mandals where the shrimp production and culture area is significant and detailed study was carried out in 32 villages with respect water quality management.

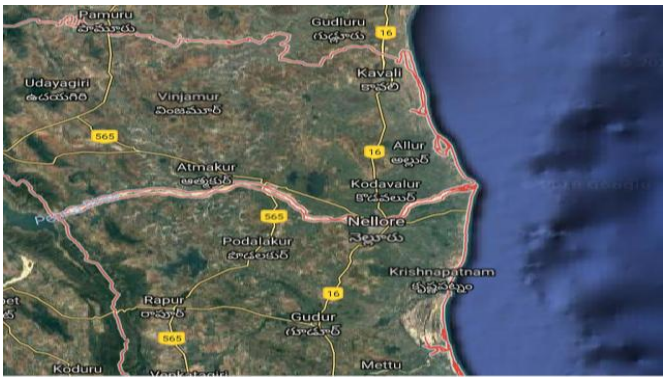

Fig. 1: Study area showing three locations of Nellore district

2.2. Description of the Sampling sites

The shrimp samples were collected from culture ponds of Nellore district of Andhra Pradesh. The samples were collected from three different locations of the district for a period of 2 years i.e., 2014 to 2015. The sampling locations are as follows:

Location 1 (L1): Kavali – Allur: 11 villages (Allur, Isakapally, Isakapalli Pallipalem, Indupurukaluva, Tatichetlapalem, Simbunipalem, North Amalauru, Bangarupalem, Gogulapalem, Purini and Juvvaladinne), 96 ponds with area 396.8 ha. Out of 96 ponds, 4 ponds were randomly selected and samples were collected from them throughout the study period at fortnight intervals each pond size is about 1 Ha.

Location 2 (L2): Nellore: 9 villages (Brahmadevam, Kothakoduru, Gangapatnam, Ramudupalem, Utkuru, Kudithipalem, Mypadu, Muthukuru and Indukurupeta), 98 ponds with area 313.6 Ha. Out of 98 ponds, 4 ponds were randomly selected and samples were collected from them throughout the study period at fortnight intervals each pond size is about 1 Ha.

Location 3 (L3): Gudur-Kota: 12 villages (Chittamuru, Govindapally, Aruru, Kokupalem, Kogili, Kotagunta, Mallam, Pallamparthy, Karlapudi, Muttambaka, Battevolu, Kolanukuduru), 95 ponds with area 294.7 Ha. Out of 95 ponds, 4 ponds were randomly selected and samples were collected from them throughout the study period at fortnight intervals each pond size is about 1 Ha.

2.3. Collection and preservation of samples

Water samples were collected randomly from at least four ponds in three different study locations of *P. vannamei* culture ponds at the depth of 30 cms below water surface. Water is collected with unbreakable polyethylene and polypropylene bottles which are more convenient for use. For all other parameters, water samples were collected, transported and analysed in laboratory. The collected samples were preserved by adding 5ml / litre of Chloroform (exclude light and air) for pH, alkalinity and hardness. Two Winkler Reagents were used immediately without any bubble to fix the samples for dissolved oxygen. Samples for water quality analysis were collected in 500 ml capacity polythene bottles (PVC), stored in an ice box and brought to the laboratory with in 2 hr of sampling. Water temperature, pH and salinity were recorded on field using thermometer, pH meter and salinometer (Refractometer) respectively.

2.4. Water Quality Variables

Water quality variables were determined in shrimp *L. vannamei* culture ponds of three different locations (L1,L2 and L3) on 15, 30, 45, 60, 75, 90, 105 and 120 days of culture following standard methods [6].

2.5. Methods of Water Sampling Analysis

2.5.1. Temperature

Temperature was measured using mercury centigrade thermometer with an accuracy of 0.1°C. To minimize error, the thermometer was calibrated with another thermometer of known accuracy. While taking the reading, the thermometer should be immersed in water for one minute and up to the level of mercury in the capillary column. Temperature was expressed as degrees Celsius (°C).

2.5.2. pH

pH was measured using pH scan (pHep model, Hanna Instruments). Water samples were collected from four corners of culture ponds in a clean beaker separately and pH scan was dipped into the water and readings recorded.

2.5.3. Salinity

Water Salinity was measured using "Refractometer". Pond water was collected from four corners of the pond separately into beakers. One or two drops of water were put on the transparent lens of the refractometer and the readings taken by adjusting the eye piece. Salinity is expressed as ppt.

2.5.4. Transparency

Transparency was measured (in cms) using "Secchi Disc". The disc is lowered into the pond water with the help of a rope marked with scale. Initial reading "d1" (cms) was taken at the point where the disc cannot be seen. Immediately the rope was pulled up till the disc reappears and the reading was taken as "d2". The average of d1 and d2 is taken as transparency of the pond water. Transparency was always measured during mid day of a sunny day for obtaining better results.

2.5.5. Dissolved oxygen

Dissolved oxygen (DO) of collected samples was measured using a digital DO metre. Water sample in a clean beaker is taken and the electrode of the pH meter is dipped into it. The indicator of the pH meter shows the pH readings directly. The meter should be calibrated routinely at pH 7.0 using appropriate buffer solution and then accuracy verified by testing a pH 9.2 buffer. Dissolved oxygen was also checked by modified Winkler's Iodometric method [6]. The concentration of dissolved oxygen present in the sample was expressed in mg/l.

2.5.6. Alkalinity

Alkalinity was measured following modified titrimetric method [6]. Water samples were collected from the pond and transferred into clean conical flasks. Two drops of phenolphthalein (indicator) was added to the water sample, titrated against 0.1 N HCl until the pink colour disappears and the initial and final readings were recorded. Two to three drops of methyl orange was added to the same sample and titrated again against 0.1 N HCl until the yellow colour changes to pink. Total alkalinity was expressed as mg/l.

2.5.7. Hardness

Hardness of water sample was measured using ethylene diamine tetra acetic acid disodium salt (EDTA) titration method. The principle is Calcium and magnesium ions are titrated with the complexity agent ethylene diamine tetra acetic acid disodium salt (EDTA) to form the stable complexes. The end point of the titration is signalled with an indicator called Erichrom black-T. Required reagents namely Buffer solution, Erichrome black-T, Standard calcium solution, and Standard EDTA solutions are kept ready and titrate the calcium solution with EDTA solution following the prescribed procedure. Hardness was expressed as mg/l ($CaCO_3$).

2.5.8. Total ammonia nitrogen

Total ammonia nitrogen (TAN) was determined using spectrophotometric method [6]. 50 ml samples were collected into clean conical flasks from four corners of the pond. To each of the water samples 1 ml Nessler's reagent (solution A: 5 g Mercuric Iodide and 4 g potassium iodide are dissolved in 100 ml of distilled water; Solution B: 20 g NaOH is dissolved in 100 ml distilled water. Solution A and B are mixed just before use) was added. The intensity of brown colour developed was read at 425 nm using spectrophotometer (Systronics UV-VIS spectrophotomer 108) against a reagent blank. The concentration of TAN is expressed in mg/l.

2.6. Statistical analysis

Data were statistically analysed and comparison among different locations was done by Two-way analysis of variance (ANOVA) to find out any significant ($P<0.05$)

deference among the results was done using Statistical Package for Social Sciences (SPSS; 16.0 version).

3. RESULTS

3.1. Temperature

The temperature was found to be varying in different crops of the study period and also vary between different locations between 18°C to 32°C. Mean values of temperature during the study period is presented in Fig.2.

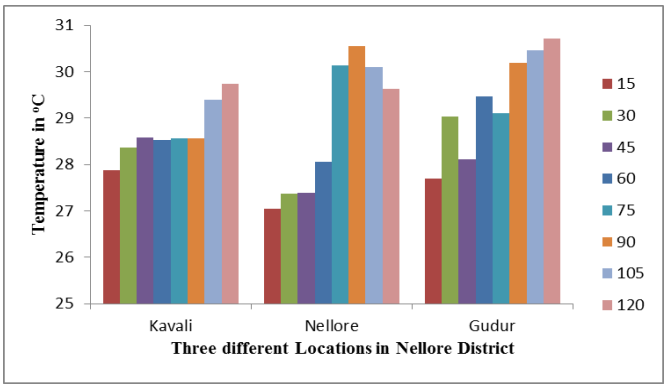

Fig. 2: Mean values of temperature during the study period

3.2. pH

The pH was found to be vary in different crops of the study period and also vary between different locations between 18°C to 32°C. Mean values of temperature during the study period is present in Fig.3.

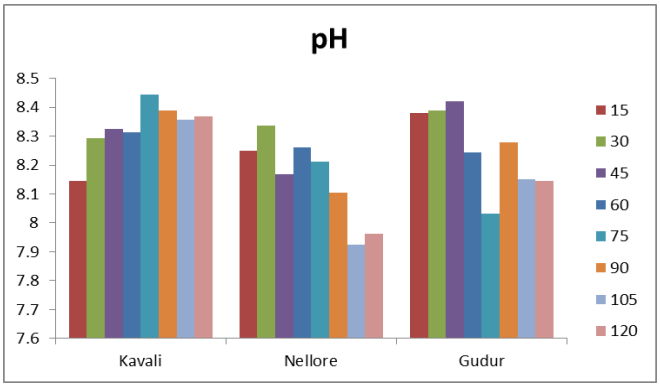

Fig. 3: Mean values of pH during the study period

3.3. Salinity

The salinity was found to be varying in different crops of the study period and also vary between different locations between 18°C to 32°C. Mean values of temperature during the study period is presented in Fig.4.

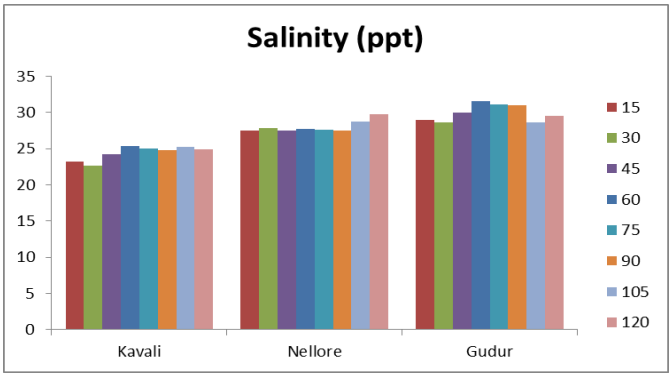

Fig. 4: Mean values of Salinity during the study period

3.4. Transparency

The transparency was found to be varying in different crops of the study period and also vary between different locations between 18°C to 32°C. Mean values of temperature during the study period is presented in Fig.5.

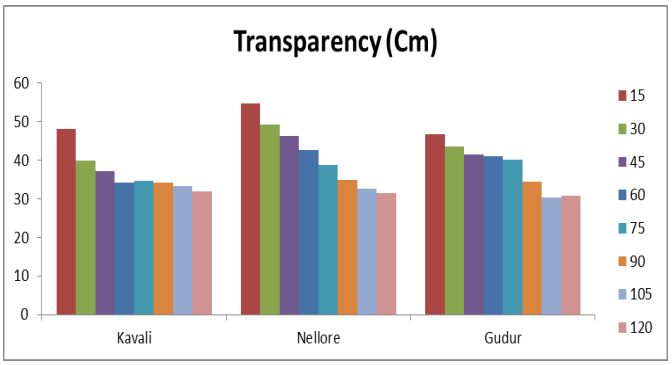

Fig. 5: Mean values of transparency during the study period

3.5. Dissolved Oxygen

The Dissolved oxygen was found to be varying in different crops of the study period and also vary between different locations between 18°C to 32°C. Mean values of temperature during the study period is presented in Fig. 6.

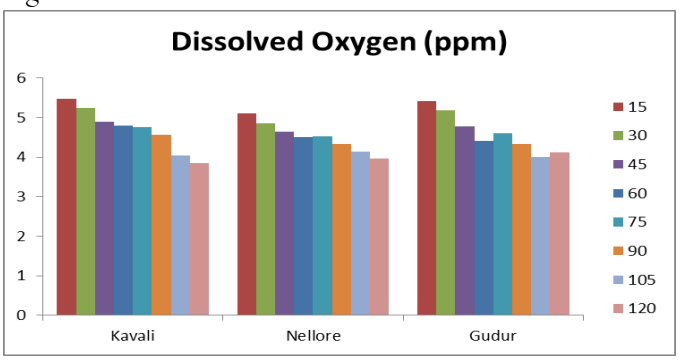

Fig. 6: Mean values of Dissolved oxygen during the study period

3.6. Alkalinity

The Alkalinity oxygen was found to be varying in different crops of the study period and also vary between different locations between 18°C to 32°C. Mean values of temperature during the study period is presented in Fig.7.

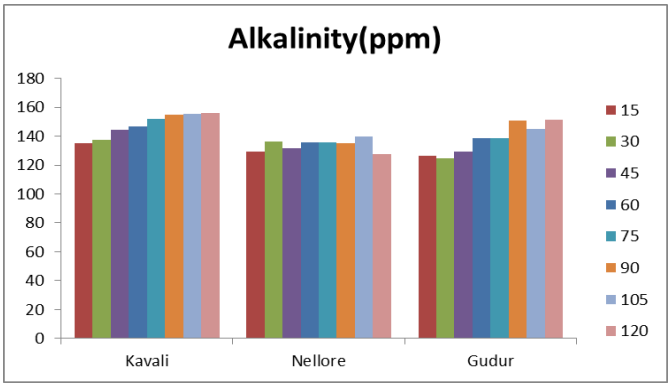

Fig. 7: Mean values of Alkalinity during the study period

3.7. Hardness

The Hardness was found to be varying in different crops of the study period and also vary between different locations between 18°C to 32°C. Mean values of temperature during the study period is presented in Fig. 8.

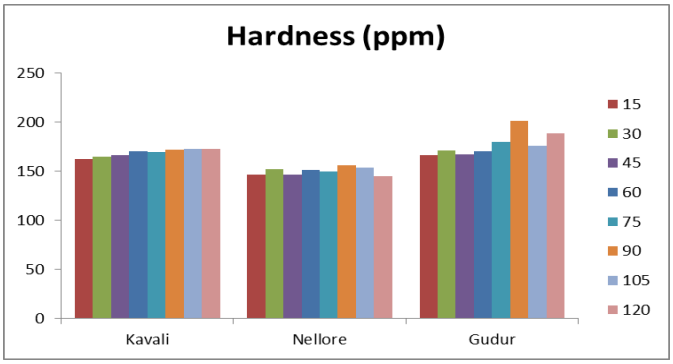

Fig. 8: Mean values of Hardness during the study period

3.8. Total Ammonia Nitrogen

The Total Ammonia Nitrogen was found to be varying in different crops of the study period and also vary between different locations between 18°C to 32°C. Mean values of temperature during the study period is presented in Fig. 9.

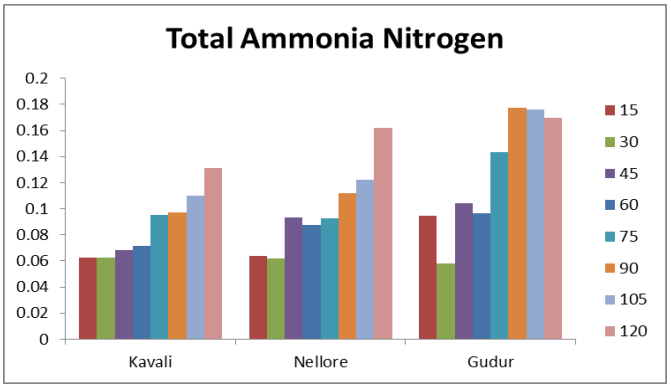

Fig. 9: Mean values of Total Ammonia Nitrogen during the study period

4. DISCUSSION

4.1. Temperature

Water temperature is an important environmental factor for shrimp. It has a direct influence on metabolic rate [7], growth and survival of shrimp [8]. The optimum temperature for growth and survival of Penaeus vannamei juveniles of more than 5 g is 27°C [8]. Water temperature in shrimp farms fluctuates diurnally and seasonally as it depends on air, temperature, water depth, pond design and water management. Water temperature can easily reach 330C in shrimp ponds at least for several hours per day in many tropical countries such as Bangladesh [9], China [10], Thailand [11], Vietnam [12] and Mexico [13].Temperature is an important environmental factor which influences growth and metabolism of aquatic organisms. Two way ANOVA results clearly showed that there were no significant differences in the water temperature among the three locations. On the contrary there was a significant increase ($P<0.01$) in the water temperature when compared with days of culture with the locations. It is suggested that the increase in water temperature is due to increase in seasonal temperature from mid March (33±10C) to mid July (38±10C) with temperatures reaching 400C + during May/June every year in this part of the Country. This is but natural because the temperature of a water body is known to vary with season, weather and solar intensity, especially in natural field conditions, and thus, cannot be influenced by other extraneous factors or added substances during a particular season [14].The results of the present study are in conformity with the above observations.

Table 1: Mean (± SD; n=6) values of Water quality parameters in P. *vannamei* culture ponds of three different locations (L1,L2 & L3) in Nellore district during the four crops (C1,C2,C3 & C4)

Crop	Location	Temperature (°C)	Transparency (Cm)	D.O. (ppm)	Salinity (ppt)	pH	Alkalinity (ppm)	Hardness (ppm)	Total Ammonia Nitrogen (ppm)
C1	L1	29.6 ± 2.0	34.6 ± 4.1	4.6 ± 0.7	24.9 ± 2.9	8.3 ± 0.29	145.8 ± 9.6	171.1 ± 4.7	0.08 ± 0.03
	L2	28.9± 2.4	40.2 ± 6.9	4.5 ± 0.4	27.7 ± 2.4	8.1 ± 0.33	122.5 ±10.9	156.4 ± 13.0	0.08 ± 0.01
	L3	30.6± 1.2	34.3 ± 7.0	4.6 ± 0.7	31.0 ± 2.1	8.3 ± 0.34	128.8 ± 15.1	166.4 ± 13.8	0.14 ± 0.05
C2	L1	28.0 ± 1.1	34.2 ± 3.2	4.7 ± 0.3	24.2 ± 1.9	8.4 ± 0.28	150.9 ± 6.3	172.3 ± 5.5	0.08 ± 0.05
	L2	29.1± 1.1	43.0 ± 8.0	4.5 ± 0.4	27.8 ± 2.2	8.2 ± 0.34	127.9 ± 7.8	159.0 ± 8.3	0.12 ± 0.04
	L3	28.0± 1.1	37.5 ± 8.0	4.5 ± 0.5	29.4 ± 2.3	8.4 ± 0.32	144.8 ± 19.1	168.2 ± 13.9	0.16 ± 0.07
C3	L1	29.4 ± 2.2	43.2 ± 4.1	4.8 ± 0.7	23.6 ± 3.7	8.3 ± 0.34	145.8 ± 13.3	164.4 ± 14.8	0.10 ± 0.04
	L2	28.3± 3.7	39.3 ± 8.7	4.5 ± 0.4	27.9 ± 2.2	8.1 ± 0.24	121.0 ± 12.0	121.1 ± 12.0	0.08 ± 0.02
	L3	29.6± 2.2	34.3 ± 7.0	4.6 ± 0.7	30.4 ± 2.4	8.2 ± 0.34	132.0 ± 7.0	195.9 ± 34.4	0.08 ± 0.02
C4	L1	27.6 ± 1.3	38.2 ± 9.3	4.6 ± 0.6	24.4 ± 2.5	8.2 ± 0.30	149.2 ± 10.6	167.5 ± 10.8	0.08 ± 0.03
	L2	28.7± 1.3	42.6 ± 8.4	4.5 ± 0.5	28.5 ± 2.8	8.1 ± 0.50	163.9 ± 16.8	163.9 ± 16.8	0.10 ± 0.03
	L3	29.0± 2.0	44.0 ± 9.8	4.6 ± 0.6	28.7 ± 2.6	8.0 ± 0.45	146.5 ± 22.0	179.6 ± 20.0	0.11 ± 0.09

Table 2: Two factor ANOVA on the values of temperature

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	19.20674	7	2.74382	6.00814	0.002219*	2.764199
Columns	1.97107	2	0.985535	2.158025	0.152431@	3.738892
Error	6.393574	14	0.456684			
Total	27.57139	23				

** Significant (p < 0.01), @ NS (Not Significant)*

4.2. pH

pH is defined as the negative log of the hydrogen ion concentration and, thus, low pH values indicate high hydrogen ion concentrations, while high pH values indicate low hydrogen ion concentrations. Although shrimp can tolerate pH from 7.0 to 9.0, a pH range of 7.5 to 8.8 is generally regarded as most suitable for shrimp production. Two way ANOVA results clearly showed that pH is not significant (P>0.05) in three locations of L1, L2 and L3 (Table 3, Fig. 3) in the water The P value (P > 0.05) is not significant at different time intervals of culture in three locations. Generally the farmers maintain a good pH because of the importance of pH in culture. In the present study the pH ranged between 7.9 to 8.4 in the three locations for four crops, which is within the ideal limits and hence no significant differences existed between locations.

Table 3: Two factor ANOVA on the values of pH

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.094736	7	0.013534	0.775858	0.617449@	2.764199
Columns	0.125033	2	0.062516	3.583914	0.055356@	3.738892
Error	0.244211	14	0.017444			
Total	0.46398	23				

Result of pH @ Not Significant (p > 0.01),

4.3. Salinity

Salinity is an important water quality variable that has profound influence on the growth of aquatic organisms especially in artificial culture systems. Salinities <15 ppt and >25 ppt are reported to retard growth in *P. monodon* [15]. Two way ANOVA results clearly showed that salinity is highly significant (P<0.05) in three locations of L1, L2 and L3 in the water The P value (P>0.05) is not significant at different time intervals of culture in three locations. Salinity is an important parameter to control growth and survival of shrimps. Even though the shrimp is euryhaline animals it is conformable when exposed to

optimum salinity. The results of the present study are suggesting that there is significant differences exist in three locations of Nellore district with respect to Salinity. At high salinity the shrimps will grow slowly but they are healthy and resistance to diseases. If the salinity is low the shell will be weak and prone to diseases. Further, recommended a salinity range of 10-35 ppt was ideal for shrimp [16, 17].

Table 4: Two factor ANOVA on the values of Salinity

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	9.510254	7	1.358608	1.627831	0.207202[@]	2.764199
Columns	125.0107	2	62.50537	74.89152	0.00[**]	3.738892
Error	11.68457	14	0.834612			
Total	146.2056	23				

[@] *No Significant ($p > 0.01$)* [**]*Highly Significant ($p < 0.05$)*

4.4. Transparency

Transparency, which denotes the depth to which the sunlight penetrates, is an equally important water quality variable that has a significant bearing on the growth of aquatic organisms in culture systems. Transparencies less than 25 cm and greater than 45 cm are reported to influence the growth of *P. monodon* and thus the productivity. Two way ANOVA results clearly showed that transparency was significantly higher ($P<0.05$) in three locations of L1, L2 and L3 in the water and highly significant at different three locations and also at different time intervals of culture suggesting that the periodical growth of microalgae and zooplankton which in turn might have reduced the transparency in a significant manner. In general, the transparency of a water body is influenced by dissolved organic substances, suspended clay particles and microscopic algae. The results of the present study are suggesting that there is significant differences exist in three locations of Nellore district with respect to transparency. The results confirm that transparency will be influenced by dissolved organic substances, plankton load and left over feed etc.

Table 5: Two factor ANOVA on the values of Transparency

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	834.6756	7	119.2394	17.08823	0.00[**]	2.764199
Columns	87.67188	2	43.83594	6.282142	0.01[*]	3.738892
Error	97.6901	14	6.977865			
Total	1020.038	23				

** *Highly Significant ($p < 0.01$)* **Significant ($p < 0.05$)*

Table 6: Two factor ANOVA on the values of Dissolved Oxygen

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	4.563524	7	0.651932	38.47319	0.00[**]	2.764199
Columns	0.156296	2	0.078148	4.611826	0.028932[*]	3.738892
Error	0.237231	14	0.016945			
Total	4.957051	23				

** *Highly Significant ($p < 0.01$),* * *Significant ($p < 0.05$)*

4.5. Dissolved Oxygen

Oxygen is required by shrimp for respiration, the physiological process in which cells oxidize carbohydrates and release the energy needed to metabolize nutrients from the feed. If oxygen is in short supply, the ability of the shrimp to metabolize feed will be limited, causing growth rates and feed conversion to suffer. Best growth and feed conversion ratios (FCRs) are obtained when dissolved oxygen (DO) levels are maintained at or above 80% of the saturation level. As a general rule no stress will be placed upon aquatic organisms, including shrimp,

if DO levels are maintained within 4-6 ppm (mg/l) range. Two way ANOVA results clearly showed that dissolved oxygen was significantly higher (P<0.05) in three locations of L1, L2 and L3 in the water The P value (P<0.05) is highly significant at different time intervals of culture in three locations. Dissolved oxygen plays an important role on growth and production through its direct effect on feed consumption. Oxygen affects the solubility and availability of many nutrients. Low level of dissolved oxygen can cause damages in oxidation state of substances form the oxidised to the reduced form. Lack of dissolved oxygen can be directly harmful to shrimp and cause a substantial increase in the level of toxic metabolics. Low level of oxygen tension hampers metabolic performances in shrimp and can reduce growth and molting and cause mortality. In the present study, significant differences in dissolved oxygen levels were observed in days of culture or location wise suggesting that it is due to phytoplankton growth. The differences also arise due to use of aerators in the ponds during the culture. The present study results conform that DO will be influenced by the factors like phytoplankton increase and also use of probiotics in culture.

4.6. Alkalinity

Alkalinity is defined as the sum of exchangeable bases reacting to neutralize acid when an acid is added to water. In other words alkalinity is the buffering capacity of water. This buffering capacity is primarily due to bicarbonates, carbonates, hydroxides or a mixture of these. In general alkalinity range of 100- 200 ppm is good for shrimp production because this range reduces pH fluctuations and enhances productivity [18]. The results show that the total alkalinity is well within range in all three locations. Two way ANOVA results clearly showed that alkalinity is highly significant (P<0.05) in three locations of L1, L2 and L3 in the water The P value (P<0.05) is significant at different time intervals of culture in three locations as the source of water is different indifferent location.

Table 7: Two factor ANOVA on the values of Alkalinity

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	874.6457	7	124.9494	3.69044	0.017992*	2.764199
Columns	807.2256	2	403.6128	11.9209	0.000949**	3.738892
Error	474.0062	14	33.85758			
Total	2155.877	23				

*Significant ($p < 0.05$), **Highly Significant ($p < 0.01$)

4.7. Hardness

Optimum hardness for aquaculture is in the range of 40 to 400 ppm of hardness. Hard waters have the capability of buffering the effects of heavy metals such as copper or zinc which are in general toxic to fish or shrimp.

Two way ANOVA results clearly showed that hardness is highly significant (P<0.05) in three locations of L1, L2 and L3 in the water. However, the P value (P>0.05) is not significant at different time intervals of culture in three locations.

Table 8: Two factor ANOVA on the values of Hardness

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	656.992	7	93.856	2.384157	0.078885@	2.764199
Columns	3155.314	2	1577.657	40.07609	0.00**	3.738892
Error	551.1315	14	39.36654			
Total	4363.437	23				

@ Not Significant ($p > 0.05$) **Highly Significant ($p < 0.01$)

4.8. Total Ammonia Nitrogen

In shrimp culture ponds nitrogen exists in different forms such as nitrate, nitrite, ammonia and various forms of organic nitrogen. Ammonia-nitrogen (or simply ammonia) is a product of shrimp metabolism and decomposition of organic matter by bacteria [19].

Ammonia levels in a culture pond must be carefully managed because ammonia can be highly toxic to shrimp. Ammonia exists in two different forms in the water: as unionized ammonia (NH_3) & as ammonium ion (NH_4^+). These two forms are usually present simultaneously in the water and are transformed from one form to another depending upon a given situation. Ammonia is usually measured as total ammonia nitrogen (TAN). TAN is a measure of the combined concentrations of unionized ammonia and (ionized) ammonium ion. Further, observed that total ammonia nitrogen in the range of 0.1 to 0.8 mg/l maximizes shrimp yield [20]. Two way ANOVA results clearly showed that TAN is highly significant ($P<0.05$) in three locations of L1, L2 and L3 in the water. However, the P value ($P<0.05$) is also highly significant at different time intervals of culture in three locations.

Table 9: Two factor ANOVA on the values of Total Ammonia Nitrogen

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.022825	7	0.003261	13.29905	0.00**	2.764199
Columns	0.006784	2	0.003392	13.83381	0.000483**	3.738892
Error	0.003433	14	0.000245			
Total	0.033041	23				

** Highly Significant ($p < 0.01$) **Highly Significant ($p < 0.01$)

5. CONCLUSION

The results show that there is significant difference in water temperature at different time intervals of culture. There is no significance of temperature between the locations. The results of transparency are highly significant at different time intervals of culture and there is significance between the locations. The results of dissolved oxygen show that it is highly significant at different time intervals of culture and there is significance between the locations. The results show that there is no significant difference in salinity at different time intervals of culture and it is highly significant between the locations. The results show that there is no significant difference in pH at different time intervals of culture. There is no significance between the locations. The results show that there is significant difference in alkalinity at different time intervals of culture and it is highly significant between the locations. The results show that there is highly significant difference in total ammonia nitrate at different time intervals of culture and it is highly significant between the locations. Hence it is it is concluded that the water quality parameters will vary from location to location within region, during days of culture and also during summer and winter crops.

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7. REFERENCES

1. FAO. *The State of World Fisheries and Aquaculture (SOFIA) FAO*. 2016; Fisheries and Aquaculture Department, Rome.
2. Anderson J, Valderrama D and Jory D. *Global Aquaculture Alliance, GOAL,* 2016; PowerPoint presentation.
3. Tri NH, Adger WN and Kelly PM. *Global Environmental Change* , 1998; **8**:49-61.
4. Lewis Roy R III, Michael J Philipps, Barry Clough and Donald J Macintosh. *Thematic Review on Coastal Wetland Habitats and Shrimp Aquaculture*, 2003
5. Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Framers Welfare, GOI. *Annual Report*, 2016-17.
6. APHA. *Standard Methods for the Examination of Waste Water*. 1995; **14th Edition**, APHA, AWIWA-WPCHCF, Washington DC
7. Allan E, Froneman P and Hodgson A. *Journal of Experimental Marine Biology and Ecology*, 2006; **337:** 103-108.
8. Wyban J, Walsh W A and Godin D M. *Aquaculture*, 1995; **138**:267-279
9. Wahab M A, Bergheim A, and Braaten B. Aquaculture. 2003; **218**: 413-423.
10. Wang X, Ma M, Dong S and Cao M. *J. of Shellfish Res.* 2005; **23:** 231-236.

11. Thongrak S, Prato T, Chiayvareesajja S and Kurtz W. *Agricultural Systems*, 1997; **53**: 121-141
12. Alongi DM, Tirendi F, Dixon P, Trott LA and Brunskill GJ. *Coastal and Shelf Science*, 1999; **48**, 451-467.
13. Ruiz Fernandez AC, Paez-Ouna F. *Water Environ Res.* 2004; **76(1)**:5-14.
14. Guerrero-Galvan S R, Páez-Osuna F, Ruiz-Fernández A C and Espinoza-Angulo R. *Hydrobiologia.* 1999; **391**:33-45.
15. Chanratchakool P, and Phillips M J. *FAO Fisheries Technical Paper.* 2002; 177-189.
16. Muthu M S. *Proceedings of the Symposium on shrimp farming (MPEDA).* 1980; 97-106
17. Karthikean J. *American Society of Civil Engineers*. 1994; Technical paper submitted to Seminar – Our Environment – Its Challenges to Development Projects. Paper ID **NOV1621131213**.
18. Ponnuchany R. *Practical guide to shrimp farming an eco-friendly approach*, 1997; **ISBN, 81-85517-36-3.**
19. Jun X, Xiuzhwng F and Tongbing Y. *Naga, The ICLARM Quarterly*. 2000;
20. Fast AW, Lester LJ. *Marine shrimp culture: Principles and practices.* 1992; p. 866