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STUDY ON THE MANAGEMENT PROTOCOL, GROWTH, YIELD AND ECONOMICS OF *LITOPENAEUS VANNAMEI* (BOONE, 1931) WITH VARIED STOCKING DENSITIES AND SALINITIES AT SPECIFIED COMMERCIAL CULTURE TANKS OF PURBA MEDINIPUR, WEST BENGAL, INDIA.

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ABSTRACT
White leg shrimp (*Litopenaeus vannamei*) production is now most demanding and high economic value culture practices through worldwide. The main objectives of the present studies is to evaluate growth, yield and economics of the species with varied stocking densities, salinity and management practices at commercially cultured six ponds with gradients of salinity, stocking density and survivability in study area of Purba Medinipur, West Bengal with different days of culture periods. During the crops harvest the final average body weight was 22.40gm, 23.00gm, 26.00gm, 20.25gm, 18.40gm & 16.10gm and yields (in Kg/Ha./Crop) are 9246.72, 8280.00, 5200.00, 8922.96, 8402.91 and 7545.68 respectively. The average daily gains (gm/day/Shrimp) are 0.235, 0.23, 0.24, 0.217, 0.204 & 0.178 and FCR value measured 1.25, 1.27, 1.38, 1.21, 1.05 & 1.04 respectively. The result showed the profit (in percentage value) is 42.84, 43.72, 32.82, 30.42, 19.09, 19.09 and 7.30 from pond P1 to P6 respectively. At the harvesting the highest growth rate observed at lowest final stocking (20/m^2) densities but higher yields observed at the final stocking density (SD) of around 40/m^2 though highest profit percentage at 35/m^2 of SD at the same unit area. The best management practice with good quality of seeds for culture periods of 100 ± 10 days fetching higher margin of profit. The shrimps are observed to grow well at the salinity range from 5.00ppt to 25.5 ppt. It is observed that with 80% survivability after sixty ± five days of culture (DOC) the average body weight (BW) was 10.00 ± 01gm/Shrimp. The optimum management of feed, water quality and disease control should be followed during management practices to get the higher profit in this shrimp culture.

KEYWORDS: Feed Conversion Ratio, Growth, *Litopenaeus vannamei*, Management practices, Stocking Density.

INTRODUCTION

The production of aquaculture related organism has rapidly grown-up enormously in the last few years (Karuppasamy and Mathivanan 2013). In 2006 Crustacean aquaculture has followed the equal growth in which the yearly production has stands with about 05 million tons (Department 2000). Now a day's Penaeid shrimps are most favored in aquaculture for shrimp farming which leads to expansion of the aquaculture areas (Pasharawipas et al. 2005). Now India ranks in second position after China in saline water shrimp production worldwide (Ravuru and Mude 2014b). Due to the high profitability and high demanding market, farmers are cultured with organic and inorganic fertilizer, high amount of stocking densities and artificial feed to earn the maximum profit (Ayyappan 2006). Besides, there is a chance of higher stress for the growing organism with the over intensification. Under stress the pathogens present in the pond may enter and cause disease resulting in severe mortality. From last couple of years Asian countries were severely affected with many viral diseases like White Spot Disease and faced massive economic losses particularly due to continuous outbreak (Krishna et al. 2015).

Since 2012-13, in India the production of white leg shrimp *Litopenaeus vannamei* has become highest crustacean species than the *P.monodon* (Alcivar-Warren et al. 2007; Frias-Espericueta et al. 2001). Among other species, *L. vannamei* has represented about 90% of saline water shrimp culture in the Western part of hemisphere due to its fast growth and short culture period (McGraw et al. 2002; Saoud et al. 2003). Usually survival, growth and production of

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shrimp depend on the type of culture system, high stocking density, feeding rates, water quality (temperature, salinity, pH and dissolved oxygen) and sediment deterioration. Besides that, the aquatic ecosystem the culture pond may also influence the production performance culture practices (Krishna *et al.* 2015; Liao 1977; RAJYALAKSHIMI 1972; Verghese *et al.,* 1975). It has been cultured in saline waters ranging in salinity from 1ppt to 40 ppt (Bray *et al.,* 1994). Information regarding consequence of stocking density of the shrimp performance during intensive culture is limited, inconsistent and sometime controversial. The present investigation emphasized on management techniques in respect to salinity and stocking density of mentioned shrimp species.

MATERIALS AND METHODS

The study was conducted at the commercial brackish water ponds on the both sides of the Rosulpur and Haldi River of Purba Medinipur District, West Bengal. They were treated as Pond No. 01 (P1) to Pond no. 06 (P6) and they are equal in size of 100Decimal or 4000m^2 (Table 1) from 2017 to 2018. After draining the previous year's water the black soil of the bottom is allowed for 75 to 90 days for sun drying to eradicate harmful gases, small animals, oxidation of the black soil etc. Then the dried black soil are removed by tractors outside the dyke and allowed for another 15 days for sun drying and applied lime at required doses. Both the vertical and horizontal bio security measures are taken strictly to prevent the chance of occurrences of diseases outbreak.

Table 1: Study area with geographical location.

Location of Tanks				
Sl. No	**Experimental pond**	**Name of the Block**	**Latitude**	**Longitude**
1	P1	Nandakumar Block	$22^0$07'44''N	$87^0$55'47''E
2	P2	Nandakumar Block	$22^0$07'41''N	$87^0$55'49''E
3	P3	Bhagwanpur-II Block	$21^0$55'58''N	$87^0$44'51''E
4	P4	Bhagwanpur-II Block	$21^0$54'55''N	$87^0$44'50''E
5	P5	Khejuri-I Block	$21^0$56'04''N	$87^0$48'35''E
6	P6	Khejuri-I Block	$21^0$56'08''N	$87^0$48'31''E

After that either during full moon or new moon the filtered water is introduced from river by the mechanized pump filled above 01 meter of depth. Then the pond is allowed for two days sedimentation and then the water treatments are done. After pond preparation the certified seeds were procured from reputed company from the nearby state the carrying procedure was maintained as per (Balakrishnan et al. 2011). The seeds were liberated at the pond water after maintain proper acclimatization. Generally best times for release are morning and night time to minimize the water temperature fluctuation between packets and pond water. The packets locally called as 'Ball' with around 2000-2500 seeds should first be kept at untied condition on an around one hour at pond water to eradicate water temperature fluctuation, after that water should be sprinkled over the opened mouth of the packets slowly to adjust temperature, salinity and pH differences. The artificial diet was prearranged by Manamei feed pellet [Protein 35% and Protein 34% (Ravuru and Mude 2014b) from 2nd day to till harvest. Initially the feeding was done as, 'blind', four times daily but after 37 days five times. To minimize size variation sometimes back feeding also maintained after 35 to 40 minutes of every meal application. Initially forty to fifty minutes of aeration was done after 2 hours of each meal, then it was increased to one hour to one hour thirty minutes plus from 37 DOC and lastly after 60 DOC it was maintained even after lifting of check tray from pond to fifteen minutes before the next meal. Check tray was maintained from 35 DOC after one hour and forty five minutes from feeding of each meal.

The soil, water and feed Probiotics and minerals were used fortnightly though feed supplements were at weekly basis as per requirement. Bleaching was spread at the outside of the dyke fortnightly and KMn4 solution was always kept at the entrance for leg and hand wash. The ponds were initially stocked with seeds @ 50/m^2, 40/m^2, 30/m^2, 60 /m^2, 70/m^2 and

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80/m^2 having the salinity (in ppt) of 05,08,12,17, 22 and 25 from P1 to P6 respectively. The reading of length and weight was done from 37 DOC at weekly basis and the sampling of animals was done by cast net at 7 am. The required other parameters were measured from 02 DOC to till harvest at weekly basis along with growth measurement.

RESULTS AND DISCUSSION

The recent trends of *L. vannamei* farming both for the area under culture (AUC) and expected productions (EP) are tremendously increasing at the Indian Maritime States and definitely West Bengal is not exception of that. The Figure 1 clearly showed the trends of shrimp production in India. Though this L. *vannamei* production has started in India from 2009-2010 but it increases tremendously as compared to other shrimps till the year 2015-16.

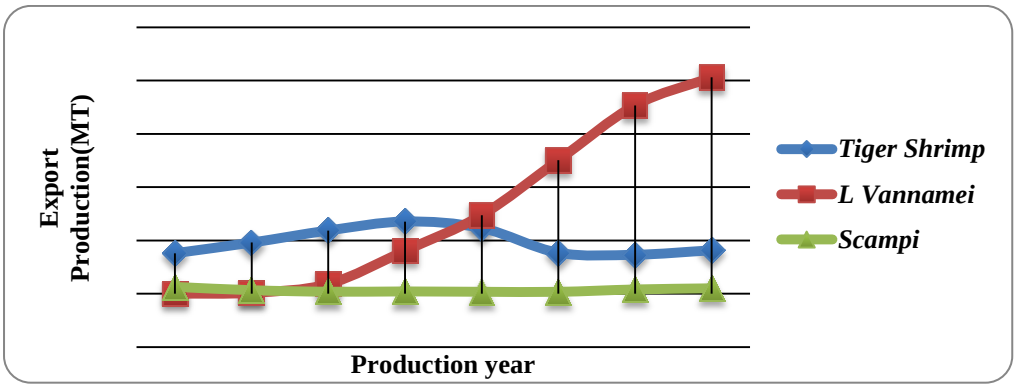

Figure 1. From year 2008 to 2016 the yearly tiger shrimp, L. Vannamei and Scampi production in India. (*Source: MPEDA, Ministry of Commerce & Industry, Govt. of India*)

Growth and Yield:

In this experiments harvesting were done at the DOC of 95, 100, 107, 93, 90 and 90 with average body weight (in gm/shrimp) of 22.4,23, 26, 20.25, 18.4 and 16.1 at initial salinity (in ppt.) of 5, 8, 12, 17, 22 and 25 and final SD obtained are (Shrimp/m^2) 41.28, 35, 20, 44, 46 and 49.63 from pond P1 to P6 respectively. The growth show in terms of weight when calculated the maximum average daily gain (gm/shrimp/day) was at P3 and minimum at P6 where final SD are 20 and 49.63 respectively. The final result showed that after following same type of management practice the total production (in Kg) are 3698.69, 3312, 2080, 3569.18, 3361.16 and 3195.85 maintaining FCR 1.25, 1.27, 1.38, 1.21,1.05 and 1.04 respectively with ADG (gm/shrimp/day) of 0.235,0.23, 0.24, 0.217 , 0.204 and 0.178 from P1 to P6 respectively (Figure 2 and 3). After completion of the experimental period of 120 days the productions were observed as 3541.2kg, 4205.4kg, 5192.6kg, 5962.2kg and 5046.6kg and the percentage survival was 80.4, 79.6, 78.4, 78.2 and 73.4 with respect to the densities of 40/m^2, 50/m^2, 60/m^2,70/m^2 and 80/m^2respectively. Also observed that the mean average weight of shrimps were 27.7, 29.0 and 30.0gm with survival percentage of 86,88 and 90 by maintain FCR of 1.78, 1.81 & 1.82 for 120,123 and 126 days & yield achieved to 8337, 8932 & 9450kg when pond size of 175 dec. each.

The species *L. vannamei* grow well, the body weight increased 2.0-4.5g and ADG 0.20g at 15 days in present climate conditions, which is much more favorable than other countries. (Araneda et al. 2008) reported that the shrimp maintained at 35^{0}C had the highest rate of food consumption recorded the average growth rate of 0.38 g/wk in the 90 shrimp/$m^2$and lowest in the 180 shrimp/m2 (0.33 g/wk). Like this, (Wyban et al. 1987) also reported the declined growth and increased yield with increased density in Penaeid shrimps. In this work survival percentage is 82.56, 88.25, 66.67, 73.44, 65.24 and 62.03 when stocked initially with 50/m^2, 40/m^2, 30/m^2, 60/m^2, 70/m^2 and 80/m^2 and observed highest survival at 40/m^2. Survival rate of growing *L.vannamei* were 80.4, 79.6, 78.4, 78.2 and 73.4 with respect to the densities.

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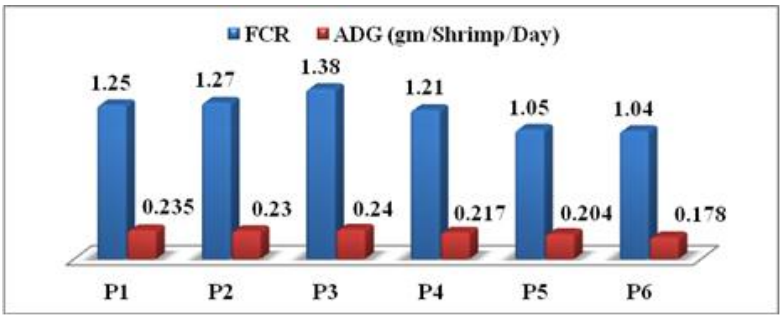

Figure 2. FCR (Food conversion ration) and ADG (Average daily gain) are mentioned in six study sites throughout the study period by bar diagram.

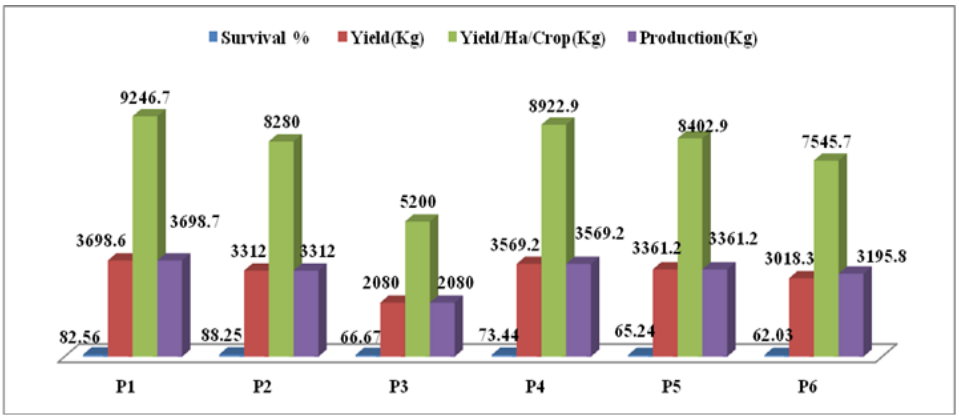

Figure 3. The survivability (in %), yield/Ha/crop (kg) and production (kg) of *L. vannamei* has been studied out during the culture period.

Economics:

It was observed that the highest expenditure was incurred for feed followed by seed in all farms (Figure 4). The feed cost percentage were 43.38, 43.27, 39.85, 41.03 and 36.09 where final SD are @ 41.28/m^2, 35/m^2, 20/m^2, 44/m^2 & 46/m^2 at DOC of 95, 100, 107,93 and 90 and profit of crops (Rs./Kg) are 95.98, 100.39, 88.96, 69.98 and 39.92 respectively from P1 to P5 . The profit margin majorly depends upon the differences of production cost and rate of selling crops. It was observed that at DOC of 70±5 if the animal attain 15+ gm weight then the farmers can't face loss and after that average weekly weight gain of 1.5 gm showed cost benefit ratio=1:1. The selling price observed during the study periods for fifty count (50 Shrimp/Kg) was Rs. 300.00/kg and further an amount of Rs.10.00/kg is added to per gram of weight or vice versa.

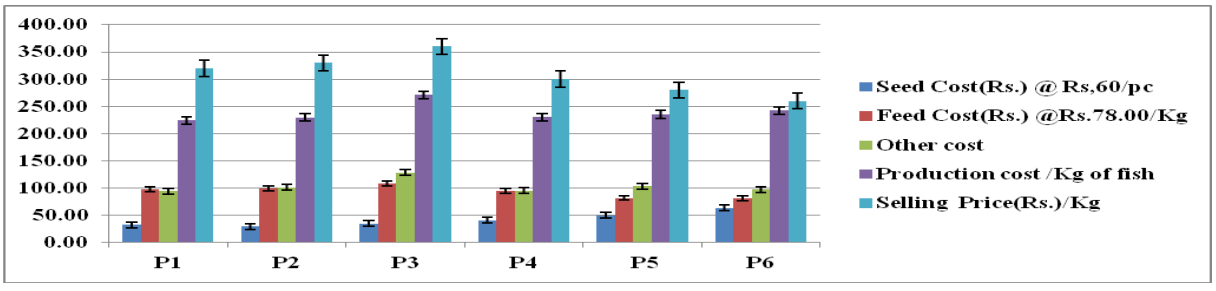

Figure 4: The bar plots with error bar shows the seed cost, feed cost, other costing, production cost and selling price according to the P1 to P6.

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Stocking Densities:

The final stocking densities obtained are 41.28/m^2, 35/m^2, 20/m^2, 44/m^2, 46/m^2 and 49.63/m^2 when they are stocked initially was 50/m^2, 40/m^2, 30/m^2, 60/m^2, 70/m^2 and 80/m^2 respectively. Though the optimum benefits fetches the Final SD of 35/m^2, followed by 41.28/m^2, 20/m^2, 44/m^2, 46/m^2 and lastly 49.63/m^2. So it can shows that the final SD of 35/m^2 is best when all other conditions found favorable. The result clearly showed that best economic results were possible at optimum stocking density and that may depend upon the area of the pond, the required harvesting size of the shrimp and the number of crops per year. It was observed that large organisms dominate upon the smaller ones for feeding and space at the higher density treatments. So in this study regular back feeding was done as stated earlier to avoid size variation. The result confirmed that the survival rate was maximum at initial stocking of 40/m^2 and minimum at 70/m^2.

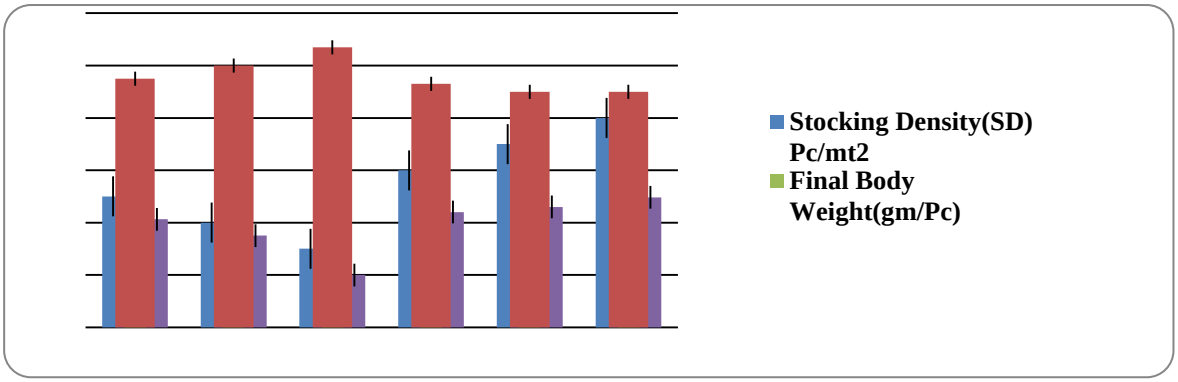

Figure 5: The bar plots with error bar shows pond wise stoking density and final body weight.

Salinity and other phyco-chemical parameters:

In these experiments it was observed that the shrimp can grow up well at wide range of salinity from 5ppt to 25.5 ppt at the different experimental ponds though highest survival at 8ppt, highest yields at 5ppt. and highest ABW at 12ppt. in same categories of study and other phyco-chemical parameters are also monitored (Figure 6 and 7). Though (Ravuru and Mude 2014a) observed that most favorable development has seen in between 3 to 14 ppt which is somewhat less than (Bray et al. 1994), but that's are far greater than the observations of (Huang 1983; Zhu et al. 2004). However, the shrimp tolerates the salinities of even 2.45ppt (Pasharawipas et al. 2005). From past few reports, the growth and existence of *L.vannamei* in brackish water range from 10-35ppt (Gunalan et al. 2010; Karthikeyan 1994) where (Sowers et al. 2006) observed the higher growth in low salinity (2ppt) water than in seawater.

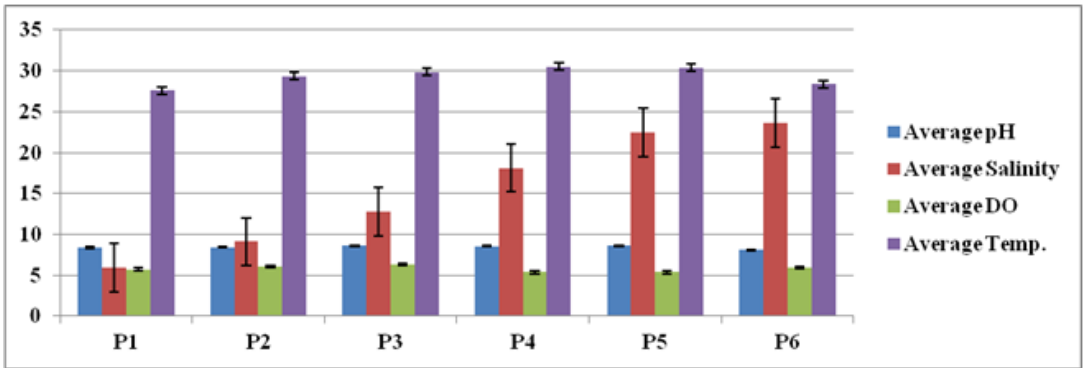

Figure 6: The bar plots with error bar shows the average pH, Salinity, DO and temperature monitored during this *L. vannamei* culture period.

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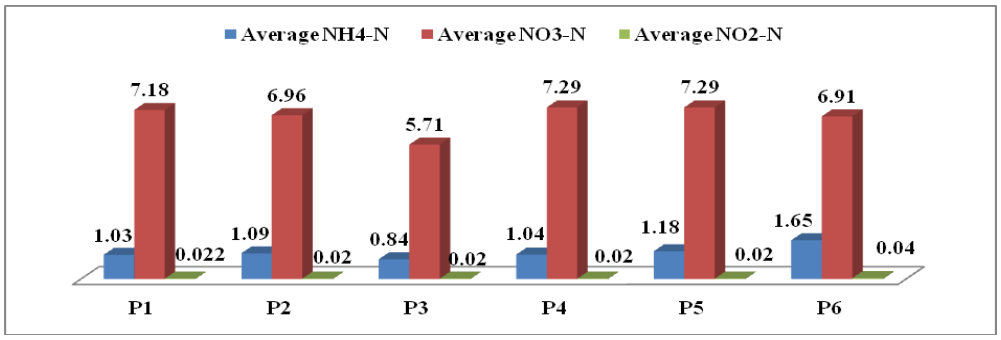

Figure 7: The average NH_4, NO_3 and NO_2 are measured during the study period

The pH of farming ponds' water are influenced by many other factors such as soil acidity, water sources, shrimp culture inputs, minerals contain and other biological activities (Lee et al. 1986). In this study pH was maintained regularly and found wide range of acceptance at different ponds from pH 7.6 to 9.2 become optimal for this cultures shrimp.

CONCLUSIONS

The initial stocking density of *L. vannamei* was 40/m^2 with proper acclimation of seed during liberation , which can helps to survive above 80 percent and optimum management of feeding with wide range of salinity the species can yield optimum production and economic benefit. As feed cost and seed cost are the first and second highest items of expenditure of *L. vannamei* culture so proper and optimum management procedure should be taken for these two items. Besides these above the water quality parameters should be maintained at its optimum range throughout the culture periods. In this study pH found wide range of acceptance at study ponds from pH 7.6 to 9.2 for this cultures shrimp.

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