



OPTIMIZATION OF *PENAEUS VANNAMEI* (BOONE,1931) CULTURE THROUGH ENVIRONMENTAL MANAGEMENT: INSIGHTS FROM POND-BASED SYSTEMS IN KAKINADA OF ANDHRA PRADESH.

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Abstract:

The success of shrimp culture depends on a number of factors, of which fertilization of the pond is a crucial step to increase the productivity of ponds for development of natural food. The required nutrients for the proper growth of shrimp are limited, because nutrient levels are depending on pond ecosystem. This can be rectified by using various fertilizers, supplementary feeds and other requirements of nutrients in pond ecosystem. The main objective of the present study is to assess the effect of physico-chemical parameters and probiotics on growth and survival of *Penaeus vannamei* in culture ponds at Kakinada, Andhra Pradesh, India. It is a first attempt in this area with an aim of understanding the *vannamei shrimp* culture practices in Kakinada and expansion of shrimp culture in this area and to increase the yield per unit area by strict implementation of better management practices like pond preparation, fertilization, feed management and application of probiotics and biosecurity measures.

Keywords: Vannamei shrimp, Ecosystem, Fertilization, Feed management, Probiotics, Biosecurity measures.

1. Introduction:

In India aquaculture sector achieved remarkable growth during mid-eighties reached in peak in especially with respect to shrimp production. The issue of malnutrition has become important for the growing populations in India as well as world. The aqua industry has expected to account progressively for the insufficient aquatic food supply that would occur for the population increase expected until 2030, and it is the fastest growing food production sector in the world with an average rate of 9.2% over the past 30 years (FAO, 2005) which makes aqua industry one of the promising industries to meet future food demand.

Aquaculture industry to be more sustainable, new strategies to control infection (other than antibiotics) are urgently needed (Defoirdt *et al.*, 2007). Application of probiotics could be relevant in this perspective. In any case use of antibiotics could not be considered as an option any more in ponds operations. Zero antibiotics use is the

need of the hour. The physical and chemical properties of water such as temperature, pH, salinity, dissolved oxygen, alkalinity, hardness, ammonia, nitrite and nitrate are the most important parameters for the management of the pond waters (SIFT, 1995). These properties play a major role in providing good growth and health of shrimp. The optimum range of physico-chemical parameters were presented in Table-1.1.

Table.1.1: Optimum levels of water parameters in shrimp culture ponds.

NAME OF PARAMETER	OPTIMUM RANGE
Temperature(°C)	26– 35
pH	7.5 - 8.5
Salinity (ppt)	10 – 15
Dissolved Oxygen(ppm)	4 – 10
Total Alkalinity (ppm)	150 – 200
Nitrite – N (ppm)	0.1 - 0.24
Ammonia (ppm)	0 - 0.1
Hydrogen sulphide	<0.001
Iron (ppm)	0.1- 1.0
Phosphorus(ppm)	0.1-0.3
Soil (organic Carbon)	1.0- 1.5

2. Materials and Methods:

The present study was conducted in ten commercial shrimp ponds of Sri Nandhana Aqua farms located at Kakinada of Andhra Pradesh, India (Fig.1)



Figure. 1: Geographical location of Sri Nandhana Aqua Farms, Kakinada.

These studies were conducted on four crops in three different seasons namely, Crop1- Winter season (02.10.2023 to 29.01.2024), Crop 2- Summer Season (1.03.2023 to 28.06.2024), Crop 3- Monsoon season (30.07.2023 to 27.11.2024) and Crop 4- Summer Season (11.01.2024 to 11.05.2025). Out of ten, five ponds were control ponds (P1-P5) and other five ponds were probiotic treatment ponds (P6-P10).

Ponds were filled with brackish water during the high tide by inlet pipes. All the culture ponds were 1.7-1.8 m depth. The soil type was Loamy clay. The minimum water level in each pond was 1.5m. The pond shape is rectangular. The pond size is 0.5 hectare each. *Penaeus vannamei* postlarvae (PL14) were procured from commercial shrimp hatchery Sri Kanaka Matya shrimp Hatchery, Kakinada Andhra Pradesh. Postlarvae were packed in oxygenated polythene bags and brought to Sri Nandhana Aqua Farms Kakinana. *P.vannamei* seeds were

PCR tested, negative virus. The PL was acclimatized in the farm with adequate aeration. The initial average weight of Postlarvae was 0.09g.

Average Daily Growth:

$$ADG = \frac{\text{AVERAGE BODY WEIGHT}}{\text{DAYS OF CULTURE}}$$

Specific Growth Rate (Vinecnt Lugert *et al.*, 2016):

$$SGR = \frac{\ln(WF) - \ln(WI)}{\text{TIMEPERIOD}} \times 100$$

Feed Conversion Ratio (Aliyu-Paiko *et al.*, 2010):

$$FCR = \frac{\text{TOTAL FEED IS GIVEN}}{\text{TOTAL WET WEIGHT GAIN}}$$

Survival Rate:

$$SR = \frac{\text{NO OF SHRIMP PRESENT IN THE POND}}{\text{NO OF SHRIMP STOCKED IN THE POND}} \times 100$$

Biomass:

Biomass= Total weight of harvested shrimp in Kg.s
The biomass expressed as Kg yield/ha

Statistical Analysis:

The growth parameters of *P. vannamei* of different culture ponds in different crops analysed by ANOVA and the correlations between the physico-chemical parameters of water and growth of *P. vannamei* was carried out by using Microsoft excel.



Fig.2. Digital Thermometer



Fig.3. Refractometer



Fig.4. pH Test Kit



Fig.5. D.O. meter



Fig.6. Alkalinity Test Kit

Fig.7. Nitrite Test Kit

4. Results:

The physico-chemical parameters of *P.vannamei* culture ponds showed variations during the study period. The overall range of temperature recorded was 25° C to 34° C. A positive correlation was noted between the water temperature and growth of the shrimp in crop-1 & crop-4. The positive correlation between temperature and survival was also noticed in crop-4.

The salinity of pond water ranges from 7.8 to 14 ppt during the study period. The salinity negatively correlated with growth, survival and yield of the shrimp during the study period. The variations in the salinity did not play any role in survival, growth and yield of vannamei shrimp. The pH ranges from 7.5 to 8.7 during the study period. The optimal pH levels are maintained in all ponds all seasons. A little variation in pH of the water did not affect the survival, growth and yield. The DO reported in different vannamei culture ponds varies from 4.4 to 6.6ppm. Fairly higher values of DO were reported in probiotic treated ponds, when compared to the control ponds. The DO positively correlated with survival, growth and yield of vannamei shrimp during the study period.

The total alkalinity reported in different vannamei culture ponds ranges from 180-207ppm during the study period. Alkalinity was negatively correlated with growth, survival and yield of vannamei shrimp. Nitrite-N in different vannamei culture ponds ranges from 0.16 to 0.29 ppm during the study period. A fairly lowest values of Nitrite-N reported in probiotic treated ponds, when compared with the control ponds. Nitrite was negatively correlated with survival, growth and yield of shrimp during the study period.

Ammonia-N was reported in different vannamei culture ponds varies from 0.04 to 0.14 ppm during the study period. The lowest values of ammonia-N were reported in probiotic treated ponds when compared to the ammonia values of control ponds. Ammonia was negatively correlated with growth, survival and yield of vannamei shrimp during the study period. The average daily growth of *P.vannamei* in different culture ponds in different seasons varies from 0.1 to 0.25g/day. Almost equal ranges of average daily growth were reported in all seasons. Overall, the highest average values of average daily growth were reported in probiotic treated ponds, when compared to the control ponds during the study period. The survival rate of *P.vannamei* in different culture ponds ranged from 60 to 92%. The highest survival rate was reported in probiotic treated ponds when compared to the control pond during the study period. Among the four crops, more than 90% of survival was noticed in crop-3 & crop-4. The specific growth rate of *P.vannamei* during the study period ranged from 3.555 and 4.869 % per day. Almost equal range of specific growth rate was noticed in all crops. Fairly highest rates were noticed in probiotic treated ponds, when compared to the control pond during the study period.

Table.4.1: Water quality parameters in *Penaeus vannamei* culture ponds during the study period.**A. Crop-1: Winter**

Ponds	NON - PROBIOTIC PONDS					PROBIOTIC PONDS				
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Temperature (°C)	28	27	26	25	26	26	26	26	27	27
Salinity (ppt)	10.0	9.0	10.5	8.0	10.0	9.8	8.5	8.8	8.0	7.8
pH	8.7	8.5	8.1	8.2	8.0	7.5	7.6	7.9	7.8	7.6
DO(ppm)	4.5	5.0	4.7	4.6	4.8	5.4	5.6	5.2	5.7	5.5
Total Alkalinity(ppm)	190	194	197	199	196	181	184	180	186	183
Nitrite – N (ppm)	0.23	0.24	0.29	0.25	0.27	0.17	0.16	0.19	0.18	0.20
Ammonia– N (ppm)	0.11	0.10	0.13	0.12	0.14	0.08	0.07	0.06	0.09	0.07

B. Crop-2: Summer

Ponds	NON - PROBIOTIC PONDS					PROBIOTIC PONDS				
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Temperature (°C)	27	31	33	32	30.5	34	32	31	28	30
Salinity (ppt)	14.0	13.2	14.0	14.03	13.5	11.05	13.01	12.05	10.04	13.0
pH	8.0	8.1	8.3	8.4	8.2	7.6	7.8	7.5	7.7	7.5
DO(ppm)	4.5	4.7	4.8	4.6	5.0	5.6	5.2	6.0	5.2	6.2
Total Alkalinity (ppm)	195	197	202	205	200	181	189	188	190	187
Nitrite – N (ppm)	0.24	0.23	0.25	0.23	0.25	0.20	0.21	0.18	0.20	0.20
Ammonia– N (ppm)	0.10	0.11	0.13	0.12	0.13	0.09	0.08	0.07	0.08	0.07

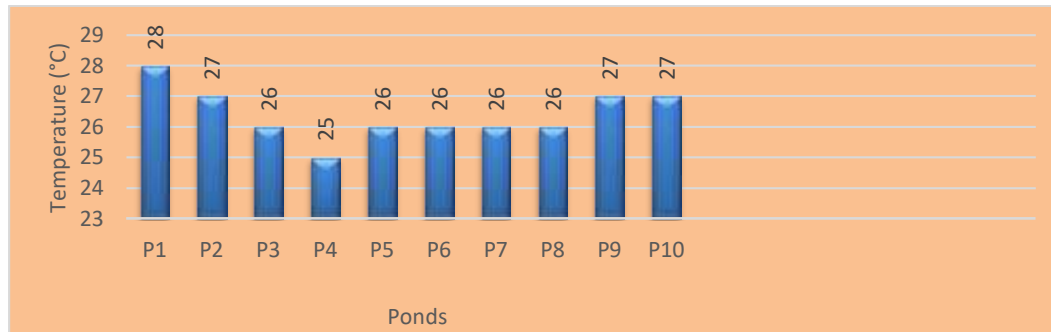
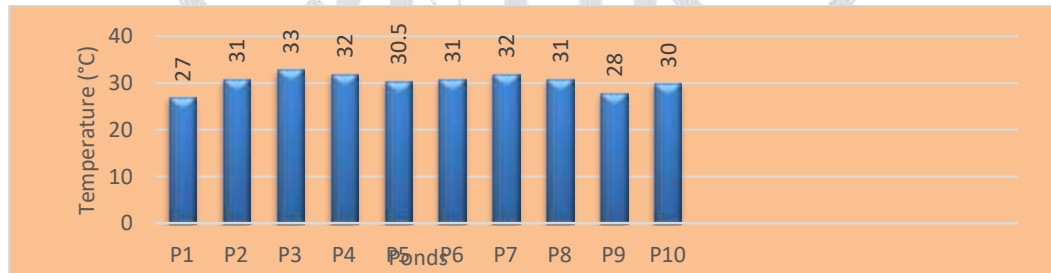
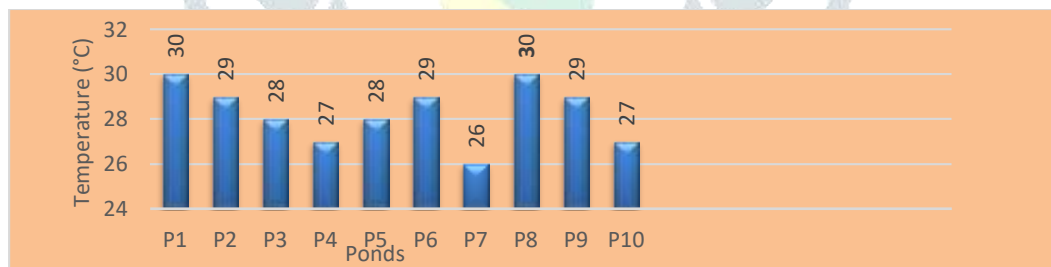
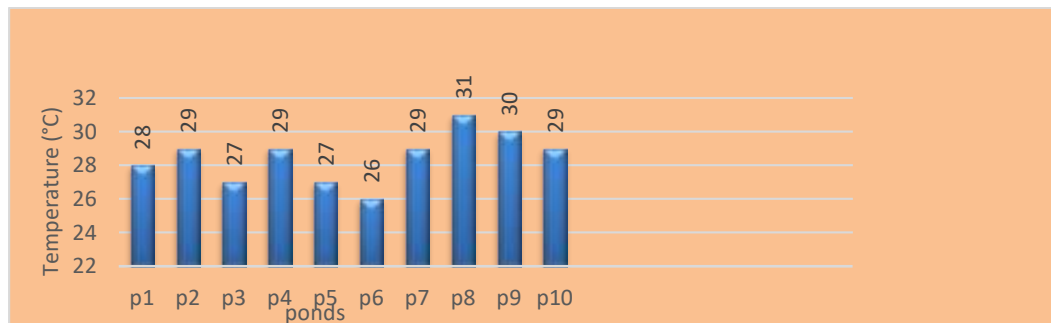
C. Crop-3: Monsoon

Ponds	NON-PROBIOTIC PONDS					PROBIOTIC PONDS				
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Temperature (°C)	30	29	28	27	28	29	26	30	29	27

Salinity (ppt)	12.05	11.00	10.00	9.06	10.03	8.08	8.00	9.05	10.00	12.00
pH	8.2	8.1	8.1	8.4	8.5	7.5	7.6	7.8	7.5	7.9
DO(ppm)	4.4	4.6	4.6	4.8	4.8	5.6	5.7	5.5	6.2	5.6
Total Alkalinity (ppm)	192	196	200	198	199	180	182	185	187	189
Nitrite – N (ppm)	0.23	0.23	0.24	0.22	0.21	0.18	0.17	0.18	0.19	0.19
Ammonia– N (ppm)	0.12	0.10	0.11	0.13	0.12	0.04	0.05	0.06	0.08	0.08

D. Crop-4: Summer

Ponds	NON - PROBIOTIC PONDS					PROBIOTIC PONDS				
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Temperature (°C)	28	29	27	29	27	26	29	31	30	29
Salinity (ppt)	12.4	12.00	10.0	11.05	11.5	9.0	8.5	8.01	9.0	9.8
pH	8.7	8.5	8.2	8.1	8.0	7.6	7.5	7.8	7.9	7.6
DO(ppm)	4.6	4.7	4.8	4.7	5.0	5.2	5.3	5.2	5.4	5.5
Total alkalinity (ppm)	200	207	201	194	190	187	186	185	189	180
Nitrite – N (ppm)	0.24	0.23	0.21	0.22	0.20	0.17	0.16	0.18	0.16	0.17
Ammonia– N (ppm)	0.11	0.10	0.14	0.13	0.14	0.07	0.08	0.07	0.08	0.06

Fig.4.1. Temperature ($^{\circ}\text{C}$) in different *P. vannamei* culture ponds during the study period**A. Crop – 1: Winter****B. Crop-2: Summer****C. Crop-3: Monsoon****D. Crop-4: Summer**

The FCR of *P.vannamei* in different culture ponds varies from 1:1.15 to 1:2.19. Fairly the highest values of FCR were noticed in winter crop. Overall, the lowest FCR values were reported in probiotic treated ponds, when compared to the control pond during the study period. The Biomass (yield/ha) of *P.vannamei* of different culture ponds during the study period varies from 3,009.6 to 6,624 kg/ha. It is also reported that the highest survival rates were noticed in crop-3 & crop-4. Overall, the highest biomass was reported in probiotic ponds, probiotic treated ponds, when compared to the biomasses reported in the control ponds during the study period.

Analysis of Variance showed that the average daily growth, Specific growth rate, Survival, FCR and biomass of *P.vannamei* were significantly different between *P.vannamei* culture ponds and crops. The Survival, growth and biomass of *P.vannamei* were positively correlated with DO and temperature during the study period.

5. Conclusion:

Better management practices are solution for obtaining high yield in the shrimp culture. Water quality parameters (Temperature and D.O.) and yeast based organic juices are directly or indirectly improves the productivity of the pond. The optimal water quality parameters are also key factors for improve the health, survival, growth and yield of *P.vannamei*. The present study clearly indicated that the application of probiotics increases the feed efficiency and growth of *P. vannamei*. The present study suggested to expand the vannamei culture in this area through implementation of strict procedure of biosecurity. It is further suggested to carry out studies on microbial loads in soil, water and gut of the vannamei shrimp for better understanding of effect of the probiotics in vannamei shrimp culture.

Acknowledgement:

The authors wish to thank Marine Biological Research Laboratory, Department of Zoology for Provided necessary laboratory facilities during this entire work

6. References:

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