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Role of Stocking Densities on Growth of *Litopenaeus vannamei* in Low and High Saline Ponds from Krishna District, Andhra Pradesh, India

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Abstract
The present study was aimed to establish the information on the growth rates of *L. vannamei* for one crop in ponds with low saline with low stocking, low saline with high stocking and high saline with low stocking, high saline with high stocking densities. The average values of pH, salinity, dissolved oxygen, ammonia and temperature in ponds with low saline and low stocking density were 8.11, 6, 4.97, 0.56 and 31 respectively. Whereas in ponds with low saline and high stocking density were 8.33, 8, 5.15, 0.63 and 30.9. Similarly, the average values of pH, salinity, dissolved oxygen, ammonia and temperature in ponds with high saline and low stocking density were 8.07, 22, 5.53, 0.61 and 32.3 respectively. Whereas in ponds with high saline and high stocking density were 8.33, 22, 4.8, 0.99 and 32.1. It is evident from the present results that, the stocking density has inverse proportion with the growth. Low stocking density favours the production. In contrary high stocking density leads to lower the production rate.

Keywords
Stocking density, production, *L. vannamei,* salinity.

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INTRODUCTION
Su *et al.,* (2010) reported the effects of salinity fluctuation on the growth and energy budget of juvenile *Litopenaeus vannamei* at different temperatures. Laramore *et al.,* (2001) studied the effect of low salinity on growth and survival of postlarvae and juvenile *Litopenaeus vannamei.* Praveen Kumar and Krishna (2015) studied about the survival and growth performance of Pacific White Shrimp *Litopenaeus vannamei* under different stocking densities. Krishana *et al.,* (2015) studied the growth, survival and production of Pacific White Shrimp *Litopenaeus vannamei* at different stocking densities under semi intensive culture systems in Andhra Pradesh. The optimal stocking density varies depending on the farm system and management practices. Stocking density range 1-3 shrimp/m^2 in extensive, 10-50 shrimp/m^2 in semi-intensive and up to 160 shrimp/m^2 in intensive farming systems. Stocking density is inversely proportional to shrimp growth. Therefore, production is optimized by using appropriate stocking density for each farm. The purpose of the present study is to estimate the growth rates of *L. vannamei* in low and high saline

ponds with low and high stocking densities form Krishna district, Andhra Pradesh, India.

MATERIAL AND METHODS

Experiments were conducted for the estimation of growth parameters in low and high saline ponds against low and high stocking densities. Ponds were initially prepared by drying, tilting (to remove the pests and predators and oxidize bottom soil) and liming to correct the pH of the soil. Enrich the natural food organisms in the water by following the Good Management Practices (GMPs).

The process of sampling to take the average body weight of the shrimps from the culture ponds is started from the 50 days of culture period and done till the harvesting of the ponds. The weekly growths in all the study ponds were recorded. The condition of the shrimp also observed during the sampling. The feeding is given in the form of estimated feed as per the feeding chart and also according to the growth of the shrimps and the estimated survival rate.

Temperature of the water was measured in the field by using mercury thermometer with 0° to 100^{0}C range and having a least count of 1^{0}C. The pH was measured by using 'ELICO' pH meter. For dissolved oxygen, the water samples were collected in a BOD bottles and fixed on the spot and bottles were taken to the laboratory and analysed by Winkler's titration method. The salinity and ammonia were measured by adopting the procedure mentioned by Grosshoff *et al.,* (1999).

Feed conversion ratio (FCR) and Average daily growth (ADG) were calculated by the given formula below

FCR = Total weight of the harvested shrimps /total feed used

ADG = Total weight gained by the shrimps / Total days of culture

RESULTS

Growth vs Stocking Density

In Krishna district, the average weekly growth is 2 gms in low stocking ponds of low saline ponds in 1st crop and it ranged from 1.42 gms to 1.68 gms in high stocking ponds of low saline waters in in 1st crop in the year 2018 (Table 1).

Table 1. Growth Vs Stocking Density in Low Saline Ponds of Krishna District in 2018

DOC	1st crop	
	AWG in Low stocking	AWG in High stocking
50	2.0	1.68
57	2.0	1.68
64	2.0	1.68
71	2.0	1.6
78	2.0	1.56
85	2.0	1.52
92	2.0	1.44
99	2.0	1.42

Table 2. Water quality parameters of Low saline, Low stocking density ponds of Krishna District in 1st crop during 2018

Parameter/ District	pH	Salinity (ppt)	D.O. (ppm)	Ammonia (ppm)	Temperature (^{0}C)	Density (no/m^2)
1st crop	8.11	6	4.97	0.56	31	25

In the 1st crop during 2018 in low saline low density ponds of Krishna district the average pH, salinity, D.O, ammonia and temperatures observed were 8.11, 6ppt, 4.97 ppm,0.56 ppm and 31^{0}C respectively. Whereas the average weekly growth is 2.00 gms at a stocking density of 25 pieces per square meter.

Table 3. Water quality parameters of Low saline, High stocking Density pondsof Krishna District in 1st crop during 2018

Parameter/ District	pH	Salinity (ppt)	D.O. (ppm)	Ammonia (ppm)	Temperature (^{0}C)	Density (no/m^2)
1st crop	8.33	8	5.15	0.63	30.9	50

In the 1st crop during 2018 in low saline high density ponds of Krishna district the average pH, salinity, D.O, ammonia and temperatures observed were 8.33, 8ppt, 5.15 ppm,0.63 ppm and 30.9^{0}C respectively. Whereas the average weekly growth is 1.57 gms at a stocking density of 50 pieces per square meter.

In Krishna district, the average weekly growth ranged from 2.14 gms to 2.28 gms in low stocking ponds of high saline ponds in 1st crop and it ranged from 1.9 gms to 2 gms in high stocking ponds of high saline waters in in 1st crop in the year 2018 (Table 4).

Table 4. Growth Vs Stocking Density in High Saline Ponds of Krishna District in 2018

DOC	1st crop	
	AWG in Low stocking	AWG in High stocking
50	2.28	2.0
57	2.28	1.98
64	2.22	1.98
71	2.22	2.0
78	2.22	1.96
85	2.22	1.96
92	2.22	1.9
99	2.14	1.9

Table 5. Water quality parameters of High saline, Low stocking density ponds of Krishna District in 1st crop during 2018

Parameter/ District	pH	Salinity (ppt)	D.O. (ppm)	Ammonia (ppm)	Temperature (^{0}C)	Density (no/m^2)
1st crop	8.07	22	5.53	0.61	32.3	20

In the 1st crop during 2018 in high saline low density ponds of Krishna district the average pH, salinity, D.O, ammonia and temperatures observed were 8.07, 22ppt, 5.53 ppm,0.61 ppm and 32.23^{0}C respectively. Whereas the average weekly growth is 2.21 gms at a stocking density of 20 pieces per square meter.

Table 6. Water quality parameters of High saline, High stocking density ponds of Krishna District in 1st crop during 2018

Parameter/ District	pH	Salinity (ppt)	D.O. (ppm)	Ammonia (ppm)	Temperature (^{0}C)	Density (no/m^2)
1st crop	8.33	22	4.8	0.99	32.1	40

In the 1st crop during 2018 in low saline high density ponds of Krishna district the average pH, salinity, D.O, ammonia and temperatures observed were 8.33, 22ppt, 4.8 ppm,0.99 ppm and 32.1^{0}C respectively. Whereas the average weekly growth is 1.96 gms at a stocking density of 40 pieces per square meter.

DISCUSSION

Maintaining good water quality parameters in the culture ponds is very much essential for the optimal growth and survival of the shrimp larvae. Excess feed, metabolic wastes, and other nitrogenous products create imbalance in the quality of water. Hence the regular monitoring is essential (Soundarapandian and Gunalan, 2008). Gunalan *et al.,* (2010) reported the good growth and survival of *L. vannamei* in brackish water ponds of 10-35ppt which was ideal for shrimp culture. However, the shrimp tolerates the salinity even 2.45ppt (Parker *et al.,* 1974). Praveen Kumar and Krishna (2015) reported the maximum Average daily growth rate at a salinity of 9.89 ppt. They maintained the salinity levels between 6.5- 12.5 ppt. Similarly, in the present study the maximum average weekly growth rates were recorded at 22 ppt. Wang *et al.,* (2004) reported that the favourable pH range of 7.6-8.6 for *L. vannamei.* Praveen Kumar and Krishna (2015) reported the pH values in between 7.2 ± 0.4 to 7.9 ± 0.3. In the present study the suitable pH for maximum average daily growth was 8.07. Praveen Kumar and Krishna (2015) reported the average dissolved oxygen levels in ponds with different stocking densities ranged between 4.6 ± 1.76 to 6.21

± 1.25. In the present study the optimal dissolved oxygen concentration for the better growth and survival was 5.53. Similarly, Praveen Kumar and Krishna (2015) reported the average temperatures in ponds with different stocking densities ranged between 35.9 ± 2.6 to 36.5 ± 2.2. In the present study the optimal temperature for the better growth and survival was 32.3^{0}C. Suriya *et al.,* (2016) reported the average ammonia concentration ranged between 0.22 to 1.8 mgl^{-1}. In the present study the ideal concentration of ammonia for better growth and survival was 0.61. The recorded growth values clearly indicated that, higher average weekly growth rate was noticed against low stocking densities and vice versa. Similar trends of results were reported in earlier studies by Suriya *et al.,* (2016) and Parvathi and Padmavathi, (2018).

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