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Research Article

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Effect of Stocking Density on Growth and Survival of Giant Tiger Prawn, *Penaeus Monodon* in Estuarine Backwater Areas

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Abstract

The present study find out most favorable stocking density on the growth, survival and production of *Penaeus monodon* was studied for 120 days. Five rectangular cages of uniform size (10x5x1m) were used for the respective stocking densities of 10, 20, 30, 40 and 50/m^2. Healthy juveniles of size ranging from 3.2 to 3.5g were used for the respective stocking densities of 10, 20, 30, 40 and 50/m^2. Healthy juveniles of size ranging from 2.9 to 3.5g were stocked as per the above mentioned stocking densities. As the culture period was 120 days, all these cages were changed at every 30 days interval. Even though the higher growth of 28.6 g and survival rate of 98.5% was observed in the stocking density of 10/m^2, the maximum production rate of 1181 g/m^2 was reported in the stocking density of 50/m^2.

Keywords: *Penaeus monodon*, cage culture, stocking density, survival and Krishna river estuary

Introduction

Since shrimps are the largest internationally traded seafood item in terms of value, India is an ideal location for aquaculture activities. Shrimps are cultured mainly in ponds, cages, pens, and raceways. The growth rate of penaeid shrimps in cages is greater than ponds, due to the circulation of water, which brings the natural food and periodically washes due to the circulation of water, which brings the natural food and periodically washes out the accumulated metabolites. In India giant tiger shrimp, *P. monodon* is euryhaline, continuous to grow in prolonged confinement and attains very large size in the brackish water enclosures. Growth and production of cultured species are, to an extent, dependent on the population density LeCren, 1962; 1965; Backiel and Le Cren, 1967. In culture conditions, manipulation of stocking density is therefore extremely important in maximizing the production. Hence the present study was designed to find out the optimum stocking density for cage culture of *P. monodon* in Krishna river estuary.

Materials and Methods

The present study was carried out in the Krishna river estuary is located at Repalle village, Andhra Pradesh, South India and the width of the estuary is 150 m close to the sea mouth and the maximum is about 250 m opposite to river side. The average depth is 4 m whereas the maximum depth is 6 m at the time of high tide. The benthic life in Krishna river estuary is very rich, because of the varied substrate available here. Apart from these the Krishna river estuary is rich in seaweeds also and thus acts as a very good nursery ground for many shell and fin fishes. Hence his estuary forms an ideal environment for practicing cages culture. Five rectangular cages of uniform dimension (10 x 50 m) were erected on the bottom soil substrate and the health juveniles of *P. monodon* size ranging from 2.5 to 3.0 g were stocked at the stocking densities of 10, 20, 30, 40 and 50 No's/m^2 respectively. As the present study was carried out for 120 days (Table 1), all the cages were changed at the regular interval of 30 days. Shrimps reared in all the cages were fed with Avanti semi-moisten feeds. Initially 10% feed were provided to shrimps of all cages and it was gradually decreased to 3 to 5%. Feed was given at dawn, midday and dusk. But the two fourth of the feed were provided to dusk since shrimps are nocturnal animals.

Results

During the present study higher growth was obtained from the low stocking densities compared to those of high stocking densities cages. The higher mean growth of 28.6 g was recorded in the cage having the low stocking density of 10/m^2 and lower mean growth 20.5 g was observed in the cage having the stocking density of 50/m^2. It clearly indicated the inversely relationship between stocking density and growth. The same patterns of

observations were also recorded in the growth increment also. The growth increment (g) per day in the stocking densities of 10, 20, 30, 40 and 50/m^2 were 0.254, 0.233, 0.210, 0.186 and 0.173 respectively (Table.1).

Table.1: The production of tiger shrimp, *P. monodon* at different stocking densities

Particulars	Stocking density (No's/m^2)				
	10	20	30	40	50
Cage type	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Water spread area (m^2)	50	50	50	50	50
Dimension (m)	10X50	10X50	10X50	10X50	10X50
Stocked animals (no's)	500	1000	1500	2000	2500
Days of culture	120	120	120	120	120
Initial average weight (g)	3.2±1.5	3.2 ±1.5	3.2±1.5	3.2 ±1.5	3.2±1.5
Final average weight (g)	28.6 ±2.5	26.5± 1.8	24.2 ±0.89	21.86±1.7	20.5±2.5
Daily growth increment (g)	0.254	0.233	0.210	0.186	0.173
Survival rate (%)	98.5	96.7	91.5	86.5	82.6
Number Harvested	492	967	1373	1730	2065
Total Production (kg/50 m^2)	14.1	27.7	39.3	49.5	59.1
Total Production (kg/ha)	2814.24	5531.24	7853.56	9895.60	11811.80
Total Production (g/m^2)	281.42	553.12	785.36	989.56	1181.18

Higher production of 59.1 kg per 50/m^2 was found in the cage having the stocking density of 50/m^2 and the lower production of 14 kg was recorded in the stocking density of 10/m^2. Direct relationship was observed between stocking density and production. The production rate (g/m^2) of the cages having the stocking densities (No's/m^2) of 10, 20, 30, 40 and 50 were 281, 553, 785, 989 and 1181 kg respectively. The production rate (Kg/ha) ranged from 2814.24 for 10/m^2 stocking density to 1181.18 for the stocking density of 50/m^2 (Table 1). It is interesting to note that the pattern of survival rate was lower in high stocking and higher in low stocking densities (Table 1). In the low stocking density of 10/m^2 the survival rate was maximum and then decreased towards highest stocking densities and reached maximum in high stocking density of 50/m^2. It showed the inversely relationship between the survival rate and stocking density. The following survival rates 98.5, 96.7, 91.5, 86.5 and 82.6% were observed in the respective stocking densities of 10, 20, 30, 40 and 50/m^2. There was no marked variation in the values of environmental parameters during the study period. The salinity ranged from 28 to 32 ppt. Temperature was recorded between 28 and 32ºC. Dissolved oxygen varied from 4.5 to 5.4 mg/l and the pH varied between 7.8 and 8.6 (Table 2).

Discussion

The results of the present study clearly shows that the higher production rate 1181g/m^2 was obtained for the stocking density of 50/m^2 followed by the order of the stocking densities of 40/m^2 (989 g/m^2), 30/m2 (785 g/m^2). 20/m2 (553g/m^2) and 10/m2 (281 g/m^2). From this it is obvious that the higher production rate was observed for the higher stocking density of 50/m^2 and as per the stocking density the production rate was steadily decreased towards the lower stocking densities and thus the lower production rate was recorded for the lower stocking density of 10/m^2 (Table.1).

Table 2: Water quality parameters in cage culture

Salinity (ppt)	Dissolved Oxygen (ppm)	pH (ppm)	Temperature (ºC)
28-32	4.5-5.3	7.8-8.2	28-31
29-32	4.5-5.1	8.1-8.5	28-32
30-33	4.5-5.2	7.8-8.5	29-33
31-33	4.5-5.1	8.0-8.5	29-32
30-32	4.5-5.3	7.8-8.6	30-32
28-32	4.5-5.2	7.9-8.5	30-32
30-32	4.5-5.2	7.8-8.6	30-33
28-31	4.5-5.4	8.0-8.5	30-33

It showed the existence of direct relationship between the stocking density and production rate. Similarly, the same results observed in relationship for the culture of *P. indicus* in cages along with *P. monodon* Srikrishnadas and Sundararaj, 1990. They reported that the higher production rate of 840.196g/m^2 at the higher stocking rate of 100/m^2 and the lower production rate of 438g/m^2 rate the lower stocking rate of 50/m^2. In many studies, maximum production was achieved by optimal stocking density Coche, 1976; Hull and Edwards, 1976; Pantulu, 1979. Maximum production rate of 943 g/m2 at the stocking density of 50/m 2 in the present study is satisfactory. The similar results were obtained in the comparative culture of *P. monodon* than the culture of *P. indicus* and *M. dobsoni* at the uniform stocking density of 50/m^2 Srikrishnadas and Sundararaj, 1990. They have conducted another set of comparative experiments for the cage culture of *P. monodon, P. indicus* and *M. dobsoni*. Among this the production rate *P.monodon* (487.66 g/ m^2 was higher than *P. indicus* (441.28 g/m^2) and *M. dobsoni* (366.35 g/m^2). The higher production rate reported in the present experiment for 120 days culture was better than the previous observations. The production rate of 197.5 g/m2 for the stocking density of 12/m^2 during the cage culture of *P. monodon* within 90 days of culture Shanmugam *et al.,* 1995. Siddharaju and Menon, 1982 conducted an experiment on the cage culture of *P. monodon* by using different stocking densities and feeds at different periods from 1975 to 1979. They showed the production rate of 390 g/m^2 for 70/m^2 stocking density for the culture period of 126 days, 380 g/m2 for 50/m2 stocking density for 100

days culture and 319.5g/m2 for 40/m 2 stocking density for 120 days culture. Further they observed the lower production rate 73g/m^2 for the stocking density of 75/m^2. This lower production at the higher stocking density may be attributed to the difference in culture periods and feed. From the finding of the present experiment it was observed that the higher growth of 28.6g was noticed at the stocking density of 10/m^2 followed by 20/m^2 (26.5 g), 30/m^2 (24.2g), 40/m^2 (21.86g) and 50/m^2 (20.5g). It showed a general pattern that the higher growth was observed in the lower stocking densities and the lower growth was observed in the higher stocking densities (Table 1). Similarly the results of Rodriguez *et al.,* 1993 reported that growth rate and survival rates were inversely related to stocking density for *P. monodon* culture in the net enclosures. This coincides with the results in the culture Krishnan *et al.,* 1983 showed higher individual w eight of 14.5 g for the lower stocking of 10/m^2 and the lower individual weight of 127.7 g for the higher stocking density of 25/m^2 for the culture of *P.monodon* in cages. Similarly, for *P. monodon* they obtained higher growth of 33.7 g for the lower stocking density of 4.15/m^2 and lower growth of 20 g for the higher stocking individual weight 27g at the lower stocking density of 3/m2 and lower culture of *P. indicus*. This was also supported by the results Srikrishnadas and Sundararaj, 1990 reported the higher growth of 24 g for the lower stocking of 22.708 g for the higher stocking rate of 100/m^2 or the culture of *P. monodon* in the cages. Further Shanmugam *et al.,* 1995 showed that the growth rate of 13.0 to 13.5g *P. indicus* for the stocking density of 12/m^2 in a cage. Similarly, in the present study, the higher survival rate of 98.2% was observed in the lower stocking density of 10/m^2 and the lower survival rate of supported by the results of Natarajan *et al.,* 1983 who reported that the high mortality rate (28.3%) in the higher stocking density of 60/m^2 and no mortality in the other lower stocking densities of 15, 30 and 45/m^2 for the culture of *Macrobrachium idae* in the cages. Similarly Siddharaju and Menon, 1982 showed the lower survival rate of 97% in the higher stocking density of 20/m^2 and higher survival rate of 100% in the lower stocking rate of 15/m^2 for the culture of *P. monodon* in the cages.

In the present study the survival rate recorded in the higher stocking density of 50/m^2 was better than the higher stocking densities of previous works. Siddharaju and Menon, 1982 reported that poor survival rates of 20 and 50 the uniform stocking of 100/m^2 *M. monoceras* culture in cages. Siddharaju and Menon, 1982 the survival rates of 56% in the higher stocking density of 25/m^2 in floating cages and 59% in the same stocking density of 25/m2 in fixed cages for *P. monodon* is recorded. Further he also stated that the predation by fishes and green crab *S. serrata* may also cause poor survival rate of shrimp in the fish farm at Krusadai. The absence of these problems perhaps may be one of the reasons for the higher survival rate even in the 50/m^2 stocking density of the present study. According to them the advantage of shrimp culture in cages are: stocking density could be increased several folds; the various problems such as high temperature and salinity, accumulation of metabolites that occur in stagnant ponds can be avoided in cage culture. The low survival rate of 32% at the stocking rate of 80/m^2 for the culture of *P. indicus* in cages was obtained by Le Cren, 1962. Similarly, ZeinpEldin, 1963 observed the survival rate of 31.8 at the stocking density of 83/m2 for *P. stylirostris* culture in the cages. Srikrishnadas and Sundararaj, 1990 noticed the lower survival rates of 32 and 36.5% for *P. indicus*, 28% for *P. semisulcatus* and *P. monodon*, 34% for *M. dobsoni* and at the stocking densities of 80 and 100/m^2. According to them, the non-availability of protective places inside the cages especially during or soon after moulting was found to be reason for the lower survival rates. Hence in the present investigation, the higher survival rates recorded may also be attributed to the availability of shelter places inside the cages which could protect the shrimps during moulting periods from cannibalism which in turn increases the survival rates. Besides Shanamugam *et al.,* 1998, also provided hide-outs inside the cage for *P. monodon* culture and observed 100% survival rate.

The higher survival rates observed in the present investigation may be compared with the previous works. Siddhraraju and Menon, 1982 reported the higher survival rates of 85.67% at the stocking rate of 30/m^2, 81 to 89% at the stocking rate of 40/m^2 and 65 to 100% at the stocking density of 50/m^2 for *P. monodon* culture in cages. They also showed the higher survival rates of 100% of the stocking densities of 5, 10 and 15/m^2 and 97% at the stocking density of 20/m^2 for *P. monodon* culture in cages. Similarly, Krishnan *et al.,* 1983 also observed the higher survival rates of 86.5, 88, 98.5, 100 and 100% for the respective stocking rates of 3, 4, 5, 7 and 10/m2 for *P. monodon* culture and 83, 95, 90, 92.3 and 94.2% survival rates for the respective stocking densities of 3,7,8,10 and 20/m^2 for the culture of *P. indicus* in cages. Siddhraraju and Menon, 1982 used 12/m^2 stocking density for the polyculture of *P. indicus*, *P. monodon* and *P. semisulcatus* in the cage at the respective ratio of 180: 30: 30 and they obtained 100% recovery for both *P. indicus* and *P. monodon*, while 0% recovery for *P. semisulcatus*. According to them the 0% recovery of *P. semisulcatus* was due to the decrease in salinity to 1.2% during monsoon period. In the present study, environmental parameters (Table 2)

showed less variation. Salinity and temperature variations are considered the most important factors influencing the growth and survival of shrimps Issac Rajendran and Sampath, 1975. For the survival of shrimps, the temperature is far more important than salinity Rodriguez *et al.,* 1993. For the growth and survival of post-larvae and juveniles of shrimp, salinity tolerance does not play a direct role according to Zein-Eldin, 1963 a range in salinity between 4.45 ppt and 39.1 6ppt and a temperature maximum up to 38ºC would in no way affect the survival and growth of *P. monodon.* Ramachadran *et al.,* 1982. This difference well coincides with the present study observations. Throughout the culture period the salinity varied between 28 between 28 and 32 ppt and temperature ranged from 28 to 32ºC and found to be optimum for the production of *P. monodon*. From the findings of this study, it is clear that the stocking density of 50/m^2 was optimum for the culture of *P. monodon* in cages.

Conclusion

Present study revealed that the estuarine environment is best suitable for culture operations of penaied shrimps especially *P. monodon* and *P. indicus.* Present study was confined that in the low stocking density *P. monodon* gave good survival and production compared to other penaied prawns under estuarine environmental conditions.

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