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Production of *Penaeus monodon* in the tide fed ponds of Sunderbans

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ABSTRACT

Penaeus monodon was cultured in two tide-fed ponds (0.162 ha and 0.184 ha) of Sunderbans, at Kakdwip, India, giving special emphasis to water quality management for sustainable production of shrimp. For first 60 days, filtered and treated tidal water and later untreated water was used for exchange. Water temperature, dissolved oxygen and pH were monitored twice daily, turbidity once in a day. TSS, total alkalinity, salinity, COD and BOD were estimated at weekly intervals. Water exchange was done when turbidity and dissolved oxygen were around 20 cm. and 4mg /1 respectively. During culture, liming @ 75 kg / ha and fertilizers, N and P @ 0.2 PPM each were used for correction of D.O and turbidity problems. During 100 days culture, at a stocking density of 6.7 / sq.m and 7.1 /sq.m, 58.26 % and 58.08 % of stocked seed survived and produced 196 kg and 217 kg of biomass with FCR of 1.150 and 1.173 respectively.

Introduction

During last two decades, the shrimp farming industry has developed rapidly into a thriving business in many countries. In Indian subcontinent, traditional system has been upgraded to extensive / semi - intensive system with the introduction of selective stocking, use of high efficiency artificial diet and maintenance of water quality through exchange of water.In Sunderbans, where the extensive system of shrimp culture is practiced in about 30,000 ha, the production is still low (average yield of <500 kg / ha / year) which is mainly due to non adoption of scientific management practices for culturing shrimp in these tide-fed farms.

With a view to develop management practices for sustained production of *P. monodon* in tide fed ponds, an experiment was conducted to culture *P. monodon* in two tide fed ponds of Sunderbans region located at Kakdwip Research Centre of Central Institute of Brackishwater Aquaculture (CIBA), Kakdwip with special reference to water management practices. In the present communication, water management criteria and performance of *Penaeus monodon* during the hundred-days culture period lasting from March 2000 to June 2000 is described.

Materials and methods

The culture trial was conducted in two ponds of 1620 sq.m(pond-A) and 1840 sq.m(Pond-B) area. The ponds were dewatered, levelled, limed @ 250 kg /ha and filled partially with filtered tidal water.

A three tier filtration system consisting of a split bamboo cylindrical cage (1.5 m x 0.3 m diameter) loosely covered with a vellon net (40 mesh) and then with bolting silk net (80 mesh) was fitted with inlet hume pipe during pond filling. Prestocking chlorination of pond water @ 15 ppm chlorine was done. Five days before stocking, ponds were fertilized with 0.2 ppm each of Nitrogen (Urea) and Phosphate (SSP). Stocking was done with *P. monodon* seed procured from a private hatchery (average wt.12 mg) @ 6.7 /sq.m and 7.1 /sq.m in ponds A and B respectively. To eradicate the probable effect of birds as predators and mechanical carriers of virus etc.(Pillay, 1992) ponds were kept covered with nets of 2" mesh made of monofilament thread.

Adjacent to these ponds another pond of 1960 sq.m. was filled with filtered water to use as reservoir. Reservoir water was treated with bleaching powder @ 150kg/ ha of chlorine, before use in culture ponds.

Feeding : Feeding was done with commercial feed in Pond-A and with CIBA, Chennai made feed in Pond-B as per standard methods of prawn feeding. Blind feeding was done @ 1 Kg / lakh of post larvae for first fortnight and thereafter @ 10 % and gradually reduced to 3% by estimating the pond biomass at 15 days interval till 100 day of culture (doc). Feed trays were used to check and adjust daily feeding ration at 6 am, 11 am, 4 pm and 9 pm. The proximate composition of commercial feed was crude protein: 38-42%, ether extract : 5 % and fiber : 4 %. Four different concentrations of crude protein (38% to 42 %) was used at different stage of growth of prawns. Proximate composition of C.I.B.A made feed was crude protein 38 %, ether extract 8 % and fiber less than 5 %. Same concentration of crude protein was used in feed throughout the culture period.

Water quality monitoring: Temperature, pH and dissolved oxygen were monitored twice a day at 0700 hr. and 1500 hr. Depth and turbidity were measured daily. Total Suspended solids, Salinity, Alkalinity, COD and BOD were monitored once in a week. Discharge water samples were collected on the day of harvest and apart from other parameters, phosphate, available nitrogen, ammonia and nitrite of discharge water

TABLE 1. *Farm inputs and water exchange in a shrimp culture pond at Kakdwip*

Day	CaO Kg/ha	Urea	SSP	Feed	Water exchange
-20	250	-----	-----		
-5	-----	4.5	12.5	From 6d to	
1	-----	4.5	12.5	40 d	No water
4	-----	1.5	4.0	total feed	Exchange
5	-----	1.5	4.0	130kg/ha	till 40 d
6	-----	1.5	4.0	From 41d to 60d	20%/d X 3
44	-----	1.5	4.0	total feed	days/week
45	-----	1.5	4.0	330kg/ha	from reservoir during 40 to 60 d
74	75	-----	-----	From 61d till	From 61d to 98d
88	75	-----	-----	harvest total	tidal water @
94	75	-----	-----	feed	20%/d
98	75	-----	-----	932 kg/ha	For 3 to 6 days /fortnight.

were estimated to assess the pollution load of the same. Available Nitrogen, Nitrite and Ammonia were quantified as per Chattopadhyay 1998. For salinity and pH, "ATAGO" refractometer and an electronic pH meter were used respectively. BOD, COD and dissolved reactive phosphorus were estimated following Stirling (1985). Other physico-chemical parameters of water were analyzed following standard methods (A.P.H.A 1965).

Results and Discussion

Inputs : As seen from Table 1 after initial application of lime (CaO) during pond preparation, it was applied later at a low dose during different dates towards the end of the culture period. To encourage phytoplankton growth, Urea and Single Superphospate were applied at a low dose on different occasions.

Water exchange: In tide fed ponds, located in high amplitude tidal zone of Sundarbans, water exchange is the best and economic method of controlling the pollution load. In Sunderbans area, water exchange is carried out during every spring tide for 3 to 4 days per fortnight, to allow entry of prawn and fish seed along with food organism. But in monoculture ponds, this type of blind flushing is detrimental for the stocked seed as the incoming organism compete for space and oxygen, share the formulated diet and increase the metabolic load. Moreover some predators also find their ways at their early stage of life and grow very fast to prey on the stocked seed. Poor survival and production achieved earlier was due to this predation problem (Chakraborti *et al*., 1985, 1986).

Aquacop (1984) reported water exchange rates for culture of shrimps, which ranged from 5 to 30% of total volume per day for density ranging from 5 to 200 no/sq.m. According to Boyd (1995), routine water exchange is an example of inefficiency. Hopkins *et al.* (1993) indicated scope of reducing water exchange practice for low stocking density culture, without affecting production. Clifford (1992) has given a relationship between water exchange requirement and shrimp biomass.

In the present trial, on the basis of water quality observation, water exchange was not required till 40 doc. During last few years culture trial in this region of Sunderbans, *P. monodon* has shown its vulnerability to white spot diseases within first 60 days of culture. Considering this probability, when water exchange was felt necessary to dilute high turbidity during 40 to 60 doc, 20 % of water volume was drained out and refilled with water from the chlorine

TABLE 2. *Water quality of a shrimp pond at Kakdwip*
Average of two weekly observations during March to June '2000

Obs.no.	1&2	3&4	5&6	7&8	9&10	11&12	13&14	15
Depth, cm	70	73	85	90	92	94	107	100
Trans. cm	54	49	40	18	18	22	19	18
Temp°C	27.1	28.5	31.2	31.4	32	32.5	31	30.2
TSS, mg/l	66	75	98	94	109	124	129	80
pH	8.5	8.5	8.6	8.5	8.8	8.5	8.5	8.7
T. Alk, mg/1	111	116	123	125	139	134	135	126
Salinity, ppt	8	10	13	13	12.5	12.5	12	11
D.O. mg/l	7.5	7.6	6.4	5.1	5.9	5	4.5	5.1
COD, mg/l	5.1	6.1	6.8	7.4	7.6	6.4	6.6	6.6
BOD, mg/l	2.7	3.2	4.6	3.5	14.6	8.2	7.4	9.2

TABLE 3. *Quality of intake and drainage water at* P. monodon *culture ponds, Kakdwip*

	Intake water (Kakdwip canal of River Hooghly)				Drainage water of Pond-A	Pond-B
Date of observation	6 May	22May	2 June	16 June	19 June	18 June
TSS, mg/l	122	176	182	194	136	142
pH	8.41	8.21	8.47	8.35	8.56	8.52
DO,mg/l	7.8	7.6	7.2	7.3	3.3	3.9
COD, mg/l	1.1	1.3	0.9	1.7	7.96	7.21
BOD, mg/l	1.0	0.8	0.4	0.8	17.8	16.2
Salinity, ppt	12	12	14	10	12	12
Total Alkalinity, mg/l	144	132	134	144	134	140
Colour, Pt.Co unit	48	95	196	117	130	165
Av.P, mg/l	0.01	0.01	0.02	0.01	0.20	0.28
Ammonia, mg/l	*	*	*	*	0.06	0.04
Nitrite, mg/l	*	*	*	*	0.008	0.012
Av.N, mg/l	0.60	0.28	0.83	0.68	1.9	1.2
H2S	*	*	*	*	P	P

* = Below detectable range P = Present

treated reservoir for 3 days per week. Tidal water was allowed to flush the culture ponds from 61 day onwards through split bamboo-vellon net filtration unit @ 20% /d for 3 to 6 consecutive days per fortnight during spring tide.

Water quality: Maintaining good water quality becomes imperative with the increase of shrimp biomass. Only by monitoring water quality at short interval, the rate of changes can be ascertained . Clifford (1992) has suggested frequency of measurement of key water quality parameters and water management techniques to achieve acceptable water quality. Water quality of pond water, intake water and drainage water during harvest, is given in Tables 2 & 3. Though the interactions are complex, the climatic weather conditions like brightness of sunlight, cloud cover, wind flow etc. influence the pond environment by affecting the temperature fluctuation and oxygen budget. Sunderbans is prone to cyclone storms during April to June. During this culture period also, incidences of depression, associated with heavy downpour affected the survival to some extent. Table 6 depicts variation of DO and pH at weekly interval and in Fig 1, air and

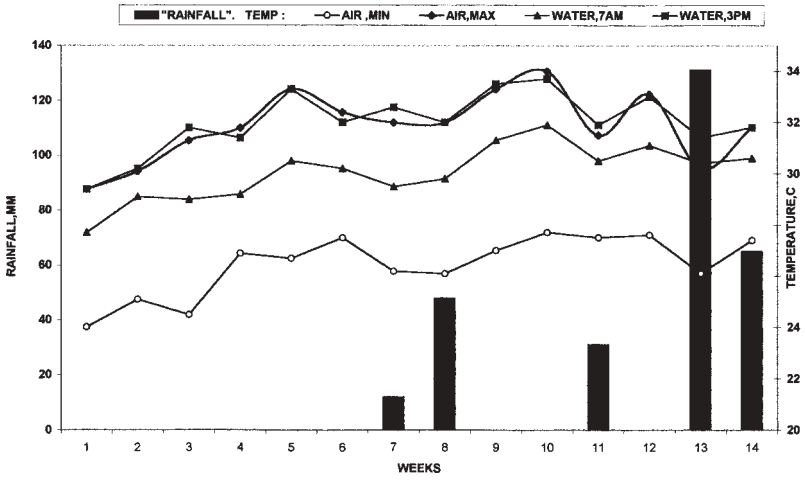

Fig.1. Rainfall, air and water temp. at Kakdwip. (March-June '2000)

water temperature along with rainfall is depicted.

Temperature: Water temperature is an important ecological parameter, which influence all biochemical and biological activity of the system. *P. monodon* too has preferred temperature range. For this species, 17-33°C is normal, 28-33°C is optimal and less than 14°C or more than 35°C is said to be critical (Wood, 1992). During the present trial, the water temperature varied between 27.1 and 32.5°C. At Sunderbans area the temperature is very suitable during March to September for culture of *P. monodon*.

Depth, transparency and total suspended solid: Water depth ranged between 70 and 107 cm. with the average of 89 cm.

Transparency was quite high during first 40 days due to initial liming effect and weak activity of juvenile shrimps. From 40th day onwards transparency was very poor and indicated critical values (Wood *et al.*, 1992). Increase in TSS values suggest that the turbidity be possibly due to suspended clay particles received from recently renovated pond dyke. As seen from Table 2, TSS indicates inverse relationship with transparency. During first 40 days it ranged between 66 mg/1 to 83 mg/l. During last two months, the TSS varied between 109 mg/1 and 135 mg/l.

Salinity: Salinity, though an important parameter for culture of *P. monodon*, varies with the geographical location and shows seasonal variation. Even though *P. monodon* is a euryhaline species, the range of salinity which supports normal growth is between 15-30ppt (Chen, 1976, Chen, 1985). During the present trial, initial salinity of 8ppt increased to 13 ppt only. Though as per Wood *et al.* (1992), this range was below optimal, growth of shrimp was quite satisfactory.

Dissolved oxygen: Dissolved oxygen is the most critical single factor to influence the survival of any aquatic organism, particularly shrimp.In monoculture of *P. monodon*, improper use of supplementary feed often lead to DO problem. Low levels of DO results in sress which is exhibited by shrimps through unusual behaviour. Law (1988) suggests that there is a long-term effect of low DO level on the growth of shrimp and generally the DO level should be kept above 2 mg/1. In the present trial, only in one occasion, morning DO was below 4mg/l. During 7th week, maximum mid-day DO was 12.8 mg /l (Table 4). The morning and evening DO curve indicate that a fair amount of dissolved oxygen was contributed by photosynthetic activity of microflora. During the present trial,due to judicious application of feed coupled with timely application of lime and exchange of water, DO level was always in the acceptable range.

TABLE 4. *Diurnal variation of dissolved oxygen and pH at 7 a.m. and 3 p.m. on different days at weekly interval*

Date	pH		D.O	
	7 a.m.	3 p.m.	7 a.m.	3 p.m.
7/4/00	7.3	9.0	6.4	10.8
14/4/00	8.5	8.81	6.0	11.6
21/4/00	8.37	8.83	6.8	10.4
28/4/00	8.3	8.63	5.6	10.4
5/5/00	8.29	8.69	4.4	10.0
12/5/00	8.0	8.76	4.0	9.2
19/5/00	8.27	8.98	4.8	13.2
26/5/00	8.35	8.82	3.8	12.0
2/6/00	8.36	8.72	4.2	10.0
9/6/00	8.36	8.79	2.8	7.0
16/6/00	8.34	8.74	5.0	8.5

Alkalinity and pH : Alkalinity and pH are interrelated parameters and expose many critical situations. The pH reflects the balance between photosynthe-

TABLE 5. *Growth of* Penaeus monodon *(G) during 10/3/00 to 19/6/00 at Kakdwip*

Date	DOC	Pond-A			Pond-B		
		Range		Average	Range		Average
10/3/00	1	-----	-----	0.008	-----	-----	0.008
30/3/00	21	-----	-----	0.43	-----	-----	0.50
6/4/00	28	2.7	3.1	2.89	2.32	4.0	2.68
27/4/00	49	6.8	15.0	8.47	7.3	14.1	10.52
11/5/00	63	14.3	17.38	16.95	14.8	21.0	16.55
25/5/00	77	22.5	25.36	23.12	19.25	24.5	23.06
8/6/00	91	22.38	31.22	25.63	21.21	29.58	23.38
15/6/00	98	23.3	33.25	29.12	21.3	30.65	26.53
18/6/00	101	-----	-----	-----			26.95
19/6/00	102			28.57	-----	-----	-----

TABLE 6. *Performance of* Penaeus monodon *in tide-fed ponds at Kakdwip during March-June 2000*

Pond no.	A	B
Pond size, ha	0.162	0.184
No. of P.L. stocked	10,900	13,100
Stocking density (no/m^2)	6.7	7.1
Culture duration, days	102	101
Nos. harvested	6,351	7,608
% survival	58.26	58.08
ABW (g) at harvest	28.57	26.95
P.monodon, kg/crop	189.68	205.36
Other prawns, kg/crop	6.8	12
Biomass produced, kg/ha/crop	1212.8	1181.3
Feed used, kg	226	255
FCR (Biomass/dry wt. feed)	1.150	1.173

sis and respiration and influences the toxicity of ammonia. For *P. monodon*, 7.5 to 8.5 is optimal pH. A diurnal variation of pH by more than 0.5 unit is undesirable. In the shrimp culture pond at Kakdwip, pH ranged between 8.5 and 8.7. Fluctuation of morning and afternoon pH was always in congenial range, maximum recorded was 9.02 in one occasion only.

Total alkalinity, expressed as $CaCO_3$, is an index of potential calcium availability. Shrimp, to replace the calcium lost during moulting, uses calcium content in water. No safe calcium level has been recommended for shrimp culture. Detrimental effect of less than 50 ppm $CaCO_3$ and beneficial effect of more than 80 ppm $CaCO_3$ in shrimp culture pond has been reported(Law,1988). Alkalinity also varies directly with salinity. During the present trial, total alkalinity ranged between 111mg/1 to 139 mg/1.

BOD and COD: BOD and COD values, which indicate organic load of the system, have greater significance to bring about long-term and short-term changes in environmental quality. Chattopadhyay *et al.* (1988) suggested 10-20 mg/1 BOD load and 80-100 mg/l of COD as the optimum range for aquaculture. Joseph *et al.* (1995) has observed wide difference in

concentration of these parameters in intake water, pond water and effluent. In the present trial,BOD or COD has never indicated unacceptable load in pond water or in the discharge water (Table 3).

The performance of *P.monodon* (Table 5 & 6) achieved during this trial regarding survival and growth is highly satisfactory. At this low stocking density of around 7/sq.m, the combination of water exchange, liming and fertilization has yielded good result for obtaining sustainable production. Hence, in tide-fed ponds of Sunderbans, having the water quality as described in the previous paragraphs, identifies the possibility of sustainable production upto 1.5 ton/ha/crop, if the rate of survival could be improved.

The discharge water quality (Table 3) of these culture ponds in comparison to discharge water from some other semi-intensive culture ponds as mentioned by Joseph (1995), indicate no possibility of environmental degradation of the receiving body. Hence it can easily be said that with this eco-friendly culture practice, the vast area of lower Sunderbans in India can be used to boost the shrimp production.

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