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46 Seed production and hatchery management of *Penaeus indicus*

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ABSTRACT

CMFRI has developed an economically viable and ecofriendly hatchery technology suited to Indian conditions, for the seed production of Penaeus indicus. The technology consists of a number of package of practices such as broodstock management, spawning, larval rearing, diatom culture and preparation of particulate feed for the postlarvae. The various package of practices are compartmentalised in separate units so as to maintain proper hygiene and prevent/reduce the incidence of outbreak of diseases. The larvae from protozoea through mysis 2/3 are fed exclusively on diatom. From mysis 2/3 stage to postlarvae 2 to 5 are fed with prawn custard along with diatom. The postlarvae 2 to 5 are transferred to the nursery and reared using egg prawn custard. Details on the maintenance of live feed culture and preparation of egg prawn custard are given. Mention is also made on the hatchery management and economics of two types of hatcheries. The main emphasis of the technology is to make the best use of the available resources and to harness the natural solar radiation and light to the maximum thereby providing an ecofriendly technology which is cost effective.

Introduction

The phenomenal increase in the importance of shrimp products in India during the last two decades has lead to an almost complete exploitation of its potential available from the inshore waters. Now it is felt that the options available to augment shrimp production are shrimp farming, supplementing the natural stock by sea ranching and by exploring new shrimp resources from deeper water. In order to meet an ever increasing demand in domistic and global markets for quality shrimps, entrepreneurs have ventured into farming shrimps in the brackishwaters.

One of the major requirements for successful shrimp farming is the timely availability of the seed. For a water area of 1000 ha, an estimated average of 200 million shrimp seed are required per year for semi-intensive farming depending on the number of harvests (2-3). Further the requirement of seed per ha increases depending on the culture system adopted. This has necessitated the development of different hatchery technologies for shrimp seed production.

Major seed production systems

Following the pioneering efforts of Hudinaga (1942) in the successful spawning of *Penaeus japonicus* under controlled conditions and subsequent rearing of larvae upto the juvenile stage, two basic hatchery techniques for mass rearing of larvae of penaeid prawns, namely the - Japanese technique and Galvenston technique have been evolved. Different hatchery systems have been reviewed by a number of authors (Muthu, 1980; Smith *et al.*, 1992; Liao, 1992; Forbes, 1992).

These two systems have certain advantages and have been appropriately modified to suit different geographical and climatic conditions and species of prawns used for aquaculture. Thus many gradations between these two systems have been noticed in different parts of the world. Sometimes combinations of these two techniques have also been used.

Hatchery systems developed in India

Kerala State Fisheries Department has developed a system for the larval rearing of *P. indicus* at the Regional Shrimp Hatchery at Azhicode in which the larvae are reared in larger out door tanks upto seed size, feeding the larvae with inert food prepared mainly from *Squilla* and *Metapenaeus dobsoni* meat (Alikunhi, 1980).

CMFRI has developed an economically viable and ecofriendly technology suited to Indian conditions for the seed production of commercially important shrimps of Indian coasts. The hatchery technology developed by CMFRI for *Penaeus indicus* (Silas *et al.*, 1985; Muthu and Pillai, 1991) is in fact a package of practices involving the following components: i) Broodstock management, ii) Spawning, iii) Larval rearing iv) Diatom culture to feed early larval stages and v) Preparation of hen egg-prawn custard for feeding postlarvae. Operational details are presented in this paper.

Hatchery operation and management

Broodstock management is described in another paper of this volume (Paper No. 47, Maheswarudu *et al.*).

Spawning: Impregnated females with fully mature ovary are collected from the trawl catches. After proper acclimatization, spawners are transferred to spawning tanks containing filtered sea water of 30-35 ppt salinity. Disodium salt of EDTA is added to the water at the rate of 0.1 g/100 litres of water. Temperature between 27-31°C and pH 8.0-8.2 are ideal for spawning. The spawning tanks are covered with black cloth to protect the spawner from bright light and to prevent it from escape and a continuous mild aeration is provided. If conditions are ideal, spawning takes place during night. Female, after spawning, is removed from the tank. Depending on temperature, hatching takes place within 12-18 hrs after spawning and by afternoon all viable eggs hatch out to nauplii. Aeration is stopped and nauplii are allowed to congregate at the surface. Dead and unhatched eggs that sink to the bottom are simphoned out along with bottom sediments. Aeration is restarted and number of nauplii estimated.

Larval rearing: 2 to 5 ton capacity tanks are used for rearing larvae upto PL 3-5. The tanks are cleaned with bleaching powder, washed with freshwater, and sun-dried for 24 hours. They are subsequently washed with filtered sea water and then set for larval rearing. Tanks are half filled with sea water filtered through 50 micromesh. Continuous aeration is provided throughout the rearing period. Nauplii (N) are transferred to the larval rearing tank at a stocking density of 75-100/l. During stocking, temperature differences of water in the spawning and larval rearing tanks should not be more than 1°C. Desired temperature for larval growing is 28°C-32°C. After 36 hrs of hatching, the nauplii will be in its 5th or 6th stage depending on the temperature of the medium. 100 to 150 litres of mixed diatom culture dominated by *Chaetoceros* spp. or *Skeletonema* spp. is added to the larval rearing tank when the larvae are in 5th and 6th stages. Concentration of the diatom in the larval rearing tank must not be below 20,000 cells/ml. The diatoms thus added will ensure the availability of food within the easy reach of first protozoea. From first protozoeal (PZ I) stage onwards 150-200 litres of diatom culture is added and the water level is made up to the maximum by adding filtered sea water. From 4th day onwards daily 1/4th to 1/3rd water is replenished. Filter bags of appropriate mesh are used while siphoning out water to prevent escape of larvae.

From mysis 2/3 stage onwards egg prawn custard of suitable particle size is also provided for the larvae. The quantity of diatom is reduced from first postlarval stage (PL 1). Larvae are reared upto PL 3-5 in the same tanks and then transferred to nursery tanks for further rearing.

From 2nd protozoea onwards, bottom sediments of the tank are removed daily. Aeration is stopped to allow larvae to surface before siphoning out the water or removing the bottom sediments. Clear seawater conforming to the following hydrological prameters are conducive for larval rearing.

Salinity : 29-35 ppt, Temperature : 28.0-32.5°C, pH : 8.0-8.5, Dissolved oxygen : 3.0-8.0 ml/litre, Light intensity in day time : 20000 to 125000 lux, Total ammonia: <0.1 ppm, Nitrite : <0.05 ppm.

A few guide lines for the water and feed management of larval raring tanks are given in Tables 1& 2.

Table 1: Rearing of larvae in 2 ton tanks

Day	Stage	Seawater removed (litres)	Diatom culture added	Egg-prawn custard	Seawater addition (litres)	Total vol. of water (litres)
1.	N-2	-	-	-	1000	1000
2.	N-5	-	100	-	-	1100*
3.	PZ 1	-	150-200*	-	700-750	2000
4.	PZ 2	500	150-250	-	250-350	2000
5.	PZ 3	500	150-250	-	150-350	2000
6.	M 1	500	150-250	-	250-350	2000
7.	M2	500	150-250	-	250-350	2000
8.	M3	500	150-250	80-100**	250-350	2000
9.	PL 1	750	100-150	80-100	600-650	2000
10.	PL 2	750	100-150	100-125	600-650	2000

11.	PL 3	750	100-150	100-125 600-650	2000
12.	PL 4	750	100-150	100-125 600-650	2000
13.	PL 5	750	100-150	100-125 600-650	2000

* - Food for the protozoea

** - Daily ration of egg custard may be split into 4-6 equal doses and fed at suitable intervals.

Postlarvae between PL 2 to PL 5 is transferred to nursery tank of 10 tonne capacity.

Table 2: Nursery rearing of postlarvae in 10 ton tanks

Day	Stage	Seawater removed (litres)	Egg-prawn custard(g)	Seawater added (litres)	Total volume of water (litres)
1-9	PL 2-10	5000***	200-300	5000	10000
10-20	PL 11-20	5000***	400-500	5000	10000

*** - 40-50% water exchanged daily.

Diatom culture

For initiating the algal culture, fresh unpolluted sea water (30-34 ppt salinity) is filtered through a 50 micron mesh bolting cloth and kept in 1000 l capacity white fibre-glass tanks placed under the transluscent - roofed shed. The sea water is fertilized as follows: Sodium nitrate : 12 ppm, Potassium orthophosphate : 3 ppm, Sodium silicate : 6 ppm, EDTA di-sodium salt : 6 ppm.

Sodium silicate has to be completely dissolved in freshwater. Other chemicals can be dissolved in freshwater/seawater, and mixed throughly with the sea water of the algal culture tanks. Continuous aeration is provided. The intensity of sunlight in the shed can vary from 20000 to 120000 lux during day time and the temperature of the culture medium from 28°C-35°C. Under these conditions the diatom cells present in the sea water multiply rapidly and give rise to golden-brown bloom of diatoms in 24-48 hrs. Although many species of

diatoms may be originally present in the sea water, under the above temperature conditions, *Chaetoceros spp.* become the dominant diatom forming 75-90% of the cells in the culture. Other diatoms like *Thalassiosira, Skeletonema* and *Nitzschia* may also be present in lesser densities. A culture containing a concentration of 3-4 lakh cells/ml is preferred for feeding. This culture is used for feeding the prawns larvae and also as an inoculum for developing batch culture on succeeding days. Diatom cultures are thus started everyday using the previous day's culture as inoculum (at the rate of 30-35 litres per m^3 of filtered seawater and fertilized as above). It attains feeding concentration within 16-20 hrs after inoculation, when light and temperature conditions are ideal. On cloudy days, diatom multiplication will be delayed, hence the quantum of inoculum can be increased.

Preparation of egg-prawn custard

Yolk and albumen of hen's egg and prawn meat of small prawns (*Metapenaeus dobsoni*) are mixed well in a mixie at the ratio of 1:5 and cooked for 10 minutes in a pressure cooker and kept in refrigerator. A solid block of this custard, after thawing can be made into suitable particle size by passing through proper sieves.

Larval diseases

Most serious diseases affecting the larval stages are caused by fungi (*Legenidium, Fusarium*), bacteria (*Vibrio*), filamentous bacteria (*Leucothrix*) and *Zoothamnium, Vorticella.*

Treating infected larvae is very difficult and often expensive. The best remedy by far, is to prevent the diseases. To achieve this, the spawning tanks should preferably be separated from the larval rearing tanks, spawners should be disinfected, and good quality filtered or purified seawater should be provided in adequate quantity. As a general rule bacterial diseases can be treated with 2-4 ppm erythromycin, fungal disease with 0.0075 ppm malachite green and protozoan infection with 10 ppm formalin.

Economics of shrimp hatchery

Economics of shrimp hatchery is dependant on the location, species, production capacity and technology. Land and labour cost vary from place to place and time to time. Some essential details on the economics of two types of

Penaeus indicus hatcheries - one for three million capacity and second for 15 million capacity - are presented in this paper, with certain minor modifications the same hatcheries could be used efficiently for the seed production of *P. monodon and P. semisulcatus.*

Small scale hatchery

Small scale hatchery of 3 million capacity is designed for farmers associated with fishing/shrimp farming activities. The hatchery must be located in a place where continuous availability of good quality seawater is ensured at least seven months in an year. Maintenance of a separate broodstock facility in a small hatchery will not be economical. Hence spawners for the hatchery has to come mainly from the wild. The hatchery could provide part time employment for 2-3 persons. Nine hatchery runs could be obtained in 7 months.

Economics of a three million hatchery for *P. indicus*

A. Initial Investment

		Rs.
i.	Land 230 m^2	25,000
ii.	Larval rearing tanks, FRP 2.5 ton, 4 nos	50,000
iii.	Nursery tank, 5 ton, 4 nos	1,00,000
iv.	Diatom culture tanks, one ton, 4 nos	30,000
v.	Water storage/treatment tanks, 5 t, 1 no.	25,000
vi.	Laboratory/store/pump house	23,000
vii.	Temporary covering for tanks	9,600
viii.	Pumps 1/2 HP - 1 no. 5000)	
	3 HP - 1 no. 20000)	
	5HP diesel 1 no.12000)	37,000
ix.	Blower & Motor 3 HP	28,000
x.	Equipments, salinometer, thermometer etc.	9,000
xi.	Towards sea water, air and electrical connections	25,000
		3,61,600

B.	**Annual operating cost**		30,000
C.	**Annual fixed cost**		
	i. Interest on initial investment @ 18% for 3,61,600- 65088)		
	ii. Depreciation	67320)	
	iii. Labour	42000)	1,74,408
D.	Total cost B + C		2,04,408
E.	Annual production of seed 3 million		
F.	Annual revenue @ 72 for 1000 seed		2,16,000
G.	Annual net profit F-D		11,592
H.	Cost of production of 1000 seed		Rs.68/-
I.	Profit investment ratio		3.2%
J.	Rate of returns		21.2%
K.	Pay back period		4 yrs & six months

Stocking rate is 75 nauplii/litre with survival of 75% from nauplii to PL 5 and 80% from PL 5 to PL 20. Between each production cycle, 5 days are provided for cleaning and drying tanks as a prophylactic measure.

Medium scale hatchery

For a medium scale hatchery (15 million capacity) it is always advisable to maintain a separate broodstock facility and also to provide some controlled conditions for larval and nursery rearing to ensure continuous operation of the hatchery. Selection of site and other facilities should ensure the continuous operation of the hatchery for a minimum period of 8 months.

Economics of a 15 million hatchery for *Penaeus indicus*

A.	Initial expenditure	Rs.
i.	Land cost 1000 sq m	1,00,000
ii.	Building (office lab/store, generator and blower sheds, flooring and raised platform for lands)	5,83,000

iii.	FRP tanks		9,00,000
iv.	Electrical items		3,73,000
v.	Electrical, seawater, air and freshwater connections		1,50,000
	Total		21,06,000
B.	Operating cost		1,06,000
C.	Annual fixed cost		
i.	18% of 21,06,000	3,79,080	
ii.	Depreciation	2,24,000	
iii.	Salary	2,25,000	8,28,080
D.	Total cost B + C		9,98,080
E.	Annual production 15 million		
F.	Annual revenue @ 72 for 1000 seed		10,80,000
G.	Annual net profit F-D		81,920
H.	Cost of production of 1000 seed		67/-
I.	Profit investment ratio		3.9%
J.	Rate of return		21.9%
K.	Pay back period		7 years

3 ton capacity larval rearing tanks 10 numbers; 10 ton capacity nursery tank 10 nos; 10 ton capacity tank 4 nos each for water storage cum treatment and broodstock maintenance, and one ton capacity tank (10 nos) for diatom culture are necessary for this hatchery.

Stocking rate in the larval rearing tank is 75 nauplii/litre and survival from nauplii to PL-5 75% and PL 5 to PL 20, 80%. 12 runs can be obtained in 8 months and providing 5 days for cleaning and drying of tanks after every hatchery run.

Remarks

The technology developed by CMFRI gives maximum opportunity for the full utilisation of the natural resources as well as manpower. Using *Chaetoceros* as food has helped to reduce the cost of larval feed considerably. Post larvae are fed with egg-shrimp prawn custard which is at once nutritive and comparatively less expensive.

FRP tanks of suitable sizes are recommended for storing and water treatment as well as diatom culture and larval rearing. Tanks constructed using bricks and mortar could considerably reduce the cost of the hatchery. But considering the operational life, mobility of the units, ease at which tanks could be cleaned, sundried, as well as repaired as and when required, FRP tanks are recommended. Although the initial expenditure is more, in the long run FRP tanks are more economical than permanent constructions.

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