Nursery rearing of Indian pompano in different culture systems

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Introduction

Fisheries and aquaculture play a pivotal role in food production, nutritional security and employment generation for millions of people. Coastal marine aquaculture is one of the emerging area for marine food fish production, and is mainly performed in the sea and in coastal ponds. Mariculture and coastal aquaculture collectively produced 30.8 million tonnes (USD 106.5 billion) of aquatic animals in 2018, and they are mainly from marine cages, coastal cages and coastal earthen ponds. Increasing marine food fish production through innovative and intensive culture methods has increased demand for marine finfish seeds either from wild collection or hatchery based production. In this context, nursery rearing plays an important role in supplying sufficient number of fingerlings at ready to stockable size in grow-out culture for better survival and faster growth. Larval rearing ends after the larvae achieve full metamorphosis. Fry harvested from larval tanks are often not strong enough for direct stocking in grow-out farms. Thus, nursery rearing of fish larvae is important for production of stockable size fish in grow-out culture system. The concept of nursery rearing system is an age old practice in finfish aquaculture. It was evident that healthy seeds are key to a good healthy grow out culture and subsequent harvest. Maintaining healthy and disease free stock is of prime importance for achieving better production in grow-out system. So, nursery rearing concept gives better opportunity to maintain large numbers of fish fingerlings in small area, which facilitate for effective management. In aquaculture, three tier farming concept is practiced and has been well advocated in commercial farming systems for both fish and shrimp aquaculture. The major steps in farming operations are initial larval rearing, mid nursery rearing and final grow-out phase. The mid nursery rearing is the crucial phase in farming practices, where properly managed and well nurtured individuals will perform better with high growth, better survival, and reduced culture duration in grow-out period. Nursery rearing practices are classified into two major categories; indoor and outdoor systems; where indoor based culture is performed either by flow through or recirculation based concept in FRP (Fibre Reinforced

Plastic) /concrete/collapsible tanks, outdoor based system is performed either running or moving waters in hapa erected or installed in earthen ponds, coastal cages and marine cages.

Nursery rearing of marine finfishes

Nursery rearing of marine finfish is mainly adopted after the advent of hatchery technologies for different species of marine finfishes. As most of the marine finfishes are mostly stocked in cages and coastal pond based systems, these advanced fry received from indoor larval rearing facilities are shifted to nursery rearing systems till they became stable to acclimatise in grow-out climatic conditions. The advanced fish fry can be stocked either in indoor tank based facilities or outdoor pond or cage based systems in small confined area. Performance of indoor or outdoor system depends on the nature and proximity of grow-out culture systems.

High value marine species attain complete metamorphosis at various age and size. Indian pompano, silver pompano and Asian seabass metamorphose between 21-30 days at a size of 1.6 to 2.2 cm of total length. Mangrove snapper, tiger grouper and green grouper metamorphose into juveniles from 2.0 to 2.5 cm of total length at days 35 - 45. Thus the newly metamorphosed advanced fry of this stage is shifted to nursery rearing arrangements. In general, pompano are usually reared in cement tanks of about 1.0 to 5.0 tonnes in a flow-through system. Net cages in brackish water ponds or coastal waters may alternately be used for nursery of metamorphosed Indian pompano larvae, grouper, snapper and sea bass fry. The fry at this stage is weaned to formulated feeds from live food such as copepods and *Artemia* nauplii, etc. While performing nursery for marine finfishes, size grading and use of probiotics are mainly followed. Probiotics in nursery tanks are used to improve the water quality and size grading is done at least once a week to control cannibalism.

Nursery rearing of Indian pompano

Indian pompano *(Trachinotus mookalee)* is a marine fish, considered to be one of the good candidate species for coastal aquaculture and suitable species for species diversification. The fish is having important characters like ease of breeding in controlled condition, quick adaptability to different culture conditions, and better acceptance to artificial feed, pleasant appearance, good meat quality and high consumer preference. All these characters together contribute and credit the fish as one of the new candidate species for commercial aquaculture operation. The fish can be cultured comfortably in sea cage as well as in coastal pond systems. Breeding and seed production technology for the species was standardized by ICAR-CMFRI, Visakhapatnam Regional Centre, and subsequently culture technology was developed. The culture technology for the species has been standardised, disseminated and presently being practised in different coastal states in marine & coastal cages, and coastal ponds. In order to

stock in these culture systems, the advanced fry produced in hatchery should be nursery reared till the size to tolerate different environmental conditions in the grow-out environments. Depending on the culture systems and locations, the nursery rearing is performed in different culture conditions with different suitable management practices. In general, 20-25 g fingerling size is considered as optimum size for stocking in grow-out culture systems, but stocking bigger size will help in reducing the grow-out culture period and will enhance the culture performance of the stocked Indian pompano seeds. The nursery reared fingerling are to be transported to the culture site, and thus the size of the nursery reared fingerlings depending on the distance between nursery and grow-out site and mode of transportation. Considering all the factors, the common nursery system used for the species includes indoor based flow through systems (FRP and concrete cement tanks), recirculating based indoor system (RAS); hapa in coastal pond, coastal cage and marine cage based outdoor systems.

Indoor culture system

FRP and concrete cement tanks

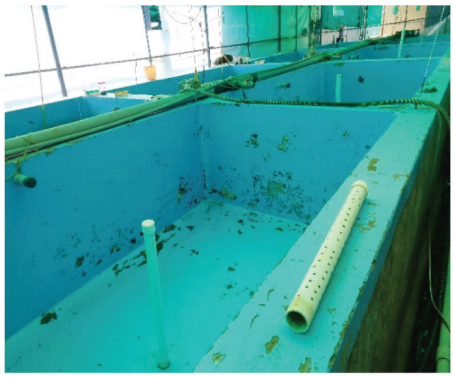
It is flow through based culture system. Circular or square shaped 1-10 tonnes capacity of FRP tanks or concrete cement tanks with 1.0 meter water holding height and central drainage system are considered as suitable for culture of Indian pompano. Tank colour plays an important role in smooth function of daily activities, where light sky blue colour is the preferred for clear visibility of the fish fingerlings and other faecal matters. The concrete tank should be coated with nontoxic epoxy paint for smooth tank surface. Indian pompano larvae attain an advanced fry (2.0-2.5 cm; 0.2 g in size) stage after 35-40 days and at this stage it can be shifted to indoor based flow through nursery facilities. Fry of this size preferably should be stocked in indoor based flow through facilities for better survival. After the stocked fry reaches 2.5 to 3.0 g in size, then it can be shifted to outdoor nursery systems and this practices gives better survival. While shifting, the advanced fry can be shifted to nursery facilities by small containers (plastic buckets) with or without oxygen if the nursery facilities are available within the proximities of hatchery complex. However, shifting with help of oxygen will help to keep the fry in better conditions without stress. The transported advanced fry is directly released to nursery rearing tank at 1000 nos/m^3 and maximum carrying capacity should be less than 5.0 kg/m^3. After transfer, the stocked advanced fry is fed with feed of 500 µ in size. The central drain in the tank is covered with PVC pipes of small slits or drain covers. These pipes and drain covers are wrapped with small mesh size nets according to size of stocked fry, which will avoid the escape of fry while water exchange. The stocked fry is fed at 4-6 times per day at 5-6% of body weight or till satiation. As feeding frequencies are more at initial stage, thus it is recommended for

100% water exchange in two different spells in the morning and evening at 50% in each time. Oxygen supply should be maintained always above 4.0 ppm and 1.5 ppm is considered as critical oxygen limit. While in tank based rearing system, one feet gap between water surface and rim of the tank is necessary as the Indian pompano respond to the light variation, thus the stocked fry jumps out of water if disturbed either by light variation or sound. Thus, enough gap is required to avoid the larvae jump out of water or the tank surface should be covered with net with small mesh. The advanced fry takes nearly one month to reach an average of 3.0 g and survival varies between 75-95%, depending on nursery management practices.

RAS based nursery rearing

The major limitations in nursery rearing and other aquaculture operations are land and water availability, gradual deterioration of aquatic ecosystems, frequent disease outbreaks and difficulties with sediment and waste water treatment. Therefore, it is very important to develop new culture methods to decrease the ecological impact in terms of waste production and water use. One important and effective method to solve these problems is the rearing

FRP tanks with central drain



Concrete tanks with central drain

Feeding in FRP tanks

Feeding in concrete tanks

Fingerlings sampling

Fingerlings sampling

of fish in re-circulating aquaculture systems (RAS). RAS is indoor tank-based water recirculation systems in which fish are grown at high density under controlled environmental conditions to maximize fish fingerlings growth year-round. The system is having the flexibility to locate the production facilities near grow–out culture site, complete and convenient harvesting and quick and effective disease control. These systems can be used to maximize production where suitable land or water is limited, or where environmental conditions are not ideal for particular species to be cultured. Added to this, it is a land-based aquatic system where the water is mostly re-used after mechanical and biological treatment process to reduce the consumption of water and energy. The system offers advantages where temperature and other water quality parameters can be controlled and provides conducive environment in order to maximise the growth and maintain fish health. Most of the modern RAS systems generally consist of components like solid collecting systems (drum filter/sand filter), foam fractionation unit (protein skimmer), bio-filter, carbon dioxide degasser, nitrate filter, sterilisation point (usually UV sterilizer), temperature control, oxygen injection system and pH control and alkalinity dosing system. All these components together helps to maintain good water quality parameters, and create conducive environment for the stocked fingerlings to grow. Stocking size and feeding is similar to indoor based tank culture systems, whereas stocking density can be increased and can be stocked with the biomass of ~20 kg/m^3, according the size. Since, this system works based on water recirculation and high stocking density is maintained and thus, maintaining proper water quality with saturated level of dissolved oxygen is highly essential to maintain high survival in the culture system. Feeding in the system is similar to tank based flow through system and survival varies between 80-95 % depending on stocking size and management practices.

Nursery rearing in RAS system

Feeding in RAS system

Outdoor culture system

Nursery rearing in hapa based coastal pond

The optimum stocking size of pompano in grow out coastal pond culture is 25 to 30 g, and if the available size is small (~1 inch), then nursing of the fry should be done before stocking in the grow-out pond. Pond based nursery culture in hapa is recommended to perform in the same grow-out pond or in separate nursery culture pond. In general less than 10% of the total grow-out culture area should be utilised for nursery rearing in pond based culture. Rectangular hapas are installed in the pond and are supported with bamboo or casuarina poles. The sizes can vary from 2 x 2 x 1.5 m to 4 x 3 x 1.5 m with mesh sizes of 0.5 mm. The size can be still bigger, but requires more manpower to manage while net exchange and other management practices. Immediately on stocking in the hapa/cage, the newly stocked fry fed with floating pellet feed after acclimatisation.The mesh size in the hapa can be increased at time interval depending on the growth of stocked fry/fingerlings. The installed hapa should be stitched with mosquito mesh of one feet height at water interface for avoiding feed wastage through hapa mesh. Nylon net is preferred material for hapa in nursery rearing since it is softer than HDPE net. The ideal stocking density varies from 250 to 350/m^3 for the fingerlings of 3.0 to 20.0 g in size and grading of stocked fry based on size should be followed on a fortnight basis, to achieve uniform growth.

The fish accepts artificial feeds, and the diet with high nutrient content (Crude Protein 45% and Crude Fat 10%) is suggested for the nursery rearing. Feeding frequency of 4-6 times/day at 5-8% of body weight is recommended during the initial phase. The commonly available supplier for nursery feeds are Skretting (Norway), Lucky star (Singapore), Uni-President Enterprises Corporation (Taiwan), Growel Feeds Pvt. Ltd. (India). The stocked advanced fry (2-3.0 g) should be cultured for 60 to 75 days till it reaches 30-40 g, which is an ideal size for stocking in grow-out pond. The expected survival for the fish during hapa

based nursery rearing is around 80-95%, and depends on efficient management. Maintaining good water quality is paramount in nursery rearing and thus, adequate aeration should be provided in the nursery pond as the fish fry are stocked at high densities in the hapa. Maintaining dissolved oxygen level of 4 to 6.0 ppm is recommended through use of paddle wheel aerators in the pond. The recommended salinity for good growth is 15-35 ppt. Water pH can vary from 7.5 to 8.5, but high fluctuations in daily pH due to algae in the pond increases the toxicity of ammonia, ultimately impacting the stocked fry, and therefore, has to be avoided.

Seed stocking in hapa in pond

Feeding in hapa

Sampling of Indian pompano

$KMnO_4$ treatment for disease

Hapa based nursery rearing in coastal cages

In India, huge estuarine resources are available bordering the coasts and this potentially available under-utilized high saline waters bodies could be efficiently utilized by culturing the different species of finfishes in cages installed there of. Optimum size of the fish for stocking in cage is 20 to 25 g. The fish stocked at the optimum size takes nearly 10 months

to attain the market size of 750 g. However, the culture duration could be further reduced if the fish stocked are of bigger sizes. Thus, nursery culture of Indian pompano is considered an important aspect in cage culture for reducing the culture duration in cage culture operation of the fish. If ambient culture conditions existing in backwater culture system, nursery rearing can be performed in cage itself by use of hapas. Hapa based backwater nursery is performed, especially where the distance between land based culture and backwater cage is far away. Keeping the culture situation in consideration, backwater cage based nursery rearing is recommended. Unlike, indoor tank based nursery facilities, the initial stocking size should be 3.0-5.0 g in size due to rough climatic conditions. In general 5x5x3m GI cages are used for grow-out culture, and therefore, a hapa of either 2x2x2.5 or 3x3x2.5 size are recommended for nursery in cages. The mesh size of the hapa should be 5 mm in size, and should be stitched with feed mesh of 1 feet height at water and air interface to avoid feed wastage through hapa mesh. Optimum stocking density is 300-350 nos/m^3

Coastal backwater cages

Hapa installed in coastal backwater cages

Seed stocking in coastal backwater cages

Sampling of Indian pompano seed in coastal cages

and this stocking density can be maintained till 25.0 g in size. Immediately after stocking, the fingerlings can be fed with floating pelleted feed of 0.8 to 1.0 mm in size, at 5-6% of body weight. Feeding frequency should be 4-6 times and minimum of 4 times / day is highly recommended at initial stage. As backwater is prone for bacterial load due to domestic waste accumulation, the nursery rearing fingerlings should be continuously monitored and necessary medications with feeding should be incorporated based on requirements. The estimated survival in this system is varied from 75-80% and more mortality is encountered during initial stage of nursery rearing and especially more at the time of net exchange.

Hapa based nursery rearing in marine cages

Cage farming technology is widely recognized as one of the most important culture technology in mariculture for increasing fish production. Different species of marine finfishes are cultured in marine cages and Indian pompano is considered as a suitable potential candidate species for marine cage culture system. Cage culture is operated in isolated locations at 1-5 km distance from the coast. Thus seldom transportation of the bigger seed is problematic to transfer for long distance, and in this situation performing nursery rearing in cage using small hapa is preferred if conducive environmental conditions exist in cages. Similar to coastal cages, hapa of 2x2x2.5 or 3x3x2.5 or other optimum size is preferred for nursery rearing. In compared to tanks and other system, the initial stocking size should be bigger (3.0 to 5.0 g) as wave action and water current are high in sea cage. The recommended stocking density is less than 10 kg/m^3 (400-500nos/m^3 till 20.0 g) and then slowly the stocking density is reduced as fingerlings grow. Stocked fingerlings fed at 5-8% of body weight with minimum of 4 times/day with floating feed. Feed mesh prepared using mosquito mesh should be attached at water and air interface to avoid wastage of floating feed due to wave actions. While in culture, hapa should be exchanged once in a month in order to avoid blockage of water movement due to fouling in the net. Hapa installed in cage is prone for folding due to high wave action and thus use of ballast pipe in hap is preferred, which will

Seed transport – polythene bag

Seed stocking

Seed stocking in hapa in cage

Seed transport – Via sintex cylinder

Hapa in cage for nursery

Feeding in Hapa

avoid net folding due to wave action. The survival of nursery reared fingerling in this system is in the range of 70-80%.

Effect of nursery rearing environments on growth

Growth performance is one of the important traits which determine long time existence of a species in commercial culture operations. Fish growth is a complex process in which the ingested energy is converted to biomass and is regulated by genetic growth potential of the fish and several other abiotic factors provided by culture systems. Marine fishes are nursery reared in different culture systems and growth in all these systems is influenced by different environmental factors brought by the respective culture systems. In comparison with indoor culture environments, outdoor culture system exhibit better growth due to availability of natural feed in addition to merely pelleted feed. The natural water movements were also found to enhance the growth. However, outdoor systems are more prone for bacterial and other kind of infections, which seldom reduce survival. Growth rate and feeding details in nursery rearing of Indian pompano in different culture system is given below.

Days (DOC)	Pond	Cage	Tank	RAS	Feed Size	Frequency	Feed Weight
	Weigh (g)				(mm)	(Time/day)	% of BW
0	3.5	3.5	3.5	3.5	0.8 to 1.2	4-6	5-6
30	19.35	27.7	10.55	18.8	1.2 – 1.8	4-5	4-5
60	48.05	48.4	21.35	35.55	1.8 to 2.0	4	4
90	73.3	90.5	39.8	73.6	2.0 to 3.00	4	4
Survival (%)	80-85	70-80	85-95	85-95			

Seed transportation

It is preferred to establish the nursery unit near to grow-out culture site for ease of transportation. Advanced fingerlings to nursery rearing or nursery to grow-out culture system are transferred via polythene bags filled with oxygen or sintex / FRP tanks supported with oxygen. When fingerlings are to be shifted at more than 5.0 g in size, preferably they should be transported via container supported with pure oxygen for achieving maximum survival and smaller sized advanced fry of less than 1.0 g in size can be transported via polythene bags. Fingerlings transported in stressed condition (overcrowding and less dissolved oxygen) are more susceptible to vibriosis after stocking. Thus adequate care should be given to keep the animals under stress-free conditions. Use of ice while seed transportation is recommended during summer season in -order to avoid heat shock to the transported larvae. Seeds transported over long distances should be in sintex tanks supported with oxygen, and for short distances of less than an hour can be in open FRP tanks supported with oxygen. Based on the experience, the optimum fish size, stocking density and mode of transportation are given in the table below.

Fish Size (g)	Duration (hr)	Stocking (nos/lit)	Mode of transportation
> 0.25	24-36	50-60	Polythene bag filled with oxygen
1.0 to 2.0	15-30	20-25	Polythene bag filled with oxygen
2.0 to 5.0	12-24	10-15	Sintex tank supported with oxygen
5.0 to 15.0	12-20	5-6	Sintex tank supported with oxygen
25.0 to 30.0	12-20	2-2.5	Sintex tank supported with oxygen

Indian pompano seed transportation by sintex tank with pure oxygen for long distance by lorry

Indian pompano seed transportation by polythene bag filled with pure oxygen

Points to be considered for nursery rearing of Indian pompano

- Rearing fish larvae through the early life stages is performed in nursery, and this is the phase between hatchery and grow-out. Thus, before stocking for grow-out, culture species needs to be nursed for attaining optimum stocking size.
- Optimum size of Indian pompano for stocking in grow-out culture is 25.0 g, and the fish stocked at the optimum size takes nearly 10 months to attain the market size of 850.0 g. However, culture duration can further be reduced if the fish stocked is of bigger sizes.
- Nursery rearing of Indian pompano is essential in cage culture for reducing the culture duration during grow-out. Three types of nursery systems are preferably used: concrete or FRP tank-based flow-through, recirculating aquaculture system (RAS) based system, hapa-based nursery in earthen ponds, coastal and marine cages These nursery facilities should be established near to cage site for ease of fish transfer.
- Feed used in nursery should have a high nutrient profile; 45% Crude Protein and 10% Crude Fat. Feeding frequency of 4-6 times/day at 6-5% body weight is recommended. The feeding rate varies with size of the fingerlings reared.
- For proper initial nursery, advanced fry of 2.5 cm (0.5 to 0.6 g) stocked at 500 nos/ m^3 should reach 6.25 cm (5.0 g) within 45 days. Optimum feed size to avoid size variation should be 0.8 to 1.2 mm, at 12% of body weight. During the later phase of nursery, early fingerlings stocked at 5.0 g size should attain 25.0 g size in 30 days at a stocking density 300/m^3 with a feeding rate of 6-5% body weight. Therefore,

during the entire nursery duration, advanced fry of 2.5 cm size should reach 25.0 g in two and half month (75 days).

- Indian pompano,being fast-moving pelagic fish, dissolved oxygen requirement is very high; therefore, during nursery, the dissolved oxygen concentration should always be above 4 ppm.
- With proper feeding and water quality management, expected survival in RAS and indoor tank-based cultures should be above 96%, whereas in hapa-based earthen ponds, more than 90-95% survival; and in hapa based cages 70-85% is expected.
- Fishes are very active during nursery rearing; therefore, they tend to jump to at-least 15.0 cm above the water level. Thus water level should be at least 30.0 cm below the tank surface for avoiding fish fingerlings falling out of water. It is suggested to cover the tank surface with fish net to avoid fish jumping out of the tank.
- Vibriosis is the most common bacterial infection occurring during nursery, because of stress. Minimising stress in nursery will help to keep the fishes free from bacterial infection. Possible stressors are: overcrowding, more waste accumulation in tank bottom, rough handling, higher water temperature and lower dissolved oxygen.

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