Indian J. Fish., 60(1) : 71-75, 2013

Effect of stocking density on growth and survival of hatchery reared fry of Asian seabass, *Lates calcarifer* (Bloch) under captive conditions

SURESH KUMAR MOJJADA[1], BISWAJIT DASH[2], PHALUGUNI PATTNAIK[2], M. ANBARASU[1] AND IMELDA JOSEPH[3]

[1]*Veraval Regional Centre of Central Marine Fisheries Research Institute, Matsya Bhavan, Bhidiya, Veraval - 362 269, Gujarat, India*

[2]*Visakhapatnam Regional Centre of Central Marine Fisheries Research Institute, Pandurangapuram, Visakhapatnam -530 003, Andhra Pradesh, India*

[3]*Central Marine Fisheries Research Institute, Ernakulam North P. O, Kochi - 682 018, Kerala, India*

e-mail: sureshkumar.mjd@gmail.com

ABSTRACT

One of the important factors determining the success in open sea floating cage farming is the availability of quality seeds of appropriate size. The commercially available hatchery produced seeds should be further reared to appropriate size before stocking in the sea cages. The Asian seabass, *Lates calcarifer* is an important candidate species for open sea floating cage culture. Availability of seeds of required size is an important bottleneck in the sea farming of this species. To address this issue, an experiment was conducted in 2007 off Visakhapatnam coast of India in the Bay of Bengal, to study the effect of different stocking densities on the growth and survival rate of hatchery reared seabass fry. Asian seabass fry with a mean total length of 23.9 ±3 mm and mean body weight of 0.45±0.05 g were stocked in 5 t FRP tanks with 3.5 t of filtered seawater, at three different stocking densities *viz*., 1000, 1500 and 2000 nos. m^{-3} in triplicate. The fishes were fed with commercial dry pellet feed (Godrej) at 6-8% of fish biomass. Feeding was done 6 times daily at 4 h intervals . The water quality parameters were monitored and maintained within the favorable ranges for seabass culture. The growth and survival under different stocking densities were monitored for a period of 90 days. Results observed from these experimental trials showed that the specific growth rate (SGR) was inversely proportional to that of the stocking density ($p<0.05$), and no significant variation was noticed in the survival rate. An overall biomass production of 1.11 kg day^{-1} was obtained at a high stocking of 2000 nos. m^{-3}. The results of the experiment indicated that these high stocking density techniques with proper feeding and water quality management can be used to produce large numbers of seabass fingerlings of stockable size for open sea cage culture.

Keywords: Asian seabass, Captive condition, *Lates calcarifer*, Stocking density

Introduction

The Central Marine Fisheries Research Institute (CMFRI) has been undertaking open sea floating cage culture experimens since 2007 off Visakhapatnam coast of India in the Bay of Bengal. Among the finfish species, the Asian seabass, *Lates calcarifer* is considered as one of the most important candidate species suitable for farming in ponds and cages in freshwater, brackishwater and marine ecosystems (Kungavankiu *et al*., 1986; Rimmer and Russell, 1998; Anil *et al*., 2010). The success in open sea floating cage farming depends on the availability of seeds of appropriate size for stocking. The commercially available hatchery produced seabass seeds need to be further reared before stocking in sea cages. Increased stocking density during the nursery rearing phase is essential to meet the high demand for advanced seabass fingerlings for farming operations. Density is one of the most deterministic factors in larviculture, affecting social interactions such as aggressiveness (Kaiser *et al*., 1995; Sakakura and Tsukamoto, 1998; 1999), hierarchical phenomena (Schreck, 1981) and cannibalism (Hecht and Pienaar, 1983; Katavic *et al*., 1989; Moore and Prange, 1994), resulting in variations in size, survival and growth performance in fish populations (Suteemechaikul and Petchrid, 1987; Papoutsoglou *et al*., 1998; Hatziathanasiou *et al*., 2002). The present study was undertaken to estimate the effect of different stocking densities on the growth and survival rate of hatchery reared Asian sea bass, *Lates calcarifer*.

Materials and methods

Asian seabass fry with a mean total length of 23.9 ±3 mm and mean body weight of 0.45±0.05 g were stocked in 5 t FRP tank with 3.5 t of filtered seawater at three different stocking densities *viz*.,-1000, 1500 and 2000 nos m^{-3} in triplicate. The fishes were fed with commercial dry pellet feed (Godrej) at 6-8% of fish biomass. The feeding was done 6 times daily at 4 h intervals. The tanks were provided with continuous aeration and water was changed daily before feeding. Tanks were cleaned and the uneaten feeds were collected 2 h after the feeding. Collected uneaten feeds were dried and weighed for calculating the feeding rate. Water quality parameters such as temperature, pH, salinity and dissolved oxygen, were monitored daily using portable instruments, while critical parameters such as total ammonia (NH_3) and nitrite (NO_2) were measured on alternate days following standard methods (APHA, 1998). The growth and survival under different stocking densities were monitored for a period of 90 days.

The main performance variables were calculated using the following formulae:

Survival (%) = (number of fish harvested/number of fish stocked) × 100.

Specific growth rate (SGR) = $[\ln Wt_2 - \ln Wt_1 \times (t_2-t_1)^{-1}] \times 100$ where: Wt_2=final weight (g), Wt_1=initial weight (g) and t_2-t_1=number of days.

Feed conversion ratio (FCR) = total amount of feed consumed (kg) / biomass increase (kg)

Data from each treatment were subjected to one-way analysis of variance (ANOVA). Means were compared by Tukey's test (p=0.05). The level of significance was chosen at $p<0.05$, and the results are presented as mean±standard error of the mean (S.E.M.).

Results and discussion

Ingredients and proximate composition of the pellet diet (Godrej) used in the present study are provided in Table 1. The effects of stocking density on survival (%), specific growth rate (SGR) and feed conversion ratio (FCR) are presented in Fig. 1, 2 and 3 respectively. The fishes adapted well to the experimental system, and no disease or water quality problems were observed during the study period. The water temperature ranged from 27.5 to 31.5 °C, pH 7.4 to 7.8, salinity 28.5 to 33.5 ‰, dissolved oxygen (DO) 5.8 to 6.2 mg l^{-1} and nitrite (NO_2) 0.01 to 0.03 ppm in different treatments. The total ammonia (NH_3) varied from 0.01 to 0.07 ppm in treatment with a stocking density of 1000 nos m^{-3}, 0.01 to 0.15 ppm in 1500 nos m^{-3} and 0.01 to 0.63 ppm in 2000 nos m^{-3} stocking density. The water quality parameters were within the limits cited by Rimmer and Russel (1998) for the rearing of Asian seabass nursery and grow-out. This is also one of the reasons that all the stocks in the treatments yielded almost 100% survival rate.

Overall survival rates recorded wree: 98.3, 97.6 and 98.7% at stocking densities of 1000 nos. m^{-3}, 1500 nos. m^{-3} and 2000 nos. m^{-3} respectively (Fig. 1). Statistical analysis showed no significant differences in survival rates up to the 30 days of experimental period, at 1000 nos. m^{-3}, 1500 nos. m^{-3} and 2000 nos. m^{-3} ($p>0.05$). But significant differences were noticed in the survival rates after 90 days of culture period at 1000 nos. m^{-3} as compared to 1500 nos. m^{-3} and 2000 nos. m^{-3} stocking densities ($p<0.05$) (Fig. 1). Kailasam *et al*. (2001) observed a survival rate of 65% in higher stocking densities of 20 and 30 nos. l^{-1}. Kailasam *et al.* (2002) opined that seabass fry are highly carnivorous, voracious feeders and development of fast-growing individuals (shooters) during the larval phase drastically reduces the survival rate mainly through cannibalism. But, in the present study, higher percentage of survival was obtained at high stocking density of 2000 nos. m^{-3} and also very less amount of fast-growing

Table 1. Ingredient and proximate composition of the commercial pelleted diet (Godrej) used (g 100 g^{-1} dry weight).

Ingredients (g 100 g^{-1})	
Muscle fish meal	58.57
Krill meal	11.14
Cod liver oil	13.28
Lecithin	1.00
Gelatin	6.50
Corn starch	3.00
Mineral premix	3.75
Vitamin premix	2.75
Antioxidant premix	0.01
Proximate composition: (g 100 g^{-1} dry weight)	
Crude protein	61.8
Crude lipid	21.5
Ash	6.1
NFE + crude fiber	10.6
Gross energy (kJ g^{-1}):	24.9

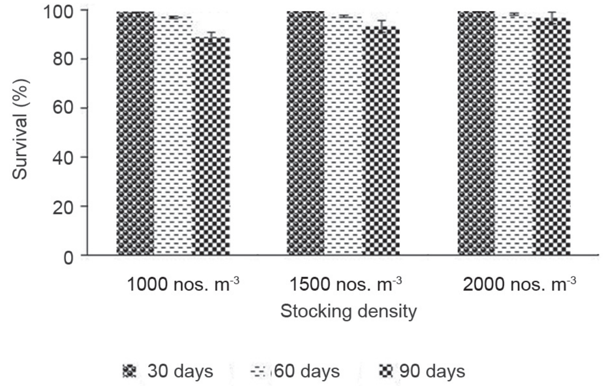

Fig. 1. Survival (%) of Asian seabass *Lates calcarifer* cultured at three different stocking densities for a study period of 90 days (All values are mean ± S.E.M)

individuals (shooters) were noticed in high stocking density than in the low stocking densities. There was no significant interaction between size distribution, stocking density, survival, cannibalism and natural mortality. High stocking density (2000 nos. m^{-3}) and initial size distribution without interaction influenced the survival of juveniles in the present investigation.

Weight gain per day during the initial period ranged from 0.16 to 0.38 whereas the SGR ranged from 7.11 to 4.41. This agrees with the previous report by Katersky and Carter (2005), where SGR was 5.6% per day at 27 °C in a 20 days experiment using 5 g fish. In the present study, SGR decreased from 4.51 to 4.41 in 1000 nos. m^{-3}, 6.36 to 5.39 in 1500 nos. m^{-3} and 7.11 to 6.89 in 2000 nos. m^{-3} stocking density after the 90 days rearing period (Fig. 2). There is an inverse relationship between SGR and fish weight and therefore, SGR decreases as fish weight increases (Jobling, 1994; Catacutan and Coloso, 1997; Eusebio and Coloso, 2000). Results observed from these experimental trials showed that the SGR was inversely proportional to that of the stocking density ($p<0.05$), but not much variation was noticed in the survival rate.

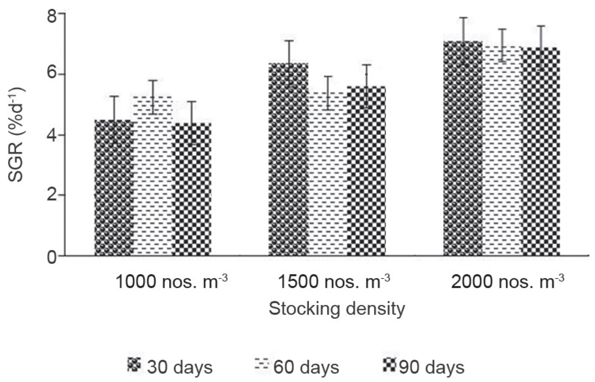

Fig. 2. Specific growth rate (SGR) of Asian seabass *Lates calcarifer* cultured at three different stocking densities (All values are mean ± S.E.M)

Philipose *et al.* (2010) reported FCR of 1.15 in 45 day nursery rearing of Asian seabass in indoor cement tanks. In the present study, the FCR recorded at the three stocking rates were, 0.86, 0.85 and 0.90 for 1000 nos. m^{-3}, 1500 nos. m^{-3} and 2000 nos. m^{-3} respectively during the culture period of 90 days (Fig. 3). Significant differences ($p<0.05$) between 2000 nos. m^{-3} and the other two stocking rates were recorded, but on the other hand 1000 nos. m^{-3} and 1500 nos. m^{-3} did not differ significantly (Fig. 3). The FCR values indicate that 2000 nos. m^{-3} stocking density group utilised the feed most efficiently and showed better feed conversion than the other two groups, resulting in an overall biomass production of 1.11 kg day^{-1}. In the case of rainbow trout (*Oncorhynchus mykiss*), it has been demonstrated that social interactions affect fish growth negatively, because dominant fish monopolise and do not allow the subordinates to feed properly (Alanärä and Brännäs, 1996). However, when European seabass was reared up to the age of 6 months, high densities enabled the highest growth rates from 6.6 to 27.6 g (Papoutsoglou *et al*., 1998).

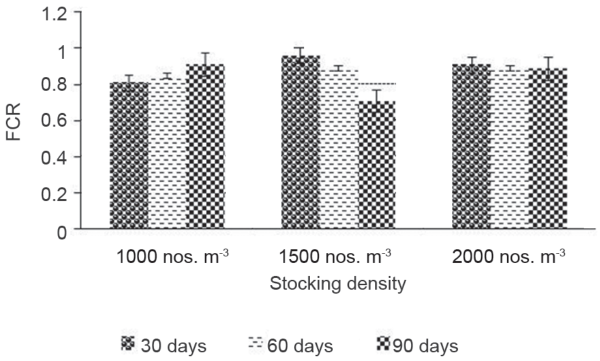

Fig. 3. Food conversion ratio (FCR) of Asian seabass *Lates calcarifer* cultured at three different stocking densities (All values are mean ± S.E.M).

Seabass fry reared under controlled conditions face competition among individuals for feed and space resulting in uneven growth causing cannibalism (Mackinnon, 1985; Van Damme *et al*., 1989; Sukumaran *et al*., 2011). Hecht and Pienaar (1993) stated that cannibalism is also a phenomenon believed to be caused due to genetics and behaviour of the fish. Cannibalism due to size variation caused by genotypic differences dictates individual growth rate (De Angelis *et al*., 1979). Several environmental factors like food availability, population density, refuges, water clarity, light intensity, feeding frequency and the frequency at which alternative prey is presented are found to influence the behavioural pattern of larvae and juveniles which ultimately lead to cannibalism (Braid and Shell, 1981; Li and Mathias, 1982). In the present investigation, such phenomenon was noticed to some extent in low stocking density groups whereas in high stocking density group it was almost nil. Kailasam *et al.* (2002) reported that social dominance is one of the causes of size variation, which leads to hierarchical territoriality and associated behavioural patterns. In high stocking density, there was very less chances for social dominance and hierarchical territoriality and associated behavioural patterns, which lead to efficient utilisation of the available space and feed in the culture environment.

The results of the present study indicate that high stocking density (up to 2000 nos. m^{-3}) with proper feeding rate, feeding frequency and water quality can help to reduce cannibalism and to obtain maximum survival rate and growth in seabass. The technique can be used to produce large numbers of seabass juveniles for open sea cage farming of Asian seabass.

Acknowledgements

The authors express their gratitude to the Ministry of Agriculture, Government of India for the financial support provided to carry out the work. The authors are grateful to the Head, Mariculture Division, CMFRI, for his encouragement during the study. We are thankful to all the staff of Visakhapatnam Regional Centre of CMFRI for their help in field work.

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Date of Receipt : 31.05.2012
Date of Acceptance : 09.11.2012