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Effect of Different Substrata on the Growth and Survival of Green Mussel *Perna viridis* in Raft Culture at Ratnagiri (India)

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Abstract

The rens from two substrata *viz.*, nylon rope (2.5 m length and 24 mm diameter) and nylon strip (1.5 m length and 5 cm width) were prepared and suspended from wooden raft (6.32 x 2.7 m), anchored at depths 3.5-4.0 m in the Kalbadevi estuary (10°59'1''N and 73°10'25''E) at Ratnagiri. The seeds of *Perna viridis* with an average initial shell length of 31.1 ± 0.08 and 31.2 ± 0.07 mm were seeded in nylon rope and nylon strip rens, respectively. In this experiment, 10 replicates were used for each ren. The green mussel attained the shell length of 67.3± 0.7 and 65.5 ± 0.62 mm in 7 months for nylon rope and nylon strip rens, respectively. The average survival of 54.09% with an average production of 11.32 $kg.m^{-1}$ was obtained in nylon rope, whereas average survival of 35.26% with average production of 9.12 $kg.m^{-1}$ was obtained for nylon strip rens in 7 months. The growth of mussels on nylon rope and nylon strip ren was not significant, but survival and production of mussels were significantly higher in nylon rope compared with nylon strip ren during raft culture.

Introduction

Coir and other natural fibre ropes have been used extensively in mussel farming (Andreu 1968; Mason 1969; Maclean 1972). Their success has been attributed to their hairy and creviced nature. Most natural fibre ropes have a comparatively short life in seawater. Therefore, a synthetic substitute was used in the mussel farming industry.

In India, for culture of green mussel (*Perna viridis*, Mytilidae), coir rope (12 mm thickness) and nylon rope (14 mm thickness) was used by Appukuttan et al. (1998), whereas 14 mm diameter nylon rope and 20-25 diameter coir rope were used by Kuriakose (1980b). Parulekar (1980) used the strip of cotton mosquito curtain cloth (3 m length and 35 cm width) for attachment of mussel seeds on nylon rope (12 mm diameter) in raft culture. Ranade & Ranade (1980) used nylon ropes and coir ropes for the attachment of mussel seed. Narasimham (1980) observed high growth rate of green mussels on nylon ropes than natural beds.

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However, no study on performance of nylon rope and nylon strip has been carried out. Therefore, this paper describes the efficiency of these materials for growth, survival and production of mussels in raft culture.

Materials and Methods

Study area

Experiment was conducted from February 2002 to September 2002 at Kalbadevi estuary, Ratnagiri (10°59'1''N and 73°10'25''E) situated in Maharashtra state, along the West coast of India. The raft was anchored in the site protected from the strong winds and currents. The site had bottom of muddy sediments with mean depth of about 3.54 m at low tides.

Raft

The rectangular wooden floating raft (6.32 x 2.7 m) towed to a selected site with dugout canoe and moored at water depth of 3.5 m.

Collection of mussel seeds

Green mussel seeds were collected from Bhatye creek, about 8 km away from culture site. Mussel seeds were collected by hand picking method during the low tides in the month of February 2002. They were transported in wet gunny bags. Seeds were washed with fresh seawater to eliminate sand, detritus, predators, possible competitors and dead mussels before seeding.

Ren

Two types of ren materials *viz.*, nylon rope and nylon strip were used as substrata for the attachment of mussel seeds. Ten replications were used for each type of material.

Nylon rope ren

Each ren was prepared using the nylon rope of 2.5 m length and 24 mm diameter. The nylon rope was placed over the nylon net (mesh size = 18 mm) by leaving 0.7 m on one end and 0.3 m on another end for attaching the weight. Both ends of the nylon netting were tied to nylon rope using nylon thread. Mussel seeds were placed around the rope, and nylon netting was stitched to form the tube. At distal end of ren, stone ballast was attached to prevent it from becoming tangled with others.

Nylon strip ren

Each ren was prepared using nylon strip of 1.5 m length with 50 mm width. The nylon rope (3.5 m length with 4 mm diameter) was passed through nylon strip at regular interval of 30 cm in zigzag manner. Nylon strip along with nylon rope was placed on net

material. Both ends of nylon rope and nylon strip were tied with the net using nylon thread, leaving 1.2 m length of nylon rope at one end for suspending from raft and 0.3 m for attachment of stone at its distal end.

Seeding

Mussel seeds of an average initial shell length of 31.1 ± 0.08 and 31.2 ± 0.07 mm and average initial live weight of 2.51 ± 0.13 and 2.63 ± 0.09 g were seeded in nylon rope and nylon strip rens, respectively. Mussels were seeded at the rate of 1.67 $kg.m^{-1}$ for each ren.

Sampling

Samples were randomly collected from each replicate at interval of every month. The length was measured using vernier caliper to the nearest of 0.01 mm. Weight was recorded using 'Shimadzu' weighing balance with 0.01 g accuracy. Shell length was measured from the tip of the umbo to the posterior margin of the shell, shell height was measured in the greatest dorsoventral direction, and shell width was measured from side to side in the broadest region. Total live weight was recorded by weighing whole individual mussel; shell weight was recorded by removing meat and water from shell cavity; meat weight was recorded by removing meat from shell cavity, and dry meat weight was obtained from the soft tissue dried to a constant weight at 80°C using 'TEMPO' thermostat.

The initial and final numbers of mussels were recorded from each ren for estimation of survival. The mussel production (P) per meter rope was calculated using the following formula given by Karayucel & Karayucel (1999).

$$P = [N_t + N_{(t+1)} \times 2^1] \times (W_{(t+1)} - W_t)$$

where N_t is the number of mussel per meter of rope at the time of seeding, $N_{(t+1)}$ is the number of mussel per meter of rope at the time of harvest, W_t is the mean live weight at the time of seeding, and $W_{(t+1)}$ is the mean live weight at the time of harvest.

Water parameters

Water parameters such as water temperature, conductivity, total dissolved solids, pH, dissolved oxygen, carbon dioxide, salinity, total hardness, nitrite-nitrogen, nitrate-nitrogen, orthophosphate and silica were analysed by every 15 days during culture period following standard methods (APHA 1998).

Statistical analysis

Data on growth parameters, survival and production were analysed by Student's *t*-test (Snedecor & Cochran 1967).

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Results

Water parameters

Water parameters such as temperature, conductivity, total dissolved solids, pH, dissolved oxygen, carbon dioxide, total hardness, nitrite-nitrogen, nitrate-nitrogen, orthophosphate and silica ranged from 26.5 to 30.5°C, 43.4 to 58.4 MS, 21.7 to 29.7 $g.L^{-1}$, 7.44 to 7.83, 4.8 to 5.8 $mg.L^{-1}$, 2.82 to 7.15 $mg.L^{-1}$, 6132 to 8001 $mg.L^{-1}$, 0.0079 to 0.025 $mg.L^{1}$, 0.425 to 1.1428 $mg.L^{-1}$, 0.0351 to 0.06 $\mu g.L^{-1}$ and 14 to 39.7 $\mu g.L^{-1}$, respectively. Salinity was fluctuating from 35 $g.L^{-1}$ in summer months (May-June, 2003) to 8 $g.L^{-1}$ in monsoon months (July-August, 2003).

Growth parameter

Average shell length, shell height, shell width, live weight, shell weight, wet meat weight and dry meat weight of green mussels reared for 7 months on nylon rope and nylon strip are given in Table 1. The growth parameters of the mussels reared on both the substrata show no significant difference ($p > 0.05$).

Table 1. Growth and survival of green mussel, cultured using different substrata in raft culture

	Parameters	Substrata	
		Nylon rope	Nylon strip
a.	Shell length		
	Initial average shell length (mm)	31.1 ± 0.81	31.2 ± 0.71
	Final average shell length (mm)	67.3 ± 0.70	65.5 ± 0.62
	Shell length increment (mm)	36.2	34.3
b.	Shell height		
	Initial average shell height (mm)	16.8 ± 0.39	16.7 ± 0.37
	Final average shell height (mm)	34.4 ± 0.45	33.7 ± 0.45
	Shell height increment (mm)	17.6	17.0
c.	Shell width		
	Initial average shell width (mm)	8.0 ± 0.21	8.1 ± 0.57
	Final average shell width (mm)	22.0 ± 0.47	21.6 ± 0.43
	Shell width increment (mm)	14.0	13.5
d.	Live weight		
	Initial average live weight (g)	2.52 ± 0.13	2.59 ± 0.11
	Final average live weight (g)	25.80 ± 0.81	23.89 ± 0.53
	Live weight gain (g)	23.28	21.30

e.	Shell weight		
	Initial average shell weight (g)	1.30 ± 0.11	1.36 ± 0.10
	Final average shell weight (g)	12.23 ± 0.45	10.96 ± 0.53
	Shell weight increment (g)	10.93	9.60
f.	Wet meat weight		
	Initial average wet meat weight (g)	0.61 ± 0.02	0.64 ± 0.03
	Final average wet meat weight (g)	7.53 ± 0.23	7.00 ± 0.11
	Wet meat weight increment (g)	6.92	6.36
g.	Dry meat weight		
	Initial average dry meat weight (g)	0.093 ± 0.03	0.095 0.011
	Final average dry meat weight (g)	1.26 ± 0.11	1.114 ± 0.07
	Dry meat weight increment (g)	1.167	1.029
h.	Survival		
	Initial average number per meter	635 ± 1.39	633 ± 1.39
	Final average number per meter	343.5 ± 12.11	223.2 ± 9.99
	Average percentage survival	54.09 ± 1.93	35.26 ± 1.56
i.	Production ($kg.m^{-1}$)	11.39 ± 0.14	9.12 ± 0.11

Survival

The nylon rope substrata resulted in significantly higher ($p < 0.05$) average survival of 54.09 ± 1.93% compared with the nylon strip substrata which yielded average survival of 35.26 ± 1.56% in 7 months.

Production

The mussel productions at the rate of 11.39 ± 0.14 $kg \times m^{-1}$ and 9.12 ± 0.11 $kg.m^{-1}$ were obtained from the substrata of nylon rope and nylon strip, respectively. The nylon rope yielded significantly higher ($p < 0.05$) production than nylon strip.

Discussion

In this study, green mussels (31.2 mm) attained the marketable size shell lengths of 63.3 and 62.3 mm on nylon rope and nylon strip substrata, respectively, within 5 months. After 5 months, the growth rate was retarded due to freshwater influx, resulting in final average shell length of 67.3 mm for the nylon rope and 65.5 mm for the nylon strip rens in 7 months. The growth in terms of shell length was higher in the present study compared with the study carried out by Appukuttan (1980).

In this study, green mussels attained the average shell width of 22.0 mm on the nylon rope and 21.6 mm on nylon strip. They attained the shell height of 34.4 and 33.7 mm on nylon rope and nylon strip, respectively, in 7 months. However, observations

on shell width and shell height were not reported in other studies.

Ranade et al. (1973) reported monthly weight gain of 3.0 g in *Mytilus viridis* cultured for 7 months. Qasim et al. (1977) reported the monthly weight gain of 11.3 g on nylon rope for *M. viridis*.

Green mussels attained the average final live weight of 8.33-8.48 and 8.39-8.50 g on rope substrata and onion bag respectively, within 8 months (Chaitanawisuti & Menasveta 1987). In this study, *P. viridis* attained the marketable size live weight of 22.45 and 20.97 g on the nylon rope and nylon strip, respectively, within 5 months. In 7 month culture period, they grew to size of 25.80 and 23.89 g, respectively, on nylon rope and nylon strip. The retarded growth during last 2 months is because of drop in salinity due to influx of freshwater. The growth obtained in this study is higher compared with that reported by Chaitanawisuti & Menasveta (1987).

During this study, the increment in the shell weight was of 10.93 and 9.60 g on the nylon rope and nylon strip substrata, respectively, within 7 months. However, Kuriakose (1980a) reported the growth rate in shell weight of 2.58 g.month^{-1} on nylon ropes for green mussel.

Kuriakose & Appukuttan (1980) recorded monthly growth rate in wet meat weight of 2.94 g on nylon ropes in 5 months. In this investigation, increment in the wet meat weight of 6.92 and 6.36 g was obtained on nylon rope and nylon strip substrata, respectively, within 7 months.

Dry meat weight increment was 1.16 and 1.03 g in 7 months for the substrata of nylon rope and nylon strip, respectively, during this study. However, no significant difference was found in growth parameters.

During this study, the final survival was found to be better on nylon rope compared with nylon strip in 7 months. It was found that because of continuous water current, the substrata, which is lighter than rope substrata, does not withstand against prevailing water current resulting slippage of mussels from nylon rope substrata.

The average per meter productions of 12 kg in 5-6 months (Kuriakose 1980a) and 6.9 kg within 5 months (Kuriakose & Appukuttan 1980) was observed on nylon rope. Ranade & Ranade (1980) recorded the production of 7 kg.m^{-1} in 6 months, and Parulekar (1980) reported average production of 18 kg.m^{-1} in 4½ months on nylon rope in raft culture method. In this study, the final production obtained was 11.39 and 9.12kg on nylon rope and nylon strip substrata for *P. viridis* in raft culture during summer months.

Conclusion

The nylon rope substratum is better compared with nylon strip substratum for growth, survival and production of *P. viridis* in raft culture system.

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