Kasetsart J. (Nat. Sci.) 40 : 167 - 171 (2006)

A Comparison of Rearing Pacific White Shrimp (*Liptopenaeus vannamei* Boone, 1931) in Earthen Ponds and in Ponds Lined with Polyethylene

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ABSTRACT

Pacific white shrimp (*Liptopenaeus vannamei*) were reared in three earthen ponds and three ponds lined with polyethylene of the same size. The larvae at post larval stage 15 were stocked at a density of 75 shrimp/m^2. Shrimp were fed with commercial pellet feed only. The water salinity level during culturing period was 3-5 ppt. Culturing period was 112 days. The average yield in the earthen ponds was 1,470.8±61.7 kg/rai, while in the polyethylene-lined ponds was 1,737.5±208.6 kg/rai. The levels of total suspended solids and total ammonia nitrogen of earthen ponds were significantly greater than those of the polyethylene-lined ponds ($P<0.05$). While temperature, dissolved oxygen, salinity, electrical conductivity, alkalinity, hardness and chlorophyll a were not significantly different. The amount of plankton, especially blue-green algae *Merismopedia*, *Chroococcus* and *Phormidium*, were higher in the polyethylene-lined ponds than in the earthen ponds throughout the culturing period. It could be concluded that using polyethylene to line shrimp ponds would solve certain problems associated with low yields in certain areas where seepage in sandy soil, high acidity due to acid sulphate soil, and high suspended solids levels were found.

Key words: Pacific white shrimp, *Liptopenaeus vannamei* , lined pond, polyethylene, earthen pond

INTRODUCTION

Pacific white shrimp (*Liptopenaeus vannamei* Boone, 1931) were originally reared in South America and then transferred for culture in Taiwan and China in 1998. In Thailand, popularity grew, and its production was 170,000 to 200,000 t, while black tiger shrimp (*Penaeus monodon* Fabricius) production was only 120,000 to 150,000 t in 2003 (Kiertpinyo, 2001). Pacific white shrimp culture spread throughout the country, especially in the central area by using low salinity culture systems. Culture in ponds lined with high-density polyethylene (HDPE) plastic liners have been proven to be effective in some countries that face disease and acid soil problems (Anonymous, 2001). This type of pond can prevent bottom deterioration. Pruder *et al* (1992) and Lopez *et al*. (2002) demonstrated that pond liners are technically feasible in the culture of *L. vannamei*. The aim of the study was, thus to compare the Pacific white shrimp production, the abundance of plankton and water quality between earthen ponds and ponds lined with polyethylene for one crop.

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Received date : 30/06/05 Accepted date : 31/10/05

MATERIALS AND METHODS

This research was conducted at the private shrimp farm in Bansang district, Prachinburi province that comprised four, 3 rai reservoirs and six, 2.5 rai rearing ponds which were three earthen ponds and three high-density polyethylene lined ponds. An average depth of all the ponds was 1.50 m.

Pond preparation

Before culturing, all ponds were cleaned by plowing and adjusted for suitable bottom level. Lime ($CaCO_3$) was applied at a rate of 200 kg/rai in two ponds, while the other two ponds were lined with 0.15 mm thick high-density polyethylene sheet on the bottom and dikes. The pond water was adjusted to a salinity of 5 ppt and an application of 1 mg/l Trichlorfon removed the disease carriers such as shrimp and crab. One week later, 15 kg of molass and 20 l of superphosphate fertilizer was applied in each pond in order to promote plankton bloom.

Larval stocking

Prior to stocking, post larvae 15 (PL 15) proved free from Taura syndrome virus (TSV) and infectious hypodermal and hematopoietic necrosis virus (IHHNV) using polymerase chain reaction (PCR) technique. PL 15 were stocked at a density of 75 PL/m^2 or 120,000 PL/rai and fed a 35% protein of feed. Feed was applied four times a day and feed quantity was adjusted following Chanratchakool's method (Chanratchakool *et al*., 1994).

Aeration and water exchange

Four long-armed paddlewheel aerators and two spiral type aerators were used in each pond. The aerators were powered by four, 11 hp diesel motors, and water exchange was started after 50 days of culture period. Water exchange was done at around 10% of pond water volume every week.

Water quality analysis

Water quality parameters i.e. temperature, pH and dissolved oxygen were monitored twice (6.30-7.00 and 14.00-15.00) everyday using thermometer, pH meter (ORION Model sa520, USA) and Do Meter (YSI model 51B, USA), respectively. Water salinity, alkalinity, hardness, total ammonia-nitrogen, nitrite-nitrogen, total suspended solids and chlorophyll a were measured every week. Water salinity and conductivity were measured with a salinometer (YSI 30/10 FT, USA). Alkalinity and hardness were tested using the Strickland and Parsons (1972) method. Total suspended solids and chlorophyll a were done following standard methods (APHA *et al*., 1992).

Plankton Abundance and Identification

Four liter of water samples were collected from each experimental pond at 30 cm depth of 2 two opposite positions at 11.00 am. Water was mixed and filtrated through a 20 μ plankton net. Then water sample was kept in a 250 ml plastic bottle and preserved with 4% formalin. Plankton identification was done following the Shirota (1996), Wongrat (1998) and Wongrat (1999) using Sedwick-Rafter counting cell.

Data analysis

Means and standard deviations of production, body weight gain, FCR, survival rate, production costs, water quality parameters and the amounts of plankton were calculated. Differences ($P<0.05$) between the two types of ponds were analyzed using the T-test.

RESULTS

The average growth rate of shrimp in the polyethylene-lined ponds was 0.24±0.08 g/day compared to 0.19±0.04 g/day in the earthen ponds. After 77 days of culturing, shrimp in the polyethylene-lined ponds grew significantly faster

than that in the earthen ponds (P<0.05) (Figure 1). Table 1 shows that an average weight of the shrimp in the polyethylene-lined ponds was 23.04±1.83 g, while an average weight of the shrimp in the earthen ponds was 18.93±1.52 g. After 112 days, the shrimp were harvested. An average yield of the earthen ponds was 1,470.8±61.7 kg/rai. An average yield in the polyethylene-lined ponds was 1,737.5±208.6 kg/rai.

Average total production costs were 178,477 and 210,210 Baht/rai in culturing in earthen ponds and ponds lined with polyethylene, respectively. However, the average net return was 74,900 and 138,765 Baht/rai cultured in earthen ponds and ponds lined with polyethylene, respectively (Table 2).

Most of water quality parameters between the two types of ponds were not significantly different (P>0.05) except for total ammonia nitrogen and total suspended solids of earthen ponds which were significantly higher (P<0.05), and abundance of plankton were significantly lower (P<0.05) than those in the ponds lined with polyethylene (Table 3). Genera of plankton frequently found in both types of ponds during culture period were *Merismopedia*, *Chroococcus*, *Nephryocytium*, *Oocystis*, *Scenesdesmus*, *Cyclotella* and *Nitzschia.*

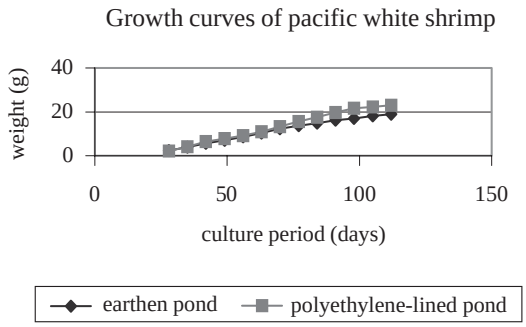

Figure 1 Comparison of pacific white shrimp growth curves between rearing in earthen ponds and high-density polyethylene (HDPE) lined ponds.

Table 1 Production of rearing pacific white shrimp in earthen ponds and ponds lined with polyethylene.

Pond	Production (kg/rai)	Average final body weight (g)	FCR	Survival rate (%)
Earthen	1,470.7±61.7	18.9±1.1	1.59±0.78	65.1±7.9
HDPE Lined	1,737.5±208.6	23.0±2.4	1.46±0.13	62.7±2.4

Table 2 Costs and benefit return of rearing pacific white shrimp in earthen ponds and ponds lined with polyethylene.

Unit : Bath/rai

Item	Earthen pond	HDPE lined pond
Production costs		
Larva	30,000	30,000
Fuel	27,059	27,059
Labor	32,000	32,000
Feed	46,834	47,192
Chemicals	29,312	31,526
Maintenance and others	13,272	12,433
Polyethylene sheets and installation		30,000
Total production cost	178,477	210,210
Return	253,377	348,975
Net profit	74,900	138,765

Table 3 Water quality of rearing pacific white shrimp in earthen ponds and ponds lined with polyethylene.

Parameter	Mean ± S.D.	
	Earthen pond	HDPE lined pond
Temperature (°C)		
Morning	29.5 ± 0.9	30.0 ± 0.8
Afternoon	30.7 ± 1.0	31.3 ± 1.1
pH		
Morning	7.7 ± 0.1	7.7 ± 0.1
Afternoon	8.1 ± 2.1	8.3 ± 0.1
Dissolved oxygen (mg/l)		
Morning	4.8 ± 0.7	4.8 ± 0.8
Afternoon	5.9 ± 1.1	6.3 ± 0.8
Salinity (ppt)	4.4 ± 1.0	3.7 ± 0.9
Conductivity (mmhos/cm)	8.1 ± 1.9	6.9 ± 1.6
Alkalinity (mg/l)	142.8 ± 30.3	134.1 ± 28.5
Total ammonia-nitrogen (mg/l)*	0.44 ± 0.40	0.35 ± 0.20
Nitrite-nitrogen (mg/l)	0.61 ± 0.60	0.74 ± 0.64
Hardness (mg/l)	1,113.8 ± 215.1	947.3 ± 224.5
Total suspended solids (mg/l)*	262.0 ± 197.0	98.6 ± 36.0
Chlorophyll a (mg/l)	218.4 ± 137.4	285.3 ± 144.5
Plankton (cell/l)*	$2.6\times10^6 \pm 2.5\times10^6$	$1.6\times10^7 \pm 3.6\times10^4$

* It is significantly different at $P<0.05$ between two types of pond

DISCUSSION

The average total ammonia nitrogen was high in earthen ponds with some shrimp mortalities (10% of total number) during the 5^{th}- 9^{th} week of culturing. High total suspended solids in earthen ponds was due to high erosion associated with aeration and rain. The result of less plankton in the earthen ponds was a consequence of high total suspended solids and therefore limited light penetration for photosynthesis (Boyd, 1990). Moss (1995) revealed that *L. vannamei* grew 1.5 to 1.9 times faster if the water had a high algae content, compared to clean water. A high level of ammonia-nitrogen and a low level of natural nutrient were a major cause of lower production in earthen ponds compared to lined ponds. This present study result is similar to the study of Moss (1995) and Pruder *et al.* (1992), who reported that *L. vannamei* juveniles performed better in plastic lined ponds, compared to earth bottom ponds. This was probably because *P. monodon* spent more time digging and foraging for food in the pond bottom (Motoh, 1981), while *L. vannamei* was not a burrowing species (Wassenberg and Hill, 1994), they usually roamed to whole area of pond to capture the feed (Boddeke, 1983).

CONCLUSION

Ponds lined with polyethylene could obtain high production and could be applied in areas of high porosity, sand and mineral acid soil. They also showed low levels of total ammonia-nitrogen and abundance of plankton. However, it is not necessary for the areas having high clay content (>40% of clay) as lining pond with polyethylene is rather costly, which is estimated at 30,000 Baht/rai.

ACKNOWLEDGEMENTS

Authors would like to thank the Thai National Research Institute for supporting the fund.

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