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THE PERFORMANCE OF BIO-FILTER ON THE PRODUCTION AND DISEASE INCIDENCE OF PRAWN *(PENAEUS MONODON FAB.)*

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ABSTRACT

It has been long known that the most potent factor that influences prawn production was unfavorable environment due to industrial, agriculture and habitat wastes as well as improper application of good husbandry management. This research was designed to study the effect of biological filter on the growth of tiger prawn, water quality, and disease incidence. Two sets of experiments, namely field study and laboratory experiment were conducted . Field survey was carried out to collect field data on actual husbandry practices, production, water and soil quality. Laboratory experiment was aimed at evaluating the effectiveness of biological filter and disease incidence. Juvenile prawn e (± 5 gr.) at a density of 15 animals/M^2; 20 animals/M^2, and 25 animals/M^2 were used as experimental animals. The observed parameters were field productivity, growth, survival rate, water quality, bacterial counts, soil quality and disease incidence. Experiments were carried in 3 replicates.

Field survey showed that prawn production decreased steeply at the third production cycle as low as 627.65 kg/Ha compared to the first cycle (1893.28 kg/Ha). Most prawn were weak, and very vulnerable to diseases. Bacterial count was more than 10^5cfu/ml. Water quality rapidly declined as prawn grew especially during the second and third cycles.

Laboratory experiment with biological filter in contrast demonstrated better water quality and healthier prawn,. although water quality declined slightly along with both the age and density. The growth rate was better than during field trials; among three treatments there were significant differences; the survival rate was best at density of 15 animals/M2 but, the best estimated production was reached by density of 20 animals/M2 producing 2645 kg/Ha/cycle without any problems for around 4 cycles. Disease incidence and parasites infestation was undetected in the tank during the experiment.

Keywords: Prawn, Production, Biological filter, and Disease incidence

I. INTRODUCTION

Prawn world production reported that in 1990 Indonesia became the second largest prawn producer in the world with a product of more than 120 thousand tons (Prayitno, 1994a). Unfortunately this achievement did not last long. Production declined steeply since then to less than 50 thousand tons in 1998. That failure of prawn harvest has brought about a significant decrease on the local and national income. As a result, many brackish water ponds (tambaks} were closed down and many fish farmers were out of business. The two most potent causes of the failure were unfavorable environment and bad husbandry management. Unfavorable environment could originate from industrial, agriculture and habitant wastes as well as improper application of good husbandry management (Prayitno, 1994b). Mass failure of production due to disease outbreaks in Indonesia have been reported by many researchers, and they indicated that virus, bacterial, and parasites infestation as well as fouling organisms were the major causes (Nurjana et al, 1977; Lightner, 1985; Poernomo, 1985; Dana and Sukenda, 1990).

This research was designed to investigate the major causes of environmental deterioration, poor growth rate, and disease incidence by the application of a biological filter.

II. MATERIAL AND METHODS

Research was conducted in two steps, firstly field survey and secondly laboratory experiments. Field survey was carried out at semi-intensive tambaks around Pidodo Village, Cepiring, Kendal District, Central Java. Stocking density at the surveyed ponds was 15- 20 animal/M^2. Analysis of water quality, plankton and benthic quality as well as bacterial count were done at three points, namely at the time when the tambaks were just about to be stocked with prawn seeds; when the prawns were 2 months old and on harvest day (4 months).

Application of the biological filter was carried out at the laboratory. The biological filter consisted of seaweed and green mussel (1 tons/Ha each), Oreochromis niloticus 10,000 fish/Ha. Those filters were applied to the experimental tanks with 3 (three) different treatments which were 15 animals/M^2, 20 animals/M^2, and 25 animals/M^2 . Parameters observed were survival rate, prawn production, water quality, and disease incidence. Experiment was carried out in 3 replicates, 3 cycles for 2 months each.

III. RESULTS AND DISCUSSION

3.1. Field Survey

Results of field survey showed that prawn density used by farmers at the sample area were 15, 20, and 25 /m^2. With three production cycles per year, the survival rate of prawn during the cycles was different markedly according to the density, and tended to decrease sharply in the third production cycle compared to the first cycle (table 1). This trend was also demonstrated in the prawn production. Good husbandry practices were able to produce 1,894.7 kg (SD 20) but conversely it could decline as low as 703.8 kg (SD 25). This indicates that experimental ponds were unable to maintain their capacity. Deterioration of water quality due to wastes of uneaten food, and feces might be the main causes.

Table 1. Survival rate and production of prawn in brackish water ponds at Pidodo village per production cycle

No	Density Per m^2	1st cycle		2nd cycle		3rd cycle		Mean	
		SR (%)	Prod (kg)	SR (%)	Prod (kg)	SR (%)	Prod (kg)	SR (%)	Prod. (kg)
1	15	65.43	1,668.9	48.96	1,101.6	38.33	804.9	50.24	1,191.8
2	20	67.67	1.894.7	43.24	1,124.2	34.12	722.8	48.34	1,247.2
3	25	50.20	1.506.9	40.39	1,211.7	23.46	703.8	39.02	1,140.8

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The table shows that the density of 15 prawn/m^2 gave a higher survival rate than the rest at all cycles and the highest was obtained at the first cycle. (67.67%). On the other hand , a density of 25 animals/M^2 gave the lowest survival rate at all cycles. Prawn survival was within the critical stage in all three densities during the second cycle (about 45 %). It seemed that 15 prawn/m^1 is the right density for 'semi intensive 'tambak' in Pidodo Village, although it was recorded that the mean total harvest/year was highest (1,247.2 kg) at the density of 20 animals/M^2. Unfortunately, production yielding those figures only occurred once, and declined significantly in the following year.

Density, therefore, is one of the triggering factors in disease occurrence in semi-intensive and intensive culture due to accumulation of waste products and uneaten feed (Plumb, 1994). Therefore, carrying capacity and technology being used should be considered before the density is set.

Most prawn observed at the third cycle had poor growth rate, weak and very vulnerable to disease. Organoleptic observation showed that many prawns were infected by fouling organism, broken setae, tail erosion (table 2). The presence of fouling organism in prawn is an indication of the height of organic matter at the bottom of the pond (Prayitno, 1994b).

Table 2. Parasites and fouling organism found in tambaks

Parameter	1st cycle	2nd cycle	3rd cycle
Fouling org.	+	++	+++
Parasites	-	+	+
Abnormalities	-	+	+

Water quality in tambaks during one cycle (4 months) is presented in table 3. Deterioration of water quality occurred in tambaks after 4 months of grow out period (1 cycle). By this time bacterial count increased significantly. Accumulation of uneaten food and fecal wastes produced load of organic matter in the water and in turn becomes stressor for prawn. Organic matter also consumed oxygen that is essential for prawn survival (Plumb,1994). The high numbers of prawn infected by parasites and fouling organism demonstrated that transmission of disease easily occurred in more crowded population (Chanratchakool et al, 1994).

Table 3. Water quality measurement in tambaks (mean value) during one cycle (4 months) culture period

Parameters	Units	Culture period (Month)		
		0	2	4
DO	ppm	5.2	4.32	4.51
PH	-	7.1	6.5	6.4
COD	ppm	20.8	96.12	101.3
BOD_5	ppm	8.2	63.15	83.22
H_2S	ppm	0.0010	0.0020	0.0031
Nitrite	ppm	0.0068	0.0115	0.0113
Nitrate	ppm	0.3211	0.1334	0.1411
Ammonia	ppm	0.0008	0.0013	0.0022
Tot. Bact.	Cfu / mL	1.28×10^4	2.20×10^5	1.78×10^6
Tot. Vibrio	Cfu / mL	1.47×10^6	2.15×10^6	1.16×10^7

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The low survival rate during the third cycle, especially at density 25 animals/M^2 is in line with water quality profile at the 4-month culture period. This caused stress to prawn, induced poor growth rates, and increased susceptibility to pathogens (Chanrat-chakool et al, 1994).

3.2. Laboratory Experiment

The survival and growth rate of prawn cultured in concrete tanks with the application of bio-filter is presented in table 4.

Table 4. Survival rate (%) and Production of tiger prawn (kg) cultured in concrete tanks with biological filter

No	Density Per m^2	1st cycle		2nd cycle		3rd cycle		Mean	
		SR (%)	Prod (kg)	SR (%)	Prod (kg)	SR (%)	Prod (kg)	SR* (%)	Prod.* (kg)
1	15	76.67	2,300	70.00	2,205	76.67	2,415	74.46a	2,307a
2	20	65.00	2,600	65.00	2,535	70.00	2.800	66.67b	2,645b
3	25	48.00	2,160	44.00	2,090	44.00	2,035	45.33c	2,095a

Note: (*) different letter showed significant difference ($P<0.05$)

Table-4 showed that survival rate tends to decrease as the density increases. The highest survival was obtained at the density of 15 prawn/m^2. While the lowest was obtained at the density of 25 prawn / m^2. However, calculated production was highest at the density of 20 animals/M^2. This was due to the mean individual weight reached at both densities : at 15 and 20 animals/M^2 they were similar (20 gr.). When the survival rate of prawn in tambaks was compared to experimental tanks, it was clear that application of the biological filter increased survival rate significantly. However, a density of 25 animals/m^2 produced least survival at both cultured media.

Overall water quality measurement demonstrated that most parameters were within the ideal level. Moreover, within the 3 cycles the water quality was relatively stable (table-5). This indicated that the bio-filter was able to maintain organic loading from feces and uneaten food. Seaweed and mussel have proved to be instrumental in reducing organic matter and heavy metal that frequently disturb prawn culture (Prayitno, 1994b).

Total bacterial count at tambaks (1.28 10^4 – 1.78 10^6) was lower compared to experimental tanks (1.6 – 3.2 10^7) but, most of the prawn were much healthier than those from the tambaks. This indicated that bacterial numbers in experimental tanks was non-pathogenic bacteria. This trend was also shown for vibrios. Consequently, a disease outbreak was not detected.

Table 5. Mean Water quality measurement in experimental tanks (3 cycle)

Parameters	Units	Culture period (Month)	
		0	2
DO	Ppm	5.67	5.07
pH	-	8.3	7.8
COD	Ppm	4.8	4.8
BOD$_5$	Ppm	14.09	18.24
H_2S	Ppm	Nd	0.001
Nitrite	Ppm	Nd	0.003
Nitrate	Ppm	0.003	0.007
Ammonia	Ppm	0.002	0.004
Total Bact.	Cfu / mL	1.6 10^7	2.7 10^7
Total Vibrio	Cfu / mL	1.4 10^5	1.7 10^6

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The individual weight gain of prawn cultured in bio-filter tanks showed no significant difference between density of 15 animals/m^2 (7.17 gr.), 20 animals/m2 (7.47 gr.), and 25 animals/m^2 (7.13 gr.). The density of 20 animals/m^2 produced the highest individual weight gain. This might be due to more space, as the survival rate was lower than that of prawn kept at a density of 15 animals/m^2. Although the survival rate of animals cultured at 15 animals/m^2 was significantly higher than others, the biomass of prawn was lower (174.4 gr.) compared to that kept at a density of 20 animals/m2 (189.14 gr.). On the other hand, the smart performance of individual prawn at a density of 20 animals/m^2 (7.13 gr.) was unable to significantly increase biomass due to poor survival rate.

The mean individual weight gain data in table 6 were higher when they were compared to standard weight gain presented by Thailand's fish farmer (6.3 gr. for 56 days old) (Chanratchakool et al, 1994). This result indicated that bio-filter stimulated an environment that are able to indirectly enhance growth rate.

Table 6. Biomass and individual growth (g) of prawn cultured in tanks with biological filter.

Parameters	Shrimp Density /M^2		
	15	20	25
Biomass	174.4	189.14	161.5
Invidual growth	7.17	7.47	7.13

Parasites/ectocommensals and fouling organism such as Epstylis, Zoothamnium, Thymascar, Cephalolobus and fungi were not detected. This means that the water quality during the culture period was within normal range, since poor water frequently provides more nutrients to fouling organisms and therefore encourages their growth on prawn. Healthy prawn will regularly clean fouling organism themselves and any persistent fouling will be removed when they molt (Chanratchakool et al, 1994).

Abnormalities such as broken legs, poor growth rate, soft skin, bluish color were not present during observation. This also indicated that no toxic substances, and nutrient deficiency were recorded during the experiment.

Overall experiments expressed that an application of biological filter was able to maintain water quality within ideal range up to three cycles. For the semi-intensive scale, the safest stocking density was 15 animals/m2, producing a survival rate of more than 80%. However, in terms of total harvest, a density of 20 animals/m^2 was the highest. From this research it can be concluded that an application of bio-filter will produce better water quality and in turn will enhance growth rate, survival rate, and finally produced best quality of prawn. By using those densities and technology prawn was much healthier and disease outbreaks are reduced. Biofilter is then highly recommended for brackish-water ponds on a semi-intensive scale.

IV. CONCLUSION

From this research it can be concluded that:

1. Biofilter significantly maintains better water quality for 3 cycles without any significant differences.
2. The survival rate of tiger prawn cultured with bio-filter was higher than those kept in tambaks.
3. The survival rate at the density of 15 animals/M2 was the best; however, estimated highest production was reached from a density of 20 animals/M2.
4. During the experiment parasites and disease infestation was not detected in the tanks.

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