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Effects of AquaMats™ on Growth of Nile Tilapia (*Oreochromis niloticus*) Fry in Earthen Ponds at AIT, Thailand

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ABSTRACT. *This study was conducted to assess the effects of AquaMats™ on growth and yield performance of Nile tilapia (Oreochromis niloticus) fry in earthen ponds at the Asian Institute of Technology, Thailand during January to April 2001. There were four treatment combinations with three replicates each: i.e., Non-feeding without AquaMats™; Non-feeding with AquaMats™; Feeding without AquaMats™ and Feeding with AquaMats™. The experiment was carried out in 12, 330 m^2 ponds with a randomized complete block design. All-male Nile tilapia fry between 1.58-1.73 g in size were stocked at 30.3 fish m^{-2} in all ponds, which were fertilized weekly with urea and triple super phosphate at rates of 28 kg nitrogen and 7 kg phosphorus per hectare per week. Fry in the two treatments with supplemental feeding were given commercial pelleted feed (AT feed, 35% crude protein, Cargills Co. Ltd., Thailand) at 30, 6.5, 6, 4.4 and 4.2% body weight per day during the days 15-28, 29-42, 43-56, 57-70 and 71-90 after fish stocking. There were no significant interactions between feeding and AquaMats™ ($P>0.05$). Growth performance in feeding treatments was significantly higher than that in the non-feeding treatments ($P<0.05$). In both feeding and non-feeding treatments, growth performance was not significantly different between the treatments with and without AquaMats™ ($P>0.05$). However, there was no significant difference in yields between the treatments with and without AquaMats™ in non-feeding ponds ($P>0.05$), while yields were significantly higher in the treatment without AquaMats™ than that in the treatment with AquaMats™ in feeding ponds ($P<0.05$). The present experiment indicated that AquaMats™ did not enhance the growth and yield performance of Nile tilapia fry, in earthen ponds due to inactivity of the AquaMats™.*

INTRODUCTION

Nile tilapia (*Oreochromis niloticus*) is a fish suitable for farming because it is generally hard, easy to breed, rapid in growth, efficient in converting organic and domestic wastes into high quality protein and good in taste (Stickney, 1986). Culture of Nile tilapia is commonly done worldwide in semi-intensive systems with fertilization. Additionally, feed may be provided for part or all of a grow-out to increase carrying capacity and growth of fish (Diana *et al.*, 1997). However, as the feed costs are very high, farmers tend to fertilize their ponds and to utilize natural foods at their maximum capacity. Traditionally, phytoplankton is considered very important as the basis of natural fish feed production, through both autotrophic and heterotrophic pond webs. A recent research has shown that periphyton has the same functions of oxygenation and feed production as phytoplankton, but may be more stable and can be utilized more efficiently by fish (Van Dam *et al.*, 2001).

However, periphyton requires hard substrates for attachment, which are usually absent in fish ponds.

Periphyton growth can be promoted by introducing substrates such as tree branches, bamboo poles, plastic baffles, sugarcane bagasse, paddy straw and dried *Eichhornea* (Shrestha and Knud-Hansen, 1994; Ramesh *et al.*, 1999). At low fertilizer inputs and primary productivities, the addition of substrates may increase net fish yield by providing more concentrated packages of algal and detrital biomass on substrate surfaces (Shretha and Knud-Hansen, 1994; Ramesh *et al.*, 1999). One of the commercial applications of periphyton is AquaMats™, produced by Meridian Applied Technology systems, USA, which claims that the use of AquaMats™ in tilapia culture may reduce feed cost by 50%. According to Van Dam *et al.* (2001) even though the results are mixed, there seems to be a potential for using periphyton substrates in aquaculture to increase fish yields.

AquaMats™ can be positioned in a pond, tank or race way to enhance the natural food production, and thus increase fish yield. On the other hand, AquaMats™ reduces the production cost, improves the immune system, provides shelter, acts as a bio-filter, increases dissolved oxygen (DO) in water without aeration, and increases stocking density of fish (Anonymous, 1999). Furthermore AquaMats™ provide a flexible, eco-friendly way of increasing fish yield (Anonymous, 1999). Because of these features AquaMats™ may be beneficial for Nile tilapia fry production.

The overall objective of this study was to identify the suitability of AquaMats™ in earthen ponds. The specific objective of the study was to assess effects of AquaMats™ on the growth performance and survival of Nile tilapia fry.

MATERIALS AND METHODS

Experimental design and duration

The experiment was conducted in a randomized complete block design with a 2×2 factorial arrangement to test effects of AquaMats™ on the growth of Nile tilapia fry in fertilized ponds with and without supplemental feeding, during January 2001 - April 2001. There were four treatment combinations with three replicates each: (a) no AquaMats™ installed in fertilized ponds without feeding; (b) no AquaMats™ installed in fertilized ponds with feeding; (c) AquaMats™ installed in fertilized ponds without feeding; (d) AquaMats™ installed in fertilized ponds with feeding. Experimental ponds were blocked into three based on the variability of the location, and treatments were randomly allocated to the ponds in each block.

Experimental ponds and fish

Twelve earthen ponds of approximately 330 m^2 in surface area at the Asian Institute of Technology (AIT) were used in the experiment. A walkway was extended from the pond bank to the center of each pond for taking water samples and feeding. A marked wooden pole was placed in each pond for measuring the water level throughout the experiment.

Nile tilapia used in this experiment was Chitralada strain. All-male Nile tilapia fry were produced using 17 α-methyltestosterone at AIT Tilapia Hatchery. Fry with body weight ranging 1.58 - 1.73 g, were stocked at 30.3 fish m^{-2} in all the ponds to have 10,000 fish per each pond.

AquaMats™ and nutrient inputs

AquaMats™ (Meridian Applied Technology Systems Ltd., USA) were 2 m^2 (1×2 m) in area. Eight pieces of AquaMats™ were vertically suspended in two rows apart equally in each AquaMats™ treatment ponds. A sand bag was hung at the lower corner of each piece of AquaMats™ to swing it around the heavy end.

Fertilizers

All ponds were fertilized weekly with urea and triple super phosphate (TSP) at the rates of 28 kg N and 7 kg P ha^{-1} $week^{-1}$ (2.26 kg urea and 1.4 kg TSP $pond^{-1}$ $week^{-1}$). Initial fertilization took place one week prior to fish stocking. Both fertilizers were mixed with pond water, soaked overnight and spread over ponds at 0900-1000 h of the following day.

Feed

Tilapia in the two treatments which received supplemental feeding were given a commercial pelleted feed (AT feed, 35% crude protein, Cargills Co. Ltd, Thailand) at 30, 6.5, 6, 4.4 and 4.2% body weight day^{-1} (BW day^{-1}) during the days 15-28, 29-42, 43-56, 57-70 and 71-90, respectively as described (Appendix 1). The feed ration was adjusted biweekly based on fish standing crop, which was estimated using the sample weight, assuming 100% survival. Tilapia were fed twice daily at 0930-1030 h and 1630-1730 h.

Pond management

Prior to the start of the experiment, all ponds were drained completely, dried for one week, and filled with canal water. Water depths in all ponds were maintained at approximately 100 cm by adding water weekly to replace water loss due to evaporation and seepage.

Sodium bicarbonate ($NaHCO_3$) was added weekly to attain and maintain the minimum total alkalinity at 75 mg l^{-1} as $CaCO_3$, based on weekly measurement of total alkalinity in pond water.

Analytical methods

Fish growth performance

During the experiment, approximately 2% (200 fish pond^{-1}) of the initially stocked tilapia were seined, counted and bulk-weighed biweekly for each pond. A weighing scale of 0.01 kg sensitivity was used to determine the bulk weight. At stocking and harvesting, 50 fish were randomly sampled from each pond to determine individual weight and measured total length using the above weighing scale and a measuring board, respectively. Fish biomass on the sampling dates was estimated based on the measured mean fish weight and the number of fish surviving. It was assumed that all mortality of Nile tilapia fry occurred at the beginning of the experiment because no mortality was observed during the culture period. At the end of the experiment the other species present in the ponds were also observed.

Parameters related to the tilapia growth and yield performance were calculated using the following methods:

$$\text{Mean daily weight gain } (g\ fish^{-1}\ day^{-1}) = \frac{\text{Final mean weight } (g) - \text{Initial mean weight } (g)}{\text{Culture period } (days)} \quad (1)$$

$$\text{Survival rate } (\%) = \frac{\text{No. of fish at harvest}}{\text{No. of fish at stocking}} \times 100 \quad (2)$$

$$\text{Extrapolated net fish yield } (kg\ ha^{-1}\ crop^{-1}) = \frac{[\text{Final total wt. of fish } (kg) - \text{Initial total wt. of fish } (kg)]}{\text{Surface area } (m^2)} \times 10000 \quad (3)$$

$$\text{Extrapolated net fish yield } (kg\ ha^{-1}\ day^{-1}) = \frac{[\text{Final total wt. of fish } (kg) - \text{Initial total wt. of fish } (kg)]}{\text{Surface area } (m^2) \times \text{Culture period } (day)} \times 10000 \quad (4)$$

$$\text{Extrapolated gross fish yield } (kg\ ha^{-1} crop^{-1}) = \frac{\text{Final total wt. of fish } (kg)}{\text{Surface area } (m^2)} \times 10000 \quad (5)$$

$$\text{Feed conversion ratio } (FCR) = \frac{\text{Wet weight of feed given } (kg)}{\text{Wet weight gained by fish } (kg)} \quad (6)$$

Statistical analysis

Data were analysed statistically using three-way ANOVA and Least Significant Difference (LSD) test with SPSS (version 9.0) statistical software package (SPSS Inc., Chicago, USA). Differences were considered significant at an alpha of 0.05. All means were given with ± standard error (SE).

RESULTS AND DISCUSSION

Growth performance of Nile tilapia fry

At harvest, snakehead (*Channa striata*) were found in one replicate of non-feeding without AquaMats™ and feeding with AquaMats™ treated ponds causing extremely high mortality (99 and 81%, respectively). Thus, the data presented for those two treatments were based on only two replicates.

There were no significant interactions (P=0.05) found between feeding and AquaMats™. Therefore, only the major effects were discussed. Significant differences (P<0.05) in the final mean weight of Nile tilapia fry were observed among treatments (Table 1). Growth of Nile tilapia fry was similar among treatments during the first two weeks, and the growth differential started after feeding initiated on the day 14, between the feeding and non-feeding treatments (Fig. 1). In non-feeding ponds, growth differential started during days 14-28 with higher mean weight in the treatment without AquaMats™ than the treatment with AquaMats™ and the pattern continued until harvest (Fig. 1). Growth between with and without AquaMats™ treatments in feeding ponds was slow but similar during the first 42 days, and was linearly rapid until day 70, beyond which the growth in the treatment without AquaMats™ continued to be linear until harvest, while the growth in the treatment with AquaMats™ almost ceased (Fig. 1). Growth performance in feeding treatments was significantly higher (P<0.05) than that in the non-feeding treatments. In both feeding and non-feeding ponds, growth performance was not significantly different (P>0.05) between the treatments with and without AquaMats™ (Table 1). Results showed that AquaMats™ had no significant effects (P>0.05) on the growth performance of Nile tilapia fry in both feeding and non-feeding ponds (Table 1). The lowest survival was obtained in the treatment of feeding with AquaMats™, which was significantly lower (P<0.05) than those of feeding without AquaMats™ and non-feeding with AquaMats™, but not significantly different (P>0.05) from that of non-feeding without AquaMats™ (Table 1). Survival among the latter three was not significantly different (P>0.05).

The highest yields were achieved in the treatment of feeding without AquaMats™ (Table 1). Yields were significantly higher (P<0.05) in the feeding ponds than non-feeding ponds. In non-feeding ponds, there was no significant difference (P>0.05) in yields between the treatments with and without AquaMats™, while in the feeding ponds yields were significantly higher (P<0.05) in the treatment without AquaMats™ than that in with AquaMats™. At the end of the experimental period AquaMats™, in all ponds were fully covered with mud particles. This might be due to the attraction of clay particles by AquaMats™.

Table 1. **Growth performance of Nile tilapia fry during the 90 day culture period.**

Performance measures		Non-feeding		Feeding	
		No AquaMats	AquaMats	No AquaMats	AquaMats
At stocking					
Initial total weight	g pond^{-1}	1.6 ± 0.1	1.6 ± 0.1	1.7 ± 0.1	1.6 ± 0.0
Mean weight	g fish^{-1}	0.16 ± 0.01	0.16 ± 0.01	0.17 ± 0.01	0.16 ± 0.01
At harvest					
Final total weight	kg pond^{-1}	22.1 ± 5.8^{a}	17.7 ± 4.50^{a}	141.5 ± 23.5^{c}	86.0±11.3^{b}
Mean weight	g fish^{-1}	5.5 ± 0.5^{a}	4.3 ± 1.3^{a}	33.6 ± 5.8^{b}	25.8±0.2^{b}
Net yield	g pond^{-1}	20.5 ± 5.7^{a}	16.1 ± 4.5^{a}	139.8 ± 23.6^{c}	84.4±11.3^{b}
Extrapolated net yield	g ha^{-1} day^{-1}	6.9 ± 1.9^{a}	5.4±1.5^{a}	47.1 ± 7.9^{c}	28.4±3.8^{b}
Extrapolated gross yield	g ha^{-1} day^{-1}	7.4 ± 1.9^{a}	5.9±1.5^{a}	47.6 ± 7.9^{c}	28.9±3.8^{b}
Survival	(%)	39.0 ± 6.9^{ab}	42.5±4.5^{b}	42.2 ± 2.6^{b}	33.2±4.1^{a}
FCR		-	-	2.5 ± 0.5^{a}	4.2±0.4^{b}

Density (fish m^{-1}) and total no. of fish (fish pond^{-1}) were maintained at 30.3 and 10,000, respectively

Mean values with different superscript letters in the same row were significantly different at $P<0.05$

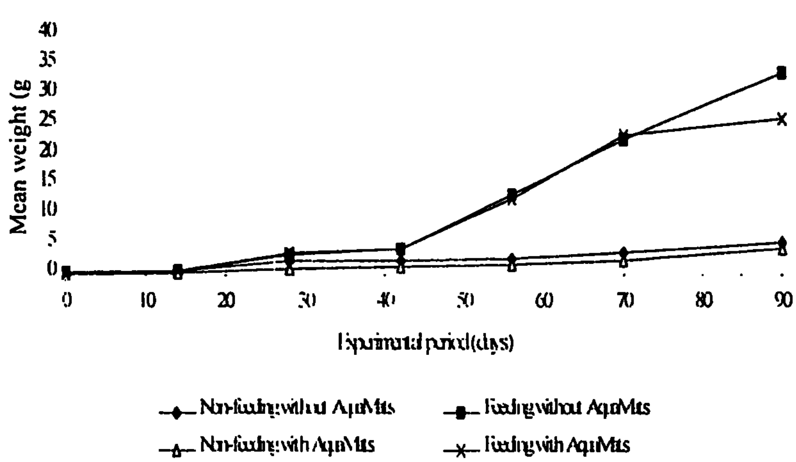

Fig 1. **Growth of Nile tilapia fry in treatments over 90-day culture period.**

Fish sampling done biweekly by seining half of the pond and due to that resuspension of bottom muds took place frequently. At the same time tilapia grazing and movements caused mud turbidity in the ponds. It is hypothesized that the activity of AquaMats™ retarded as a result of clogging of the surface area by mud particles.

AquaMats™ would be effectively used for shrimp as they do not have grazing habit, and also in tanks and ponds with sand bottom. Feeds in excess in both feeding treatments resulted higher FCR values due to the low survival of Nile tilapia fry.

Many substrate based experiments achieved higher fish survival and growth performance of cultured fish species (Ramesh *et al.*, 1999; Keshavanath *et al.*, 2001). However, Shrestha and Knud-Hansen (1994) using plastic baffles and bamboo poles as substrates, could not achieve increment in the net yield of tilapia. According to those observations, it appears that easily biodegradable substrates are better, in terms of promoting bacterial biofilm formation and enhancing the biomass of attached microorganisms (Ramesh *et al.*, 1999).

CONCLUSIONS

Results of the study revealed that addition of AquaMats™ neither enhance growth performance of Nile tilapia fry cultured nor increase yields of Nile tilapia fry cultured in non-feeding earthen ponds. Addition of AquaMats™ can even reduce yields and survival of Nile tilapia fry cultured in feeding earthen ponds.

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APPENDICES

Appendix 1. Feeding guidelines for Tilapia.

Fish size (g fish^{-1})	Amount of feed (% body weight day^{-1})
0.3	11.4
0.4	10.8
0.5	10.2
0.6	9.6
0.7	9.1
0.9	8.6
1.1	8.2
1.4	7.7
1.8	7.3
2.2	6.9
2.8	6.5
3.5	6.2
4.4	5.8
5.5	5.5
6.8	5.2
8.5	4.9
11.0	4.7
13.0	4.4
17.0	4.2
21.0	4.2
26.0	4.0
33.0	3.8

Source: Anon. 1999.