EFFECTS OF OVER-WINTERING AND WATER DEPTH ON GROWTH PERFORMANCE OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*)

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Abstract

The experiment aimed to study the effects of over-wintering and water depth on growth performance and survival rate Of Nile tilapia (*Oreochromis niloticus*) in concrete ponds. Fish were divided into 3 groups with covered different system of polyethylene sheet as 100% covered, 75% covered and use dried plant, then each group are divided to three water depths i.e. 0.75, 100, or 1.50 cm for 150 days. Fish were fed on pelleted commercial feed containing 25% protein with a rate of 10 - 2 % of total biomass according to water temperature. The obtained results can be summaries as follows: (1) The best survival rate and growth performance are showed in group that totally covered by polyethylene sheet (2) Water depth had significant effects on growth performance and survival rate, and (3) Due to decreased temperature at night and increase freeze that increased fish mortality for treatment covered with 75% polyethylene sheet and dried plant. In conclusion, growth performance and survival were significantly affected by pond depth and water temperature. It is recommended to use covered 100% polyethylene sheet, which better way to over-wintering fish reared in concrete pond.

Keywords: Nile tilapia, over-wintering, water depth, survival, growth performance.

INTRODUCTION

Tilapia aquaculture continues to expand worldwide because of key production traits including its resistance to poor water quality, parasites and diseases resistance and its easiness for handling practices. However, most tilapias do not eat or grow at temperatures below 15 °C (Dendy *et al.*, 1979). In general, fish farming is commonly practiced in ponds of about 1 m depth, but there is a wide range of depths in use. Depth is usually determined for reasons related to construction costs, habitat preference of the primary cultured species, or because of management of cohabiting organisms such as phytoplankton, benthos or rooted macrophytes (McLarney 1984). Depth as a factor in pond ecosystem management has been given little attention, despite its theoretical importance in autotrophic (Grobbelaar 1989). The previous studies indicated that ponds should be as shallow as is consistent with the requirements of the cultured animals, if optimal productivity is desired and nutrients are non-limiting. Furthermore, relatively shallow ponds might be favored because deep ponds are more prone to density stratification, which could lead to the depletion of dissolved oxygen (DO). This condition favors the possibility of low dissolved oxygen for the whole pond during night (Boyd 1990 and Chang 1989) threatening the survival of pond fish.

In regard to thermal control, there are several approaches which could be practiced during winter. Out of which, is through the use of supplementary feeding along with special feeding regimes. Pond coverage is another approach which targets to reduce the exposure of fish to winter temperature (Nour 1996 and Diab *et al.*, 2004).

The present study was conducted in concrete tanks to examine the relationship between pond water depth and so water temperature as well as different over-wintering systems in relation to growth performance and survival of Nile tilapia during winter season.

MATERIALS AND METHODS

Fish rearing conditions

This study was carried out at the Central Laboratory for Aquaculture Research, Abbassa, Abou-Hammad, Sharkia, Egypt. Fingerlings of Nile tilapia (*Oreochromis niloticus*) of 3.0±0.5 g were obtained from a private hatchery at Abbassa, Abou-Hammad, Sharkia. Fish were fed on a commercial diet during the preliminary period. Fingerlings were randomly allocated and stocked on the 1st November 2007 at a rate of 500 fish/ponds (5 m long **x** 2 m wide) to the three coverage-systems treatments. At the first and second treatments experiments, the total coverage of ponds by a plastic (polyethylene) sheet; and the 75% coverage by the plastic respectively, while the third treatment tested a total coverage of ponds by dried plants. In regard to water depths, three depths were tested; 75 cm, 100 cm and 150 cm.

The water temperature was 23 °C for first month and has declined gradually afterwards. At the end of the experiment, on the 31st March 2008, fish were harvested, counted and weighed. The different parameters of fish growth and feed utilization were calculated as described by Ahmad *et al.* (2004).

Feed adjusting during the over-wintering

In the first and second month, fish were feed 6 days/week and twice/day at a rate starting at 10% of body weight. Feeding rates were reduced to 5% and again to 2.5% as water temperature declined and so the feeding activities in the third month. In the last month fish were fed during sunny days only. During the first and second months of the experiment, fish were sampled and weight was obtained to the nearest 0.1 g and based on that, feeding allowance has been adjusted accordingly.

Analyses of water quality parameters

Water temperature, dissolved oxygen and pH were measured daily using thermometer and oxygen meter (YSI model 57). Also, pH was determined using a pH meter (Model corning 345). The samplings of phosphorus and ammonia concentrations were carried out bi-weekly according to Boyd (1990).

Statistical analysis

The obtained data were analyzed for analysis of variance by using SAS program (SAS, 1989). Differences between treatments were statistical tested by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Application of treatments

The collected data reflected the severity of the winter season of 2008 in regard to the decline in water temperature compared to previous winter seasons. Because water temperature especially during nights dropped to very low levels as 3-5 °C, (according certificate from General Authority for Meteorology, General Administration of Climate indicated that temperature at January arrived at 1.6 °C on air) and as revealed by field observations, most of fish farms in Egypt experienced a significant fish kill especially farms of earthen ponds or concrete ponds. The exception of this high mortality was in some farms that used house plastic to protect their fish against low temperature. In Abbassa fish farm, all fry stocks in earthen ponds were lost during that winter. In November and December 2008, water temperature was 18 - 20 °C that was suitable to fish growth while during January, February, and March temperature dropped to 10 °C and lower, which is not only not suitable to tilapia growth but also threatening tilapia survival. So, fish mortality started to be observed in most of the experimental ponds. In the ponds totally covered (100%) by plastic sheet, temperature was suitable for fish growth and survival. On other hand, water temperature in treatment covered by dried plants with shallow water was the least efficient one as compared with other treatments.

Fish mortality decreased gradually from shallow water to deep water in all treatments. This result indicates that water contributed to warming pond water. This result is in agreement with EL-Nemaki (1995) who reported that large fish responded faster than small fish when temperature dropped from 20 to 4, 8 and 10 °C. Mortality rate was 100% when tilapia were switched to either 4 °C or 40 °C. On the other hand, when temperatures decrease during January and February, sampling could not be performed for the safety of fish and to avoid sampling stress.

Average water quality parameters of concrete ponds as affected by treatments are presented in Table (1a and b). Results revealed that low temperature in ponds covered by dried plants gave low phytoplankton growth due to weak photosynthesis. For ponds covered totally by plastic, these values are beneficial to tilapia fish culture. Johnson (1986) reported that fish need about 5 mg oxygen/liter or more to avoid stressful conditions. He also mentioned that the tolerable oxygen level is 3 mg/l. the same author cited that the desirable oxygen range is 6.5 to 9.0. Even a pH of 5.5 will allow survival of most freshwater fish species; he postulated that a range of 7.0 to 8.5 is more desirable. Also, the obtained results are in agreement with that of Abdel-Hakim and Moustafa (2000) and Abde-Hakim *et al.* (2004) who worked with Nile tilapia reared in concrete tanks and came to similar results.

Average of dissolved oxygen value (DO) ranged between 5.2 to 6.7 mg/l, which represents the normal range for tilapia fish culture and indicates that water dissolved oxygen slightly decreased in treatments covered by dried plants than other treatments which indicated no photosynthesis in this treatment due to the limitation of the light coming to the ponds. Also, DO was better in tanks covered 75% by plastic sheet than those totally 100% covered. Furthermore, different DO values have been affected by water depth in all tanks. Averages of pH values of tanks are suitable to fish growth in ponds. Also, averages of phosphorous were 0.7 to 1.1 mg/ℓ., which represent the normal range of phosphorus in fish ponds. Also, the same table's shows that average of ammonia were 0.18 to 0.28 mg/L. These values had no adverse effect on tilapia culture.

Fish growth and survival

As presented in Table 2, the growth performances of tilapia have been affected by ponds coverage as well as by water depth. The best growth performance of Nile tilapia was attained in ponds covered totally by plastic sheets. Also, the deep water showed better growth than shallow water. Final weight was 27 g for treatment covered 100% with deep water 150 cm, 25 g for treatment with medium water (100 cm), and 21 g for treatment with shallow water. Fish growth parameters such as finial weight, weight gain, and specific growth rate have generally increased in totally covered ponds and deep water after which the growth rate was markedly decreased in other treatments.

On the other hand, the treatments of 75% coverage by plastic sheets and the coverage by dried plants with different water depths showed increasing fish mortality after two months which coincided with the decrease of water temperatures. These results indicate that the above mentioned systems failed to protect during this particular winter. The low temperature with more space in pond not covered may make more air circulation inside ponds and the hot air went out ponds, which is not saving for temperature inside ponds. Most tilapias neither eat nor grow at temperatures below 15 ^{O}C (Bardech *et al.*, 1972) and do not spawn at temperature below 20 ^{O}C (Rothbard, 1979). Rakocy and Mc Ginty (1989) indicated that the preferred temperature range for optimum tilapia growth is 28-30 ^{O}C, growth diminishes significantly at temperature below 20 ^{O}C; and death will occur below 10 ^{O}C. Eid *et al.* (1991) cleared that increasing water temperature from 16 to 27 ^{O}C improved growth rate and protein efficiency ratio and decrease mortality rate of Nile tilapia.

Effect of water depth

From above results for growth performance, that is significant difference among different treatments that were containing deep, medium, or shallow water, where fish growth were 27, 25 and 21 g, respectively. These results are in agreement with El-Sayd *et al.* (1996) who found that growth performance and survival were significantly affected by pond depth and water temperature. Fish weight gain (250 g per fish), and poorest feed conversion (3.15), and highest mortality (41.5%) occurred in the shallowest depth of 50 cm, whereas 100-200 cm depth produced the best growth performance. At 100-200 cm depth, mortality was reduced to 21-27%. Fish growth was significantly reduced when temperature was below 21 ^{O}C and when water temperature dropped below 10 ^{O}C, fish ceased feeding and severe stress has developed accompanied by fungal infection and high mortality. However, mortality rate was significantly reduced at 100-200 cm depth.

In conclusion, growth performance and survival were significantly affected by ponds depth and water temperature. It is recommended to use covered 100% polyethylene sheet, which better way to over-wintering fish reared in concrete pond.

Table 1 a. Average water quality parameters from November to December

Items	100% covered			75% covered			Covered by dried plant		
	deep	Med.	Shall.	deep	Med.	Shall.	deep	Med.	Shall.
Water depth (cm)	75	100	125	75	100	125	75	100	125
Temperature 9^{00}	20	19	19	18	17	17	19	16	19
Temperature 13^{00}	23	22	22	21	21	21	19	19	19
PH 9^{00}	8.8	8.4	8.5	8.8	8.9	8.4	8.9	8.9	8.8
PH 13^{00}	8.9	9.0	9.1	9.0	9.1	9.1	9.2	9.0	9.4
DO mg/ ℓ9^{00}	7.1	7.3	7.3	7.1	7.3	7.3	7.4	7.4	7.6
DO mg/ ℓ 13^{00}	8.5	8.0	8.1	8.0	8.0	8.0	8.1	8.1	8.3
NH_3 mg/ℓ	0.12	0.12	0.20	0.20	0.20	0.18	0.13	0.18	0.18
P_2O_5 mg/ℓ	1.2	1.2	1.3	1.4	1.2	1.4	1.0	1.1	0.9

Table 1 b. Average water quality parameters from January to March

Items	100% covered			75% covered			Covered by dried plant		
	deep	Med.	Shall.	deep	Med.	Shall.	deep	Med.	Shall.
Water depth (cm)	75	100	125	75	100	125	75	100	125
Temperature 9^{00}	14	15	15	9	9	8	8	8	8
Temperature 13^{00}	16	17	18	11	11	11	11	11	10
PH 9^{00}	8.5	8.4	8.5	8.4	8.5	8.4	8.9	8.9	8.8
PH 13^{00}	9.2	9.2	9.3	9.3	9.4	9.4	9.9	9.6	9.6
DO mg/ ℓ9 ^{00}	7.5	7.3	7.3	7.6	7.3	7.8	7.4	7.4	7.6
DO mg/ ℓ 13^{00}	7.9	8.0	8.0	8.0	8.0	8.0	8.1	8.1	8.3
NH_3 mg/ℓ	0.18	0.18	0.24	0.26	0.26	0.28	0.23	0.28	0.28
P_2O_5 mg/ℓ	1.1	1.0	1.0	1.0	0.9	0.9	1.0	0.8	0.7

Table 2. Fish growth and mortality rates of Nile tilapia reared at different depths

Items	100% covered			75% covered			Covered by dried plant		
	deep	Med.	Shall.	deep	Med.	Shall.	deep	Med.	Shall.
Initial weight (g/fish)	3.0±1 a	3.0± 1a	3.0± 1a	3.0± 1a	3.0± 1a	3.0±1 a	3.0± 1a	3.0±1a	3.0± 1a
1st sample 1-30 November	7.8±1 a	8.0± 1a	8.0± 1a	6.8±1a	7.0± 1a	7.5±0 .5a	5.5± 1.5b	5.0±1b	5.5± 1.5b
2st sample 1-30 December	12.5± 1.5a	12.0± 1.5a	12.0± 1a	10.5± 1.5ab	11.0± 2a	11.0± 2a	9.0± 1.5b	8.5±2b	8.5± 1b
Final weight (g/fish) January-March (90 days).	27± 2.5a	25± 2.5a	21± 3b	0.00±	0.00±	0.00±	0.00±	0.00±	0.0±
Weight gain (g/fish)	24±3a	22± 3a	18± 3b	0.00±	0.00±	0.00±	0.00±	0.00±	0.0±
Survival rate (%)	70± 7a	70± 8a	68± 8a	0.00±	0.00±	0.00±	0.00±	0.00±	0.00±
Total production g	8400± 120a	7700± 135a	6120± 118b	0.00±	0.00±	0.00±	0.00±	0.00±	0.00±

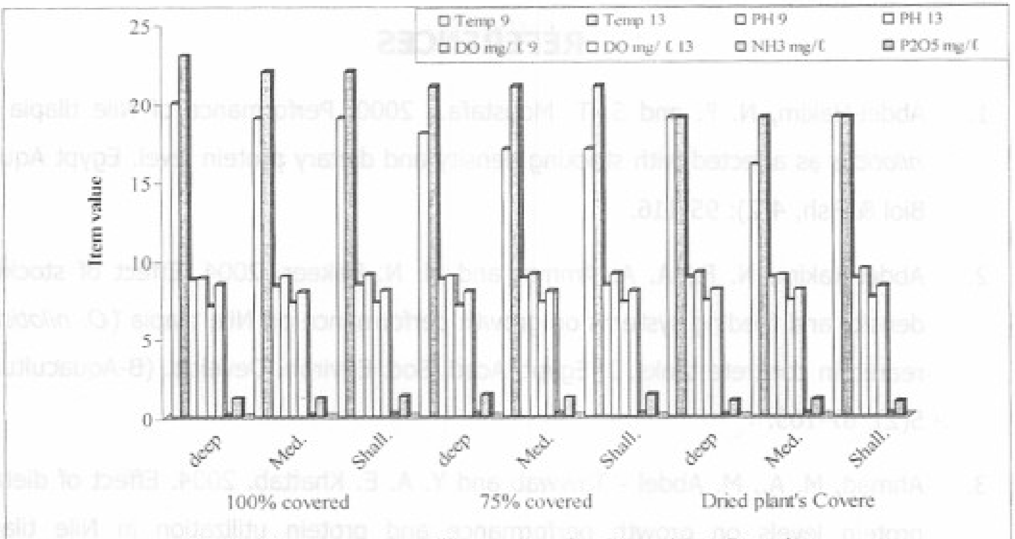

Fig. (1 a). Average water quality parameters from November to December.

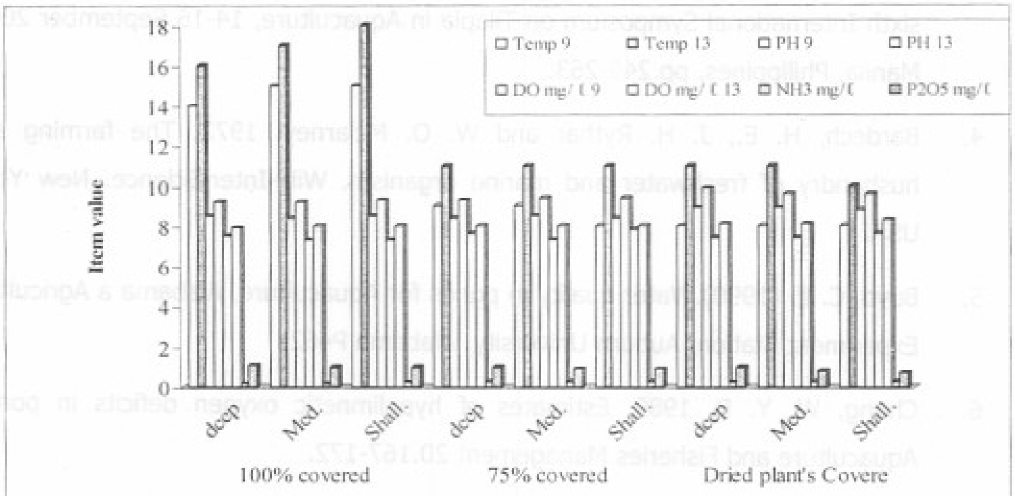

Fig. (1 b). Average water quality parameters from January to March.

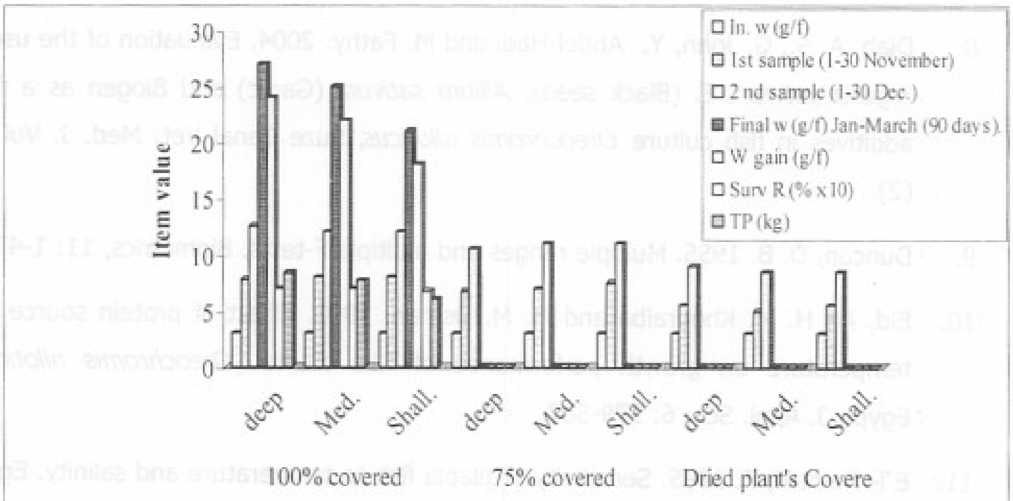

Fig. (2): Fish growth and mortality rates of Nile tilapia reared at different depths.

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أثر التشتية ومستوى عمق المياه بالأحواض على آداء النمو والإعاشة لزريعة أسماك البلطي النيلي

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المعمل المركزي لبحوث الثروة السمكية بالعباسة – أبو حماد – شرقية

أجرى هذا البحث لدراسة تأثير نظم مختلفة من التشتية وكذلك مستوى عمق المياه بالأحواض على اداء النمو والإعاشة لزريعة أسماك البلطي النيلي في الأحواض الخرسانية خلال فصل الشتاء.

تم تقسيم الأسماك إلي ثلاثة مجموعات للتغطية بالبلاستيك الكامل و٧٥% تغطيه بالبلاستيك والتغطية بالبوص الكامل وكل مجموعة قسمت إلي ثلاث مستويات من الأعماق ٠,٧٥ سم ,١٠٠سم و١٥٠سم وتم تغذيتها بمعدلات تغذية ٢-١٠% من وزن الجسم الحي خلال فترة التجربة التي استمرت ١٥٠ يوماً.

تمت التجربة في أحواض خرسانيه مساحه ١٠متر حيث تم تسكين الحوض بخمسمائه من زريعة أسماك البلطي النيلي بمعدل وزن ابتدائي ٣ جم وكانت النتائج كالتالي:

١- تحقق اعلي معدل اعاشة وأفضل معدل نمو معنويا في المجموعة التي تم تغطيتها بالبلاستيك الكامل.

٢- كان هناك اختلافات واضحة معنوية بالنسبة لتاثير مستوى عمق المياه بالأحواض على آداء النمو والإعاشة للزريعة.

٣- أدي انخفاض درجات الحرارة ليلا وارتفاع الصقيع إلي نفوق المعاملات ذات التغطية بالبلاستيك ٧٥% وكذلك التغطية بالبوص.

ونستخلص من هذه الدراسة أن أفضل نظم لتشتية زريعة أسماك البلطي النيلي في الأحواض الخرسانية خلال فصل الشتاء هو تغطيتها بالبلاستيك الكامل وليس ٧٥% تغطيه بالبلاستيك او التغطية بالبوص وذلك لتفادي انخفاض درجات الحرارة .