Impact of Climatic Changes (Oxygen and Temperature) on Growth and Survival rate of Nile tilapia (Oreochromis niloticus)

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Abstract: The aimed of the study is discuss the effects of climatic changes (oxygen and temperature) on growth, immunity and survival rate Of Nile tilapia (Oreochromis niloticus) in cement ponds. Fish were divided into 2 groups of ponds with covered different system of polyethylene sheet as 100% covered and group of ponds without polyethylene sheet and use different water temperature, then each group are divided to three group with different oxygen level i.e. 3 , 5, or 10 for 20 days. Fish were fed on pelleted commercial feed containing 25% protein with a rate of 2- 5 % 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 is totally covered by polyethylene sheet at 23 oC and oxygen level 10 had significant effects on growth, immunity and survival rate, while at 18 oC and oxygen level 3 hadn't significant effects on growth, immunity and survival rate Due to decreased temperature and decrease oxygen that increased fish mortality for non covered ponds with polyethylene sheet. In conclusion, growth rate, immunity and survival were significantly affected by pond depth and water temperature. It is recommended to use covered 100% polyethylene sheet and aerators which better way to increase fish production in fish ponds.
[Noor El Deen , A. I.E. and Mona S. Zaki. Impact of Climatic Changes (Oxygen and Temperature) on Growth and Survival rate of Nile tilapia (Oreochromis niloticus). Report and Opinion 2010;2(12):192-195]. (ISSN: 1553-9873). http://www.sciencepub.net.

Key words: Nile tilapia, climatic change, water temperature, fish survival, growth and immunity.

1. Introduction:

Tilapia aquaculture continues to expand worldwide because of key production traits including its resistance to poor water quality, parasites and diseases and its easiness for handling practices. However, most tilapias do not eat or grow at temperatures below 15 oC (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). The previous studies indicated that ponds should be good aerated as is consistent with the requirements of the cultured animals, if optimal productivity is desired and nutrients are non-limiting. Furthermore, relatively the higher of ponds temperature might be unflavored because the ponds are more prone to the depletion of dissolved oxygen (DO) which could lead to asphyxia. 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 breeding. 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 low and high temperature (Nour 1996 and Diab et al., 2004).The present study was conducted in concrete ponds to examine the relationship between oxygen level in ponds and so water temperature in relation to growth, immunity and survival rate of Nile tilapia during time of experiment.

2- Materials and Methods

2-1-Fish

This study was carried out at the private fish ponds, Kafr El Sheikh Governorate, Egypt. Nile tilapia (Oreochromis niloticus) of 100±20 g was obtained from a private farm at the same region. Fish were fed on a commercial diet during the preliminary period. Fish were stocked at a rate of 50 fish/ pond (3 m long x 2 m wide). The first and second treatments have experimented the total coverage of pond by a plastic (polyethylene) sheet; while the third treatment not covered. The water temperature was 28, 23 and 18 °C for first, second and third group ponds respectively. The different parameters of fish growth and feed utilization were calculated as described by Ahmad et al. (2004).

2-2- Analyses of water quality parameters

Water temperature and dissolved oxygen measured daily using thermometer and oxygen meter (YSI model 57). The samplings of phosphorus and ammonia concentrations were carried out bi-weekly according to Boyd (1990).

2-3-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).

3-Results

The Climate indicated that temperature from (10 -28 oC on ponds) 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 Kafr El Sheikh fish farm, water temperature was 18 - 28 OC that was suitable to fish growth. While during January, February, and March temperature dropped to 10 OC and lower, which is not only unsuitable to tilapia growth but also threatening tilapia survival. So, fish mortality started to be observed in most of the experimental tanks. In the tanks totally covered (100%) by plastic sheet, temperature was suitable for fish growth and survival. On the other hand, water temperature in treatment covered by plastic sheets 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 OC. Mortality rate was 100% when tilapia were switched to either 4 OC or 40 OC. 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 (1). 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. 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 ponds 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 plastic sheet than open ponds which indicated low photosynthesis in this treatment due to the limitation of the light coming to the ponds. Also, DO was better in ponds(23OC) than that(28 OC). Furthermore, different DO values have been affected by water temperature ponds.

Fish growth and survival

As presented in Table 2, the growth of tilapia has been affected by pond coverage as well as by water depth. On the other hand, the not coverage by plastic sheets showed increasing fish mortality 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 pond and the hot air went out pond, which is not saving for temperature inside pond. Most tilapias neither eat nor grow at temperatures below 15 OC (Bardech et al., 1972) and do not spawn at temperature below 20 OC (Rothbard, 1979). Rakocy and Mc Ginty (1989) indicated that the preferred temperature range for optimum tilapia growth is 23 OC, growth diminishes significantly at temperature below 20 OC; and death will occur below 10 OC. Eid et al. (1991) cleared that increasing water temperature from 16 to 27 OC 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 40, 50 and 50 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 average (50 g per fish), and 50 cm depth, mortality was reduced to 40%. Fish growth was significantly reduced when temperature was below 21 OC and when water temperature dropped below 10 OC, fish ceased feeding and severe stress has developed accompanied by fungal infection and high mortality. However, mortality rate was significantly reduced at 75-125 cm depth**.**

Table (1). Average water quality parameters in January.

Items	Covered 28 °C			Covered 23 °C			Covered 18 °C		
	deep	Med.	Shall.	deep	Med.	Shall.	deep	Med.	Shall.
Water depth (cm)	50	75	125	50	75	125	50	75	125
Temperature	28	27	26	23	22	21	18	17	16
DO mg/ ℓ9 [00]	7.1	7.3	7.3	7.1	7.3	7.3	7.4	7.4	7.6

Table (2) Fish growth and mortality rates of Nile tilapia

Items	Covered 28 °C			covered 23 °C			Covered 18 °C		
	deep	Med.	Shall.	deep	Med.	Shall.	deep	Med.	Shall.
Initial weight (g/fish)	100.0±20 a	200.0±20 a	100.0±20 a	100.0±20 a	100±20 a	100±20 a	100±20 a	100±20 a	100±20 a
1st sample After 15days	110±20 a	115±20 a	120±20 a	120±20 a	125±20 a	130±20 a	100±20 b	110±20 b	110±20 b
2st sample 30 days	130±20 a	130±20 a	130±20 a	130±20 a	130±20 a	130±20 a	115±20 a	115±20 a	115±20 a
Final weight 45 days	140±20 a	150±20 a	150±20 a	170±20 a	180±20 a	190±20 a	120±20 a	120±20 a	120±20 a
Weight gain (g/fish)	40±5 a	50±5a	50±5b	50±5b	50±5b	50±5b	50±5b	50±5b	50±5b
Survival rate (%)	70±7a	70±8a	68±8a	70±8a	70±8a	70±8a	70±8a	70±8a	70±8a

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11/25/2010