EFFECT OF WATER DEPTH ON GROWTH PERFORMANCE AND SURVIVAL RATE OF MIXED SEX NILE TILAPIA FINGERLINGS AND ADULTS

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SUMMARY

Nile tilapia (O. niloticus) fingerlings and adult averaging (18 and 100 g in weight) respectively, were reared under 3 different depths (75,125 and 175cm) for 90 days to study the effect of water depth on the growth and the survival of overwintered fishes using twelve standing cages. Fish were fed on a commercial diet containing 26.58 % protein. The dissolved oxygen , temperature, pH, UIA-N and transparency of water and mortality were recorded for each cage every 15 days during the experimental period. Also, at the end of the experimental period , the fish were harvested , counted and the growth measurements (weight and total length) were determined . The statistical analyses indicated that there were significant differences (≤0.05) in all parameters between all depths. Results showed that the final average total length, weight gain, condition factor and survival rate being the best at depth of 175 cm in both two sizes of tilapia during the cold season in Egypt.

Keywords: Nile tilapia, water depth, performance, survival rate

INTRODUCTION

Enhancement of tolerance to low temperature of Nile tilapia, *Oreochromis niloticus*, is important to prolong its growth period, reduce mortality for over-wintering and decrease costs (Sifa *et al.*, 2002). In temperate and some sub-tropical regions, their culture is highly affected by sensitivity to low water temperatures leading to poor growth and mass mortality during over-wintering (Charo-Karisa *et al*., 2005). Fish naturally tend to select the habitat that is most suitable for their physiological requirements. This behavior is known as 'habitat selection' or 'enviroregulation'. Therefore, fish move into deeper water when surface water temperature decreases or increases beyond their preferred range. So, fish ponds should be deep enough to meet temperature demands and other habitat requirements of cultured fish, especially in arid areas where diurnal and seasonal fluctuations in water temperature occur. (Neill and Bryan, 1991). Depth as a factor in pond ecosystem management has been given little experimental attention, despite its theoretical importance in autotrophic production (Abd El-aal, 2008)**.** Pond culture is commonly practiced in ponds of about 1 m depth, but there is a wide range of depths in use. Depth may be chosen for reasons relating to construction costs, habitat preference of the primary cultured species, or management of cohabiting organisms such as phytoplankton, benthos or rooted macrophytes (Carballo *et al.,* 2008)**.** The present study aimed to investigate the effect of pond water depth on growth performance and survival rate during over wintering period in two body sizes of Nile tilapia under the Egyptian conditions.

MATERIALS AND METHODS

This study was conducted in standing cages placed in cement ponds in cold season from January 10 [th] to April 10th., 2011 located at the Fish Research Center, Suez Canal University, Ismailia , Egypt.

Experimental fish

Nile tilapia (*Oreochromis niloticus*) with two different sizes (fingerlings of an average weight 18 gm and average total length of 9.75 cm, and adults of an average weight 100 gm and the aversge total length 17.65 cm) were obtained from Fish Research Center, Suez Canal University. Every size of fish were homogenous in size, body weights and apparently healthy.

Experimental cages

Twelve standing cages (100×200 ×200 cm) were used. The standing cages had a supporting frame of steel extending 0.3 m below the cage floor to keep it away from the bottom sediment . The mesh walls are attached to the upper part of this frame, a polyethylene net with a mesh size of 10 mm was fixed inside cages and cleaned by washing every two weeks in order to prevent the growth of algae on it, the cages were placed in a cement pond (measuring 20×10 m and an average depth of 2 m) having fresh water pumped from Ismailia fresh water canal (salinity of 0.4 ppt and total alkalinity of 112.2 mg/l $CaCO_3$).

Experimental design

Fish were reared in 3 different water depths 75, 125 and 175cm respectively,. Tilapia was stocked at

a rate of thirty fish/m^3 of water from each size (18 and 100 gm) for 90 days, each size was replicated twice in each treatment. Fishes were fed on commercial diet (26.58% protein) for the next period from (Feb. 24 [th]) to the end of the experiment and was not fed during the first 45 days of the experiment (Jan.10th to Feb. 23th. The dissolved oxygen, temperature, pH, UIA-N and transparency of water and mortality were recorded biweekly for each cage. Also, at the end of the experimental period , the fish were harvested, counted and the growth measurements were recorded.

Experimental diet

The diet used from El Bardeny Company, pellets size 2 mm was contained 26.58% crude protein according to (Stickney, 1997). The diet was stored in a refrigerator (4°C) during the experimental duration to avoid the nutrients deterioration. Contents and proximate chemical analysis of the experimental diet are provided in Table (1).

Table 1. Ingredients composition and proximate analysis of the diet fed to Tilapia fish

Ingredients	%
Fish meal	19.76
Soya bean meal	19.76
Yellow corn	25.69
Wheat bran	25.69
Fish oil	3.95
Mineral mix*	2.68
Vitamin mix**	2.47
Total	100

Proximate chemical analysis (% DMB)	
Ash	15.03
Crude protein	26.58
Crude fat	13.75
Crude fiber	4.00
Nitrogen-free extract	40.64

*Mineral mix (El Bardeny Company),each 0.25 kg contains: Iron 30,000 mg ; Manganese 60,000 mg ; Zinc 50,000 mg ; Copper 4,000 mg ; Cobalt 100 mg ; Iodine 300 mg and Selenium 100 mg .
** Vitamin mix. ,each 0.25 kg contains: (A) 10,000,000 IU ; (D3) 2,200,000 IU; (E) 10,000 mg; (K3) 1,000 mg ; (B1) 1,000 mg ; (B2) 5,000 mg ; (B6)1,500 mg ; (B12) 10,000 mg ; Panthotenic acid 10,000 mg ; Niacin 30,000 mg ; Folic acid 1,000   mg ; Biotin 50,000   mg ; Colinechloride 600,000 mg.

Feeding regime

Fish was unfed during the first 45 days of the experiment (Jan.10th to Feb. 23th) because of the lower water temperature and consequently the fish ceased on feeding (Abd El-aal, 2008). While, the daily feeding rate was 3 % of the fish biomass for the next period from (Feb. 24th) to the end of the experimental period. The fish were weighed every two weeks and the amount of food was adjusted for the next growth period based on the new fish biomass in each cage .The daily feeding rate (percent of the body weight) were assigned to a particular range of wet weight according to (NRC, 1993). The experimental diet was offered by hand spreading over cages.

Water Sampling

The water sampling bottle was filled from the bottom of each depth and then overflows until the space surrounding the bottle is filled. By using this apparatus the water in the sample bottle dose not contact air and the bottle is filled directly (Diana and Lin, 1998).

Physico-chemical analysis of water

Water pH was measured daily in the late afternoon using pH meter model 56, NR 87 BB 203 (Rad *et al*., 2006), the average was recorded biweekly throughout the experimental period.

Transparency was measured twise weekly by using Secchi-disk visibility (20 cm diameter secchi disk). It was calculated as the average between depth at which the reading of secchi disk disappeared when lowered and the depth at which reappeared when raised (Boyd and Tucker, 1992).Water temperature was measured daily using oxygen-temperature meter (YSI model L57) and the average was taken biweekly. The dissolved oxygen of the water was measured daily in the early morning by using oxygen-temperature meter (YSI model L57) and the average was recorded biweekly (Pullin and McConell, 1982). The total ammonia concentration in the water was measured biweekly in each depth by using ammonia ion specific meter (HI93715) which measures the ammonia nitrogen (NH4-N) content in the water and the average was recorded every 15 days during the experimental period, un-ionized ammonia (toxic to fish) it was calculated from total ammonia using temperature – pH tables (Emerson *et al.,* 1975).

Growth parameters

The following parameters were used to evaluate tilapia growth performance
Body weight gain (WG)=W1–W0, Average daily body weight gain (ADG): ADG=(W1–W0)/t),Specific growth rate (%/day): SGR=(Ln W1–Ln W0)×100/t),Food conversion ratio: FCR=Df/(W1–W0), Survival rate (%):SR=Ni×100/N0 , where:W1=Final wet weight, Wo=Initial wet weight, t=Time interval in days, Ni=Number of fishes at the end, N0=Number of fishes initial stocked and Df=Dry feed intake.

Statistical analysis

The data obtained were analyzed by one-way ANOVA Procedure of Statistical Analysis System (SAS, 1988). Means were compared by Duncan's new multiple range test (Zar, 1996).

RESULTS AND DISCUSSION

The physico-chemical characteristics of water

Mean water temperature , dissolved oxygen , pH, NH3-N and secchi disk depth at different depths (75, 125 and 175 cm) which were measured and recorded every 15 days intervals are indicated in Table 2. The average water temperature during the experimental period fluctuated between (12.90 and 14.70º C) in Jan. 25th – Feb.8th and (20.91 and 22.50º C) in Mar. 26th – Apr. 9th for depths 75, 125 and 175 cm respectively, thus , it seems that the temperature of the water through the rearing period is generaly unsuitable for the growth of tilapia and varied according to the water depth since it increase by increasing water depth as reported by (Stoll *et al.*, 2008 and Abd El-aal, 2008) who found that ponds tend to become colder in the winter and warmer in the summer it could be due to the high heat capacity of water which changes water temperature relatively slowly and fairly evenly. Values of pH ranged from 7.90 – 8 , 8.0 – 8.30 and 8.30 – 8.50 for depths 75, 125 and 175 cm, respectively which were in the range at which tilapia live as recorded by El-Sherif and El-Feky (2009b); Ju n *et al.* (2012) and Duy *et al.* (2012) who reported that pH values of 7 – 8.3 are quite common and most suitable for fish, the slight increases opserved in pH values at deeper depth could be attributed to the content of organic matter on the pond bottom. Dissolved oxygen concentrations were decreased with increased water depth but it is clear that the dissolved oxygen at different depths is suitable for tilapia feeding and growth as reported by Rad *et al.* (2006) the lowest concentrations of dissolved oxygen might be attributed to: Firstly: excess concentration of phytoplankton algae, though algae are DO producers, they also reduce light penetration and consume DO in the dark, excess algae therefore reduce DO production in the lower layers of the water and increase the rate of depletion of DO during the night, Secondly: abundance of organic matter on the pond bottom which increases bacterial population rapidly and consumes oxygen (Khouraiba, 1989). The UIA-N was suitable for growth of Nile tilapia and gradually increased with increasing depth and pH, this was in agreement with (El-Sherif and El-Feky, 2009 a,b) who showed that Nile tilapia produced the best growth rate when UIA-N ranging from 0.01 to 0.08 mg/l. The average secchi disk visibility throughout the experimental period was 45 – 47 cm which was suitable for growth of Nile tilapia, this result was attributed to the concentration of phytoplankton algae (Diana and Lin, 1998). However, the visibility reading were similar among all treatments, indicating that feed served not only as fish feed but also as a sourse of nutrients of aquatic populations such as phytoplankton, that contribute to productivity. Generaly, Secchi disk has been found to provide a rough estimate of phytoplankton abundance in culture ponds (Boyd, 1979).

Table 2. The physico-chemical characteristics of the water of the experimental ponds in the Fish Research Center, Suez Canal University (from 10 January to 9 April., 2011)

Parameter	Depth (cm)	Period of rearing					
		Jan 10-24th	Jan25[th]-Feb 8th	Feb 9-23th	Feb 24th-Mar10[th]	Mar 11-25th	Mar 26th–Apr 9th
Temperature (ºC)	75	13.60	12.90	13.80	16.00	18.75	20.91
	125	14.00	13.70	14.25	16.70	19.00	21.50
	175	15.60	14.70	15.30	17.80	19.88	22.50
pH	75	7.90	8.00	7.92	7.80	7.90	7.90
	125	8.00	8.20	8.10	8.22	8.10	8.30
	175	8.50	8.40	8.30	8.34	8.33	8.50
Do (mg/L)	75	7.60	8.00	7.80	8.10	8.00	7.80
	125	7.00	7.60	7.30	7.80	7.60	7.50
	175	6.40	6.60	6.40	7.00	6.80	6.80
NH_3 (mg/L)	75	0.01	0.02	0.01	0.02	0.01	0.01
	125	0.03	0.03	0.02	0.03	0.02	0.03
	175	0.05	0.05	0.06	0.05	0.04	0.05
Secchi disk (depth)	At all depth	45	47	45	47	46	45

*Un – ionized ammonia (toxic to fish) it was calculated from total ammonia ($NH^+_4 + NH_3$) using temperature – pH equilibrium tables (Emerson *et.al.*, 1975).

The growth and survival rate of Nile tilapia (fingerlings and adult)

From the presented data in Tables (3) and (4), it is obvious that the growth parameters increase (body weight and body length) as the water depth increases in both two sizes of tilapia, since, the depth of 175 cm showed highest increases. These results are in full agreement with those obtained by Dan and Little (2000); Takashi and Tadashi (2003) and Stoll *et al.*(2008). Also, it is clear that the poorest condition factor and specific growth rate was that of fish reared in the lower water depth, while fish reared in deeper water showed the best condition factor and SGR in both two sizes of tilapia, these results agree well with the data obtained by El-Sayed *et al.* (1996) and Abd El-aal (2008). Results of Table (3) revealed that the specific growth rates for fingerlings were higher than of the adult ones at different water depths used, this may be attributed to the size of fish reared under the same experimental and ecological conditions. The statistical analyses indicated that there were significant differences (P≤0.05) in growth parameters between all depths. The high survival rate % in water depth (175 cm) for both two sizes of tilapia was attributed to that the fishes live naturally in deeper water during the cold season and migrate to shallower water when the water warms up so fish avoided low water temperature during winter by moving to the bottom, and this reduced mortality. The poor survival rate in both two sizes of tilapia with shallow water of 75 cm might be attributed to

the poor of ecological conditions of the fish especially low water temperature at this depth, growth rates were extremely reduced, fungal infection occur due to the decrease in feeding activity and metabolic scope where a substantial amount of dietary energy was used to maintain the internal physiological functions rather than for growth during the winter season, also, survival rate for fingerlings was higher than that of the adult fish at different water depths, this may be due to the size of fish cultured under the same experimental and environmental conditions, also, small fish are more capable than adults of rapid adaptation to variation in water temperature and depth. This conclusion is in agreement with finding of Khouraiba (1989); El-Sayed *et al.* (1996); Charo-Karisa *et al.* (2005) and Abd El-aal (2008). They cited that the young tilapia generally being more tolerant to lower temperature than the large tilapia, the statistical analyses indicated that there were significant differences (P≤0.05) in survival % between all depths. Based on the obtained results it could be concluded that175 cm water depth was more suitable for the growth and survival % of Nile tilapia fingerlings cultured during the cold season in Egypt.

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Table 3. The growth and percentage of survival of Nile tilapia fingerlings (average weight 18g/fish) reared in standing cages for a period of 90 days at different water depths.

Item		Water depth(cm)		
		75	**125**	**175**
Initially	No. of fish(30 fish/m^3)	45	75	105
	Av. Individual weight of fish (gm/fish)	18.00	18.00	18.00
	Av. Individual total length of fish (cm/fish)	9.75	9.75	9.75
	Condition factor (CF)	1.94	1.94	1.94
Final results	No. of fish(fish/m^3)	30	56	89
	Av. Individual weight of fish (gm/fish)	20.16±0.05 [c]	26.11±0.02 [b]	30.66±0.04 [a]
	Body weight gain (gm/fish)	2.16±0.02 [c]	8.11±0.05 [b]	12.66±0.01 [a]
	Av. Individual total length of fish (cm/fish)	10.55±0.05 [c]	11.40±0.03 [b]	11.80±0.05 [a]
	Body length gain (cm/fish)	0.8±0.05 [c]	1.65±0.02 [b]	2.05±0.01 [a]
	Specific growth rate (%growth/d)	0.13±0.01 [c]	0.41±0.05 [b]	0.59±0.02 [a]
	Survival rate (%)	66.67±0.02 [c]	74.67±0.05 [b]	84.76±0.03 [a]
	Condition factor (CF)	1.72±0.01 [c]	1.76±0.05 [b]	1.86±0.04 [a]

Table 4. The growth and percentage of survival of adult Nile tilapia (average weight 100g/fish)

	Item	Water depth(cm)		
		75	**125**	**175**
Initially	No. of fish (30 fish/m^3)	45	75	105
	Av. Individual weight of fish (gm/fish)	100.00	100.00	100.00
	Av. Individual total length of fish (cm/fish)	17.65	17.65	17.65
	Condition factor (CF)	1.82	1.82	1.82
Final results	No. of fish(fish/m^3)	15	48	63
	Av. Individual weight of fish (gm/fish)	107.11±0.05 [c]	113.1±0.02 [b]	120.13±0.05 [a]
	Body weight gain (gm/fish)	7.11±0.04 [c]	13.12±0.05 [b]	20.13±0.01 [a]
	Av. Individual total length of fish (cm/fish)	18.81±0.05 [c]	18.84±0.02 [b]	19.15±0.03 [a]
	Body length gain (cm/fish)	1.16±0.02 [c]	1.19±0.03 [b]	1.5±0.01 [a]
	Specific growth rate (%growth/d)	0.08±0.01 [c]	0.14±0.03 [b]	0.20±0.05 [a]
	Survival rate (%)	33.3±0.02 [c]	48.0±0.05 [b]	60.0±0.03 [a]
	Condition factor (CF)	1.61±0.05 [c]	1.69±0.01 [a]	1.71±0.05 [b]

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تأثير عمق المياه على أداء النمو و معدلات البقاء لأسماك البلطي النيلي مختلطة الجنس البالغة و الاصبعيات

مرفت على محمد على ، آمال محمد إبراهيم الفقى ، حافظ محمد احمد خريبة ،محمد سعد الدين الشريف

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تم تربية اسماك البلطي النيلي (اصبعيات و اسماك بالغة بمتوسط وزن 19 و 100 جرام على التوالي) تحت ثلاثة أعماق مختلفة للمياه (25، 125، 175سم) لمدة 90 يوم لدراسة تأثير عمق المياه على النمو و معدلات البقاء في فصل الشتاء البارد باستخدام 12 قفص، تم تغذية الأسماك على عليفه تجارية تحتوى 26.58% بروتين، تم قياس الأكسجين الذائب و الحرارة واللوغاريتم السالب لتركيز ايون الهيدروجين ، الامونيا الغير متاينة و شفافية المياه لكل قفص على حده كل 15 يوم طوال مدة التجربة .في نهاية مدة التجربة تم صيد الأسماك و عدها و أخذت قياسات النمو (وزن و طول) . سجلت النتائج افضل قيم لمتوسط الطول الكلى و الوزن المكتسب النهائي و معامل الحالة و معدل البقاء عند عمق 175سم لكلا الحجمين من البلطي و أوضح التحليل الاحصائى أن هناك فروق معنوية بين كل القياسات عند كل الأعماق. أظهرت نتائج الدراسة أن عمق 175سم للمياه كان أكثر ملائمة لنمو و بقاء اصبعيات البلطي النيلي المر باه أثناء فصل الشتاء البارد في مصر.و بناء عليه توصى الدراسة باستخدام عمق 175 سم.