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EFFECT OF FISH SIZE AND DENSITY AT INITIAL STOCKING ON GROWTH PERFORMANCE AND FISH MARKETABLE SIZE

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ABSTRACT

Under monoculture semi-intensive system, a study on cultivation of monosex Nile tilapia (*Oreochromis niloticus* L.) in earthen ponds (each of 6000 m^2) was done.Twelve rectangular earthen ponds were used representing six treatments, three different stocking density (SD_1 , SD_2 and SD_3 being 9, 12 and 15 fish/m^3, respectivily) within each of them two fish sizes (FS_1 and FS_2 being 30 and 50 g/fish, respectivily). Two replicates were used for each treatment. The treatment of 12 fish/m^3 with 50 g/fish gave the best results of marketable size, net yield (8820.35 kg/feddan) and highest profit index (2.97 LE). Based on the obtained results, it could be recommended that the best fish size and stocking density of monosex Nile tilapia (*O. niloticus*) in monoculture semi- intensive system are 50 g /fiish at 12 fish/m^3 to get the optimal marketable fish size at harrvest under similar conditions to those of the present study.

Keywords: Stocking density, Fish size, Earthen ponds, Monoculture system, Growth performance, Fish marketable size, Profit index.

INTRODUCTION

Tilapia species are presently the most intensive cultivated freshwater fish in Egypt. There is a shortage (gab) in the Egyptian supply of fish calculated as 25% of the local demand, which is covered with import. So it is a must to cultivate fish for the over fishing, which led to depletion of the wild water bodies. However, pisciculture is sharing more than 55% of the total local fish production. Moreover, 88% of pisciculture production is produced by non governmental farms (MSSP 2001, FAO, 2004 and GAFRD, 2006). The determination of pond management parameters such as (stocking density, fish size and dietary protein levels) for intensive tilapia production has been the aim of many studies (Viola and Zohar, 1984, Megintly, 1986, Teshima *et al*., 1987, Salam *et al.,* 1992; Mahmoud *et al.,* 2003 and Samra, 2006). They reported that weight gain was slightly higher in small fish than in large fish but not significantly differed with feeding rates and dietary protein levels. The feed conversion ratio (FCR) and protein efficiency ratio (PER) were decreased with increasing feeding rates and were higher in small fish than in large fish. However, not significantly differed between 25% and 35% protein diets. Soha and Dewan (1979) studied food and feeding habits of *Tilapia nilotica* particularly types and amount of food taken by fish, its size and patterns of feeding. They showed that these fish are omnivore with higher feeding preference for detritus and plant food. Parts of zooplankton and sand are incidental gut contents and the fish also showed a certain amount of cannibalistic habit. The fish changed its food and feeding habit with change in size. It showed increased preference for debris with the increase in size. The small size group (45-90 mm) showed greater surface and column feeding, whereas the large size group (136 – 180 mm) fed more at the bottom. A slight change in food habits with changes of season was observed only in the small size group. Despite the popularity of tilapia culture, the overall production of marketable-size tilapia per feddan has remained relatively low because of the introduction of poor cultivable species, mixed – six culture and poor management (Megintly, 1983 and MSSP, 2001).

Manipulation of stocking densities is an established management consideration in pond aquaculture. Net fish yield tends to increase with increasing stocking density, but competition for natural food (Diana *et al*., 1991) and increased aggressive territorial behavior set limits to this positive relationship (Knud-Hansen and Kwei, 1996).

This experiment was designed to determine the optimal stocking density and fish size of mono sex Nile tilapia to reach the marketable size throughout the evaluation of the effects of treatments on growth traits, total production and economic efficiency.

MATERIALS AND METHODS

This work was conducted in the region of Edku, El-Behera governorate, Egypt at the Barsik fish farm belonging to Arab Fisheries Co., an affiliate of the Arab League, during season 2006 (for 160 days), to investigate the effect of mono sex Nile tilapia stocking density (SD) and its fish size (FS) on fish marketable size at harvest. Twelve rectangular earthen ponds each of 6000 m^2 were used and represented 6 treatments (three stocking rates in two fish sizes) as follow:

Treatment (1) 30 g / fish at 9 fish/m^3 ($FS_1 + SD_1$)
Treatment (2) 30 g / fish at 12 fish/m^3 (FS_1 x SD_2)
Treatment (3) 30 g / fish at 15 fish/m^3 (FS_1 x SD_3)
Treatment (4) 50g / fish at 9 fish/m^3 (FS_2 x SD_1)
Treatment (5) 50g / fish at 12 fish/m^3 (FS_2 x SD_2)
Treatment (6) 50 g / fish at 15 fish/m^3 (FS_2 x SD_3)

Experimental ponds were supplied with water from Idku drainage canal. The water level was maintain at approximately 1 m and loss of water due to evaporation and leakage was replaced whenever necessary. A monthly fish sample of 150 fish were weighted to adjest the feed quantity. Two paddle wheel aerator (1 horse power each) per pond were used.

Nile tilapia hormon-sex reversed (mono-sex) fish were fed on a commercial diet (25.6% crude protein and 4900 Kcal grosss energy/kg diet). Fish were hand fed the diet twice daily at 9.00 and 15.00hr. Diet was offered for all ponds at a daily rate of 3% of tilapia weight (5 days a week). The determined chemical composition of the diet used was 91.6% dry matter, 24.9 % crude protein, 10.9% crude fat, 4.9% crude fibers and 9.4 % ash. This commercial diet was 3 mm (sinking pelleted) size, obtained from Zo.Control Company in 6 October City.

Individual body weight to the nearest 0.1 g was measured at the start of the experiment for samples of 150 fish/pond and repeated monthly. Fish samples were withdrawn from the experimental ponds by a seine and transfered to a tank containing water from the experimental ponds and returned back to ponds after measuring their weights. Chemical analysis of the diet was performed according to the methods described by A.O.A.C. (1990).

Water quality criteria (physical, chemical and biological) were tested for all ponds according to APHA (1985) and Boyd (1992). Also, growth performance and nutrients utilization of the experimental fish were followed after Jobling (1983). The statistical analysis of data was carried out by applying the computer program of Harvey (1990). Differences among means were tested for significance according to Duncan's multiple range test (1955).

RESULTS AND DISCUSSION

Water quality criteria:

Results of water quality parameters as affected by fish size and density as averages of the monthly samples are presented in Table (1). As show in this Table, the averages of temperature ranged between 26.5 and 28.0^{o}C. In general water temperature was adequate for tilapia growth. These are in agreement with results of Boyd (1992). Who reported that warm water species which are native to temperature climate and best semitropical conditions grow at temperatures ranged between 20 and 28^{o}C.

Results revealed that transparency (Sicchi disk reading in cm) had a range between 16 cm (FS_1 x SD_1) and 28 cm (FS_2 x SD_3). These values are beneficial to fish cultivation. In this connection, Boyd (1992) reported that water quality parameters of fish ponds were in a good conditions as Seccki disk visibility was between 15 and 45 cm, when turbidity was in form of phytoplankton. Averages of pH values for treatments FS_1 x SD_1; FS_1x SD_2 ; FS_1 x SD_3; FS_2 x SD_1; FS_2 x SD_2 and FS_2 x SD_3 were 8.1, 8.2, 8.0, 7.5, 7.0 and 6.8 , respectively. The lower values of pH in ponds with higher density and fish size may be attributed to the increase in organic matter contents (fish faeces) of these ponds, which may lead to pH decrease.

Averages of dissolved oxygen (DO) have ranged between 5.0 and 6.9 mg/l. These values are beneficial to fish cultivation and indicate that water dissolved oxygen slight decreased in ponds with higher density and fish size compared to the other ponds. This may be attributed to the increase in fish size and density of these ponds, which may lead to dissolved oxygen decreases. In this connection Anand Mukherjee (2000) demonstrated that semi – intensive culture system is characterized by high stocking and requires relatively more dissolved oxygen concentration in water bodies. In this respect, aerators are used to increase the rate of oxygenation in pond water. Un-ioinized ammonia did not exceed 0.18 mg/l in different treatments.

Total alkalinity ranged between 382 and 391 mg/l in (FS_2 x SD_1) and (FS_1 x SD_1), respectively. Averages of phosphorus had ranged between 0.16 and 0.28 mg/l, which represented the normal range of phosphorus in fish ponds. The reported values of the tested water criteria were within the suitable range for rearing Nile tilapia according to Abdelhamid (2003) and Hasan *el al*. (2006). Similar results were given too by Abdel Hakim *et al* . (2000), Ismail (2001) and Soltan *et al*. (2006).

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Phyto-and zooplankton:

As shown in Table (1), the average total numbers of phytoplankton and zooplankton organisms per liter were higher in water samples collected from ponds with lower density and fish size, comparing with the samples collected from ponds of higher density and fish size. The decrease in the total number of phytoplankton and zooplankton organisms in water samples of the ponds cultured at high stocking rate of big fish size (50g) compared with the other ponds may be due to the consumption of these organisms by high total biomass. In general, numbers of plankton communities in fish ponds were affected greatly by the experimental treatments. These results are in agreement with the finding of Abdel Hakim *et al*. (2006) and Soltan *et al*. (2006). They studied semi-intinsive culture systems.

Growth traits:

Table (2) shows the effects of fish size and density and their interactions on the different body measurements studied. Regardless of stocking density, the increasing of fish size (from 30 to 50 g) increase the body weight from 184.61 to 245.68 g, body length from 21.19 to 26.21 cm. These results indicate that final body weight and length of mono sex Nile tilapia (*O. niloticus*) increased significantly (P< 0.05) with the increase in size at stocking from 30 to 50 g. These results are in partly agreement with those reported by Teshima *et al*. (1987), they studied the effect of fish size on the growth of *Tilapia nilotica* and they reported that growth performance was slightly higher in large fish. Also, Sadek *et al*. (1992), Suresh and Lin (1992), Al-Azab (2001) and Mahmoud *et al*. (2003) came to the conclusion that small tilapia stocking released negative effects on their body weigh (BW) and length (BL), where BW and BL decreased as the fish size at stocking decreased.

Averages condition factor (K) for the experimental groups are given in Table (2). As evident in this Table, fish size and stocking density have influences on fish condition factor. These results are in agreement with the finding of Megintly (1983), Salam *et al*. (1992) and Abdel-Hakim *et al*. (2004). They studied the effect of body size and condition factor on *Tilapia nilotica*, and found that the best condition factor value was recorded by small fish size. It could be concluded that big fish size (50 g/fish) used in this study gave the best growth performance of Nile tilapia in the form of body weight and body length. These growth parameters were increased significantly with increasing fish size from 30 to 50 g, but concerning the three stocking densities used in this study, these growth parameters were lower with high stocking density than with low stocking density and the differences among fish size and stocking densities were significant (Table 2).

Regardless of fish size, body weight and length were negatively correlated to the stocking density of fish (Table 2), however total fish yield at harvest increased with increasing the stocking density (Table 3). These results indicated that final body weights and lengthes of monosex Nile tilapia (*Orechromis niloticus*) increased significantly (P < 0.05) with each increase in size and density at stocking from 30 to 50 g and from 9 to 15 fish /m^3 These results are in agreement with Abdel-Hakim *et al*. (1995, 2000, 2001a & b and 2004) who found that final mean weight and length of Nile tilapia, *O. niloticus* decreased with increasing stocking rate but the net yield was increased. With regard to the interaction between the fish size and stocking density, results revealed that the 4th treatment (FS_2 x SD_1) produced the heaviest and longest fish compared to the other treatments (Table 2). The significance of variations due to the effect of interaction between fish size and stocking density on body weight and length showed that these two factors act dependently on each other and also each of them had its own significant effect.

Table 2: Means and standard errors for the effects of fish size and stocking density on the body measurements of monosex of Nile tilapia (*O. niloticus*) at harvest.

Variable	No.	Body weight (gm)	Body length (cm)	Condition factor (K)
Fish size (FS)				
Low (30 g)	450	184.61 ± 1.42^{b}	21.19 ± 0.08^{b}	1.94 ± 0.03^{a}
High (50 g)	450	245.68 ± 1.42^{a}	26.21 ± 0.08^{a}	1.36 ± 0.03^{b}
Stocking density				
SD_1 (9 fish/m^3)	300	229.84 ± 1.48^{a}	25.30 ± 0.09^{a}	1.41 ± 0.03^{c}
SD_2 (12 fish/m^3)	300	219.13 ± 1.48^{b}	23.18 ± 0.09^{b}	1.75 ± 0.03^{b}
SD_3 (15 fish/m^3)	300	187.47 ± 1.48^{c}	21.23 ± 0.0^{c}	1.95 ± 0.03^{a}
FS x SD				
FS_1 x SD_1	150	191.57 ± 1.52^{d}	23.27 ± 0.12^{d}	1.52 ± 0.02^{d}
FS_1 x SD_2	150	188.14 ± 1.52^{d}	22.19 ± 0.12^{c}	1.72 ± 0.02^{c}
FS_1 x SD_3	150	174.14 ± 1.52^{e}	20.12 ± 0.12^{e}	2.13 ± 0.02^{a}
FS_2 x SD_1	150	268.12 ± 1.52^{a}	27.33 ± 0.12^{a}	1.32 ± 0.02^{e}
FS_2 x SD_2	150	250.13 ± 1.52^{b}	24.18 ± 0.12^{b}	1.76 ± 0.02^{c}
FS_2 x SD_3	150	200.81 ± 1.52^{c}	22.14 ± 0.12^{c}	1.85 ± 0.02^{b}
Overall mean	900	212.15 ± 0.81	23.20 ± 0.05	1.72 ± 0.01

Means with the same letter in each colum are not significalty different ($P > 0.05$).

Table (3) presents some parameters of growth performance. There were significant ($P < 0.05$) differences among the experimental treatments in daily weight gain, specific growth rate (SGR) and feed conversion ratio (FCR). As described in this Table, SGR values were 1.16; 1.13; 1.08; 1.03; 1.00 and 0.86 for the treatments (FS_1 x SD_1; FS_1 x SD_2; FS_1 x SD_3; FS_2 x SD_1; FS_2 x SD_2 and FS_2 x SD_3) , respectively. Data indicated that small fish (30 g) showed the highest SGR records compared with the large fish. On the other hand , weight gains and daily weight gains recorded values indicating that large fish (50 g) at stocking showed the high weight gains and dialy gains records compared with those of the small fish (30 g). These results are in agreement with the findings of Soha and Dewan (1979), Megintly (1986), Eid and El-Gamal (1997) and Mahmoud *et al*. (2003) who studied the effect of stocking rate on the growth performance of Nile tilapia and the interaction between fish size at stocking and growth parameters. It was noticed that the best SGR was recorded by the small fish size but the weight gain and daily weight gains were recorded by the large fish size of Nile tilapia reared in earthen ponds (Table 3).

The FCR values declined as fish size increases, many studies confirmed these results, (Meyer-Burgdorff *et al*.,1989 and Sayed and Abou-Seif,2006) with *O. niloticus*, they reported that FCR decreased with each increase in fish size and this means that FCR improved significantly in Nile tilapia.

Survival rate and fish production characteristics:

Results presented in Table (3) illustrate the effects of mono sex Nile tilapia fish size and density at stocking on survival rates; final total biomass and total gain of Nile tilapia. The results indicated that survival rate ranged between 85% (FS_2 x SD_3) and 96% (FS_1 x SD_1) which indicated that Nile tilapia fish size and density had remarkable effects on tilapia survival. These results are in accordance with those reported by Viola and Zohar (1984), Teshima *et al.* (1987) Salam *et al*. (1992); Mahmoud *et al*. (2003) and Abdel-Hakim *et al*. (2006), who found that the survival rate improved in fish ponds applied lower total biomass (lower fish size and density at stocking). The initial total biomass of fish in all the experimental treatments were 1138.91; 1555.34; 1918.98; 1922.50; 2525.54 and 3175.83 Kg/fed. for treatments FS_1 x SD_1, FS_1 x SD_2, FS_1 xSD_3,FS_2 x SD_1, FS_2 x SD_2 and FS_2 x SD_3, respectiviely. Treatment FS_2 x SD_2 followed by treatment FS_2 x SD_3 produced the heaviest final total biomass and hence also total gain of fish (Kg/fed). However, treatment FS_2 x SD_2 reflected the significantly ($P<0.05$) highest dressing and flesh percentages comparing with other treatments as shown from Table (3). However fish size and density is known with their effects on fish growth and total production as given by Salam *et al*. (1992), Eid and El-Gamal (1997), Mahmoud *et al*. (2003) and Abdel-Hakim *et al*. (2004).

Cost benefit:

Costs of feed and profit index per one Kg fish (in LE) at different treatments are given in Table (4). Costs of feed intake per one Kg fish gain (in LE) at different treatments were 3.08; 2.92; 2.88; 2.56; 2.52 and 2.66 for treatments FS_1 x SD_1; FS_1 SD_2; FS_1 x SD_3; FS_2 x SD_1; FS_2 x SD_2 and FS_2 x SD_3 , respectivily. These results indicated that lower fish size and density at stocking increased the feed cost. On the other hand, profit index was improved by decreasing cost of feed intake. The best fish size and density achieved low feed cost and high profit index was for the 5th treatment (FS_2 x SD_2) followed by the 4th treatment (FS_2 x SD_1). These results are in partly agreement with soha and Dewan (1979) and Mahmoud *et al*. (2003), they examined the effect of size at stocking on growth and yield of Nile tilapia. Also El-Daker (1999) and Bakeer (2006) who working on rabbit and eel fish, respectively were getting approach from these results.

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CONCLUSIONS

Based on the obtained results from this study, it could be concluded that fish size of 50 g/fish at stocking density of 12 fish/m^3 were the optimal size and stocking density to recommend to be used at stocking in monoculture semi intensive system for monosex Nile tilapia to give the best marketable size and bigest yield at harvest, under similar conditions to those of the present study.

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تأثير كل من كثافة وحجم الأسماك عند بداية التخزين على أداء النمو والحجم التسويقى للأسماك

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في دراسة على البلطى النيلى وحيد الجنس المستزرع فى أحواض ترابية بنظام الاستزراع وحيد النوع شبه المكثف، قد تضمنت التجربة عدد ١٢ حوضاً مستطيل الشكل، مساحة كل حوض (٦٠٠٠ م^{٢}) ممثلة لعدد ستة معاملات، ثلاثة معدلات للتخزين ك$_{١}$ ، ك$_{٢}$، ك$_{٣}$ (٩ – ١٢ – ١٥ سمكة/م^{٣})، وفى داخل كل معاملة تم استخدام حجمين من الأسماك ح$_{١}$ و ح$_{٢}$ (٣٠ – ٥٠ جم/سمكة)، تم تكرار كل معاملة فى حوضين٠ أظهرت معاملة الأحواض التى استخدم فيها الأسماك بحجم ٥٠ جم للسمكة مع معدل تسكين ١٢ سمكة للمتر المكعب أفضل المعاملات إذ أدت إلى زيادة كلية فى صافى الوزن بمقدار متوسط (٨٨٢٠,٣٥ كجم للفدان)، وأقصى دليل ربحية ٢,٩٧. وبناء على النتائج المتحصل عليها توصى الدراسة باستخدام معدل تسكين ١٢ سمكة/م^{٣} بحجم ٥٠ جم/للسمكة فى النظام أحادى النوع شبه المكثف عند بداية التخزين للحصول على الحجم التسويقى المناسب عند الحصاد تحت الظروف المماثلة لظروف التجربة٠

Table (1) Means ± S.E of water quality criteria of the experimental ponds:

Parameters	**FS_1 x SD_1**	**FS_1 x SD_2**	**FS_1 x SD_3**	**FS_2 x SD_1**	**FS_2 x SD_2**	**FS_2 x SD_3**
Temperature, °C	26.7 ± 0.6	27.0 ± 0.6	26.5 ± 0.6	27.2 ± 0.6	28.0 ± 0.6	27.0 ± 0.6
Secchi Disk, cm	16.0^{b} ± 0.3	17.0^{b} ± 0.3	19.0^{b} ± 0.3	25.0^{a} ± 0.3	25.0^{a} ± 0.3	28.0^{a} ± 0.3
pH	8.10^{a} ± 0.2	8.2^{a} ± 0.2	8.0^{a} ± 0.2	7.5^{b} ± 0.2	7.0^{b} ± 0.2	6.5^{b} ± 0.2
Dissolved oxygen, mg/l	6.9^{a} ± 0.4	6.6^{a} ± 0.4	6.5^{a} ± 0.4	6.0^{b} ± 0.4	5.6^{b} ± 0.4	5.0^{b} ± 0.4
Un-ionized Ammonia, mg/l	0.09^{b} ± 0.1	0.09^{b} ± 0.1	0.10^{b} ± 0.1	0.12^{b} ± 0.1	0.17^{a} ± 0.1	0.18^{a} ± 0.1
Alkalinity,mg/l	391 ± 50.3	390 ± 50.3	391 ± 50.3	392 ± 50.3	391± 50.3	390 ± 50.3
Phosph. mg/l	0.28^{a} ± 0.05	0.26^{a} ± 0.05	0.23^{a} ± 0.05	0.18^{b} ± 0.05	0.16^{b} ±0.05	0.16^{b} ± 0.05
Phytoplankton, Organism/L						
Chlorophyta	2813^{a} ± 66.5	2350^{a} ± 66.5	2100^{a} ± 66.5	1899^{b} ± 66.5	1813^{b}±66.5	1650^{b}±66.5
Cyanophyto	1808^{a} ± 33.2	1400^{a} ± 33.2	1301^{a} ± 33.2	1101^{b} ± 33.2	1200^{b}±33.2	980^{a} ± 33.2
Bacillarophyta	973^{a} ± 31.0	944^{a} ± 31.0	983^{a} ± 31.0	950^{a} ± 31.0	918^{a} ± 31.0	730^{b} ± 31.0
Total phytoplankton	5594^{a} ±107.2	4694^{a}± 107.2	4384^{a}±107.2	3950^{b}±107.2	3931^{b}±107.2	3360^{b}±107.2
Zooplankton, Organism/L						
Rotifera	1340^{a} ± 33.8	1340^{a} ± 33.8	1211^{b} ± 33.8	1200^{b}±33.8	1118^{c}± 33.8	920^{c} ± 33.8
Copepoda	810^{a} ± 29.5	800^{a} ± 29.5	791^{a} ± 29.5	789^{b} ± 29.5	760^{b} ± 29.5	610^{c} ± 29.5
Cladocera	630^{a} ± 29.2	610^{a} ± 29.2	580^{b} ± 29.2	569^{b} ± 29.2	550^{b} ± 29.2	505^{c} ± 29.2
Total zooplankton	2780^{a}± 107.3	2750^{a}±107.3	2582^{b}± 107.3	2578^{b}±107.3	2428^{b}±107.3	2035^{c}±107.3

Mean of 12 samples (2 replicates and 6 samples for each replicate)
Means in the same row having the same super letter are not significantly different (P > 0.05).

Table 3: Effect of fish size and density at stocking on growth preferment and total Nile tialpia production and its characteristics at harvest.

Treatments	FS_1 x SD_1	FS_1 x SD_2	FS_1 x SD_3	FS_2 x SD_1	FS_2 x SD_2	FS_2 x SD_3
Average initial weight, g.	30.13 ± 1.25^{b}	30.86 ± 1.25^{b}	30.46 ± 1.25^{b}	50.86 ± 1.25^{a}	50.11 ± 1.25^{a}	50.41 ± 1.25^{a}
Initial total biomass, Kg/fed.	1138.91	1555.34	1918.98	1922.50	2525.54	3175.83
Average final weight, g.	191.57 ± 1.52^{b}	188.14 ± 1.52^{b}	174.14 ± 1.52^{b}	268.12 ± 1.52^{a}	250.13 ± 1.52^{a}	200.81 ± 1.52^{a}
Survival rate, %*	96%	95%	93%	93%	90%	85%
Final total biomass, Kg/fed.	6951.69	9008.14	10202.86	9425.49	11345.89	10753.37
% from the best value	61.27	79.39	89.92	83.07	100.00	94.77
Total gain, Kg/fed.	5812.78	7452.8	8283.88	7502.99	8820.35	7577.54
Daily weight gain, g/ fish	1.009^{c}	0.983^{c}	0.898^{d}	1.357^{a}	1.250^{b}	$0.94o^{C}$
Specific growth rate, %/d**	1.16^{a}	1.13^{a}	1.08^{b}	1.03^{b}	1.00^{c}	0.86^{d}
Dressing, %	46.48^{bc}	46.31^{bc}	48.22^{b}	49.48^{ab}	50.15^{a}	45.91^{c}
Flesh %	37.33^{bc}	37.28^{bc}	36.20^{b}	37.32^{ab}	38.25^{a}	36.48^{c}
Feed intake (g/fish)	276.06	254.79	229.88	308.50	280.02	222.59
Feed conversion ratio ***	1.71^{c}	1.62^{b}	1.60^{b}	1.42^{a}	1.40^{a}	1.48^{a}

Means in the same row having the same superscript letter are not significantly different (P > 0.05).
*** Survival rate % = (Final No of fish/Initial No of fish) x 100 ** Specific growth rate (SGR) = (Ln final wt-Ln initial wt) x 100/days**
***** Feed conversion ratio (FCR) = feed intake (g)/weight gain (g).**

Table 4: Costs of feed and profit index per one Kg fish (in LE) at different treatments.

Items	Treatments					
	FS_1 x SD_1	FS_1 x SD_2	FS_1 x SD_3	FS_2 x SD_1	FS_2 x SD_2	FS_2 x SD_3
Feed intake per one Kg gain (Kg)	1.71	1.62	1.60	1.42	1.40	1.48
Feed intake Cost [1] (LE)[2]	3.08	2.92	2.88	2.56	2.52	2.66
% of the smallest value	122.22	115.87	114.28	101.58	100.00	105.55
Profit index[3]	2.44	2.57	2.60	2.92	2.97	2.82
% of the smallest value	100.00	105.32	106.55	119.67	121.72	115.57

1- Price of one ton of feed equal 1800 LE
2- LE means Egyptian pound 0.17 US $
3- Profit index = income of Kg gain of fish/feed intake cost (price of fish was calculated as 7.5, LE per 1 Kg fish).