JOURNAL OF THE
ARABIAN AQUACULTURE SOCIETY
Vol. 6 No 2 **December 2011**

Evaluation of Reproductive Performance of Tilapia Strains and Some of Their Crosses

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ABSTRACT

Four tilapia (*Oreochromis niloticus*) strains and some of their crosses (two and three ways families crosses) were studied to evaluate their reproductive performance. The highest mean fry weight was recorded for both ZW (Zawia) MR (Marouyt) strains, while AS (Aswan) strain was recorded the lowest one. The fry no. /female (g) was highest for ZW strain, while the low fry production was obtained from AS, MR and AB strains. Positive correlation coefficient was recorded between the fry no/female and fry no./female (g) for the four strains. The correlation coefficient between mean fry weight & fry no./female was absolute positive for AS strain and negative for MR strain. In the two ways families crosses, ZW strain as a sire and AB strain as a dam gave the highest no. fry / female, whereas lowest number with MR dam. Positive correlation was recorded in the two ways crosses with AS strain as a sire with AB, MR and ZW for fry no. /female and female weight. For three ways crosses sire (MRZW) with MR strain dam recorded the highest mean fry weight which represented highly significantly differences (P>0.0001). In parallel to low mean weight for ZW strain dam with sire (ASMR). Positive correlation was recorded in all three ways crosses for fry no. /female and female weight. In two ways families crosses AS strain as sires exhibited negative heterosis for all parameter under the study, while ZW strain sires gave positive heterosis and the highest heterosis for fry no./female (g) was recorded with AS. Heterosis for all three ways crosses was positive for fry no. /female. The variation in the results in this study could be due some genetic effects and environmental effect as well as the interaction between them. Some genes found the environment which helps in express their action.

Keywords: ***Tilapia*, reproduction, individual spawning, families crosses, correlation.**

INTRODUCTION

Most of tilapia cultured in the world is Nile tilapia (*Oreochromis niloticus*) for its tolerance to a wide variation in the environmental condition. The majority of the world production of Nile tilapia is based on six initial sources: Ivory Coast, Ghana,

Egypt–Manzala, Egypt–Ismailia, Sudan–Nile and Lake George, Uganda. Stocks originating from Aswan, Egypt, and Lake Turkana, Kenya are less common (Osure, and Phelps, 2006). The gene pools of these stocks were commonly established from a limited number of fish which lead to inbreeding and genetic depression. Su *et al.* (1996) found that the inbreeding increased growth rate but reduced reproductive success.

The non-genetic nature of variation in size at maturity is the failure of population genetics studies to detect any differences between small and large maturing feral *Oreochromis mossambicus* (Peters) populations of single origin (Bluhdorn & Arthington, 1990).

As consumer demand for tilapias increases, it becomes vital that culture operations successfully meet market demand. Optimization of hatchery efficiency is of paramount importance if production is to be maximized and maintained (Coward & Bromage, 2000). The domestic market for tilapia as a food fish has increased and consequently, the number of intensive fish farming has also followed this trend. As a result, fish farmers have been introducing different strains to improve the productivity (Aparecida Moreira *et al.,* 2005). The female *Oreochromis* produces a small clutches of eggs, commercial hatchery operators have to keep and manage a large number of broodfish to fulfill the demand for seed (Bhujel *et al*., 2007).

Tilapia exhibit great variability in spawning frequency even under environmentally-controlled conditions (Coward & Bromage, 1999), in particular the age and size at maturity (Duponchelle *et al.,* 1998). The tilapias are renowned for their variability in reproductive traits. There is also evidence to suggest that the total fecundity of *O. niloticus* is more closely related to maternal age than size (Rana, 1986). Reproduction in tilapias can be inhibited under high stocking density (Coward *et al*., 1998). Large variations within and between the strains of tilapia have been reported for fecundity (Rana & Macintosh, 1988) and frequency of spawning (Macintosh & Little1995).

The number of eggs per spawn may differ among species, but within species, the larger the female the greater the number of eggs and thus it is better to use the larger sized breeders (100-150g/fish) than the smaller sized ones in case of producing fry (Badawy, 1993). Fecundity is known to vary amongst individual tilapia of similar size, particularly within the larger size classes (Coward & Bromage, 1999). Genetic inheritance undoubtedly also plays a vital role in fecundity

determination (Coward & Bromage, 2000). The reproductive traits are determined by many genes (Pullin *et al.*, 1991).

Characterization females by spawning females as indicator of productivity of individually tagged Nile tilapia, *O. niloticus*, in a hapa-in-pond culture was recorded by Tsadik and Bart (2007).

Although variations in the reproductive potential have been compared between strains of Nile tilapia *O. niloticus* and other species (Little, *et al,*. 1993; Ridha, 2004& 2010), reproduction of individually tagged Nile tilapia (*Oreochromis niloticus*) of different strains (Bolivar *et al.*, 1993) and fingerlings production of four genotypes of tilapias and their combination in earthen ponds (kamel & Badawy, 2005). The spawning performance of four crosses between the salt-tolerant tilapia *Oreochromis spilurus* and the fast-growing genetically improved farmed tilapia (GIFT) strain of the Nile tilapia was recorded by Ridha (2010).

Most of studies on tilapia strains are focused on the growth performance (kamel, 1999; Elghobashy, *et al.*, 2000).; growth performance and feed utilization strains of the Nile tilapia (Abdel-Tawwab, 2004) or growth performance for tilapia tested in different farm environment (Eknath, *et al.*, 1993). An attempt to improve the reproductive efficiency of Nile tilapia brood stock fish by using a basal diet supplemented with different additives was recorded by Abdelhamid, *et al*. (2010).

Most of heterosis in tilapia studies was focused on growth (Bentsen *et al.*, 1998; Maluwa & Gjerde, 2006; Nguyen *et al.*, 2009; Rezk & Kamel, 2010).

The overall objective of this study was to compare the four strains of Nile tilapia (*Oreochromis niloticus*) and some of their crosses (two and three ways families crosses) to evaluate their reproductive performance in individual spawning for one spawning. Heterosis for fry no/female (g), mean fry weight and fry no/female was studied.

MATERIALS AND METHODS

Fish background and history

Different strains of *Oreochromis niloticus* females (average weight 151.43 ±7.98 g) and males (average weight 162.14 ±4.56 g) of the same age, were collected from areas with geographical isolation in Egypt, namely Abbassa (AB), Maroyout (MR) and Zawia (ZW). Which were studied and described by

Kamel (1999) In addition to Aswan (AS) strain which was studied with the previous fish by Rezk and kamel (2010).

Experimental Design

Three experiments were conducted for studying the fry number per female gram (fry no/female (g)), mean fry weight and fry number per female.

First experiment was studied and compared the four strains. Second experiment was using AS and ZW, as sires for producing two ways crosses with other strains. Third experiment was studying some crosses with the pure strain as three ways crosses (Table 1).

The mating system used in the study for all experiments was individually mating (one female and one male) in nylon hapas made from fine-mesh (1×1×1m) and suspended in concrete tanks (2.5 × 5m). The filtered water from Ismalia Canal provided with aeration was supplied to each tank. Ten males and females from each strain or their crosses were fed once daily 7days/week fish pellet 25 proteins at 10% of the body weight. After two weeks of stocking the hapas were checked and males were transferred from hapas contained fry or females had yolk sac fry or egg in her mouth. After that the checked was every week. After week from recording the spawning the number of fry and the weight were recorded. One hundred fish from each pairing was transformed separately to a new hapa for nursing. The fry were fed powder 40% protein for 21 days. The temperature was measured daily ($26^{o}C \pm 2$); dissolved oxygen was 5-3 mg/L; pH was 7.2-8.3; nitrite was less than 0.05 mg/L; ammonia was less than 0.2 mg/L and salinity was 2‰ .

Data analysis

The SAS computer software was used for analysis the data. The PROC GLM and nested analysis were used for calculated the mean for each experiment as Duncan's multiply rang test to determine differences in means. Correlation coefficient and stander

Table (1) the crosses background and mating designs for producing three ways crosses.

Crosses background		Sire	Dam
Sire	**Dam**		
AS	**AB**	**ASAB**	**ZW**
AS	**MR**	**ASMR**	**MR**
AS	**MR**	**ASMR**	**ZW**
MR	**ZW**	**MRZW**	**MR**

errors were estimated for the four strains and their crosses. Heterosis was calculating according to Tave (1993).

RESULTS

The results of the three experiments were recorded for one spawning. First experiment showed significant different (P>0.05) among the four strains (Figure 1, A, B & C). The highest mean fry weight was recorded for both MR and ZW strains (0.56 &0.55), while AS was recorded the lowest mean fry weight (0.25).

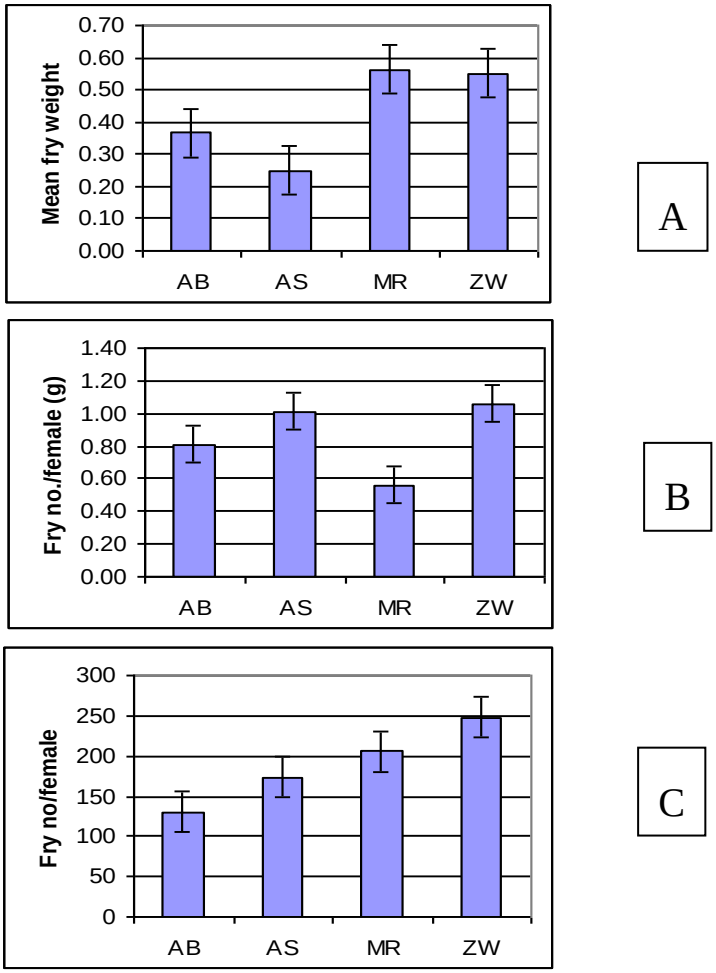


Fig (1): ***Showing mean fry weight (A), fry no. female (g), (B) and fry no. female (C) for four strain of O.niloticus.***

For fry no./female (g) AS and ZW strains showed the highest fry no./female (g) (1.01& 1.06), in contrast to MR strain gave the lowest (0.56). In regards to the fry no./female ZW strain produced the highest number (248) and AB strain the lowest (130).

Positive correlation coefficient was recorded for fry no./female & fry no./female (g) as shown in Table (2) for the four strains ranged from absolute in AS strain, moderate for MR strain , strong for AB and ZW strains. Even though negative correlation was recorded for the four strains for female weight & fry no./female (g).

Positive and absolute correlation coefficient with recorded for AS strain among mean fry weight & no. fry /female and mean fry weight for both fry no./female and fry no./female (g) as shown in Table (2).

Table (2)*: Correlation coefficient among the four strains and the combinations of tested parameters*

Strain / Tested Parameters	AB	AS	MR	ZW
mean fry weight & fry no./female	0.068	1.000	-0.795	0.189
mean fry weight & female weight	0.867	-1.000	0.335	-0.512
mean fry weight & fry no./female (g)	-0.509	1.000	-0.685	0.482
fry no./female & female weight	0.247	-1.000	0.074	-0.769
fry no./female & fry no./female (g)	0.763	1.000	0.527	0.747
female weight & fry no. /female(g)	-0.434	-1.000	-0.782	-0.999

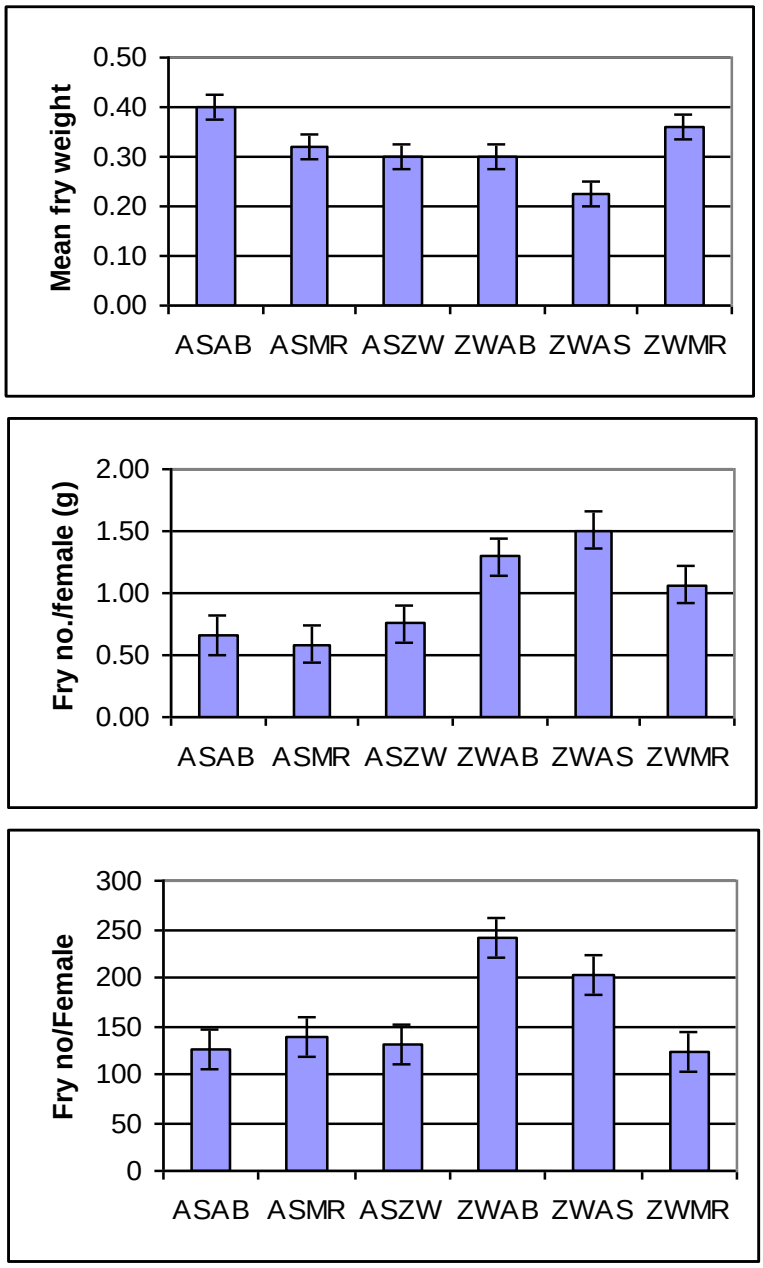


Fig.(2) Showing mean fry weight (A), fry no. female (g) (B) and fry no. female (C) for two way crosses for both AS and ZW strains sires with the other strains of O. niloticus

The correlation coefficient between mean fry weight & fry no./female was absolute positive for AS strain and negative for MR strain. The correlation coefficient between the mean fry weight and female weight was negative for both AS and ZW strains. Strong positive correlation was recorded for AB strain between the mean fry weight and female weight, while it was weak for MR strain. Absolute and positive correlation coefficient was recorded for AS strain between mean fry weight and fry no./female (g) and negative for both AB and MR strains. Weak correlation coefficient was recorded for AB strain between the fry no./female & female weight , and negative for both AS and MR strains.

The second experiment two ways crosses AS strain as a sire and AB strain as a dam gave the highest mean fry weight (0.4) in parallel to lowest ZW strain sire and AS strain dam (0.23 (P>0.05)). No significant differences were recorded for crosses AS strain sire with MR and ZW strains dam; AB strain dam with ZW strain sire (0.32, 0.30 and 0.30 respectively).

AS strain sire and MR strain dam produced the lowest (0.6) fry no./female (g) and ZW strain dam with AS strain sire (0.7, (P>0.05)). While ZW strain sire and AS strain dam produced the highest (1.5) fry no./female (g) per one spawning.

The fry no/female for one spawning showed significant differences among all two ways crosses (Figure 2). ZW strain sire and AB strain dam gave the highest fry no/female (241) in contrast to ZW strain sire with MR strain as a dam gave the lowest egg no./female (123).

Correlation coefficient among AS strain sires with the other three strains (AB, MR, ZW) in two ways crosses showed variation in the correlation (P> 0.001). Absolute and strong correlation was recorded for all two way crosses from AS sires with AB, MR, ZW strains as dams for fry no./female weight. In contrast to, AS sires with ZW, MR strains revealed negative correlation for mean fry weight and both fry no./female and female weight, while, no correlation was recorded for AB strain. Absolute and strong correlation was recorded for the two way crosses from ASAB, ASZW strains for fry no./female& fry no./female (g); female weight& fry no. /female (g), while AS MR strains revealed negative correlation coefficient.

Positive correlation was recorded in the two ways crosses with ZW strain as a sire for mean fry weight & fry no./female (g) ranged from

absolute positive with AB strain and strong for both AS and MR strains (Table 3). Negative correlation coefficient for mean fry weight & female weight; female weight & fry no. /female (g) for the two way crosses of ZW strain as sires with the other three strains was recorded.

For three ways crosses sire (MRZW) with MR strain dam recorded the highest mean fry weight (1.8) which represented highly significantly differences (P>0.0001). In parallel to low (0.3) mean weight for ZW strain dam with sire (ASMR). MR strain dam with ASMR strains sire produced the highest (1.3) fry no./female (g)in contrast to low (0.9) fry no./female (g) for ZW strain dam with sire (ASMR). Sire (ASAB) with ZW strain dam produced the highest (221.7) fry no./female in contrast to sire (ASMR) with MR strain dam produced lowest (139) fry no./female (P>0.001) (Figure 3). Positive and strong correlation coefficient were recorded for all the three ways crosses for fry no./female & female weight. Even though, mean fry weight and both fry no./female and fry no./female (g); female weight & fry no./female (g) revealed negative and weak correlation coefficient (Table 4).

Table (3): ***Correlation coefficient for two ways crosses for both AS and ZW strains of tested parameters and other strains.***

Crosses / Tested Parameters	ASAB	ASMR	ASZW	ZWAB	ZWAS	ZWMR
mean fry weight & fry no./female	0	-0.998	-1.000	1.000	0.768	-0.129
mean fry weight & female weight	0	-0.993	-1.000	-1.000	-0.726	-0.764
mean fry weight & fry no./female (g)	0	0.768	-1.000	1.000	0.816	0.823
fry no./female & female weight	1.000	0.983	1.000	-1.000	0.991	0.473
fry no./female & fry no./female (g)	1.000	-0.725	1.000	1.000	-0.924	0.114
female weight & fry no. /female(g)	1.000	-0.840	1.000	-1.000	-0.958	-0.816

Table (4). Correlation coefficient for three ways crosses for some strains of O. niloticus tested parameters for reproduction

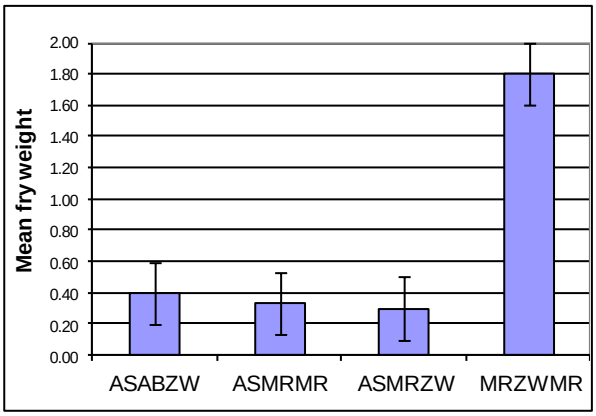
Crosses / Tested Parameters	ASAB ZW	ASMR MR	ASMR ZW	MRZW MR
mean fry weight & fry no./female	0.410	-0.990	0.410	-0.823
mean fry weight & female weight	0.326	-0.846	0.326	-0.327
mean fry weight & fry no./female (g)	0.000	0.778	0.000	-0.949
fry no./female & female weight	0.944	0.912	0.944	0.807
fry no./female & fry no./female (g)	-0.436	-0.858	-0.436	0.601
female weight & fry no. /female(g)	-0.705	-0.993	-0.705	0.013

With regard to two way family crosses AS strain as sires exhibited negative heterosis for all parameter under the study. In the same time ZW strain sires gave positive heterosis and the highest heterosis for fry no./female g) was recorded with AS (45.718 %). Fry no./Female in AS sires with both AS and MR dams gave negative heterosis in parallel to positive with AB dam (Table 5). In three ways families crosses positive heterosis were recorded and ASMRMR revealed highest heterosis for fry no./female g.

Mean fry weight was negative in crosses except ASAB and MRZWMR which showed positive heterosis.

DISCUSSION

The *O. niloticus* fish from the four strains (AB, AS, MR & ZW) were collected from area with geographical isolation and were used in this investigation of the same age to fix the age effect. The variation in average weight of males (162.14 ±4.56 g) to females (151.43 ±7.98 g) was not high to prevent the aggressive behavior of males toward the females (Kamel & Badawy, 2005; Ridha, 2010). All water quality parameters were at the



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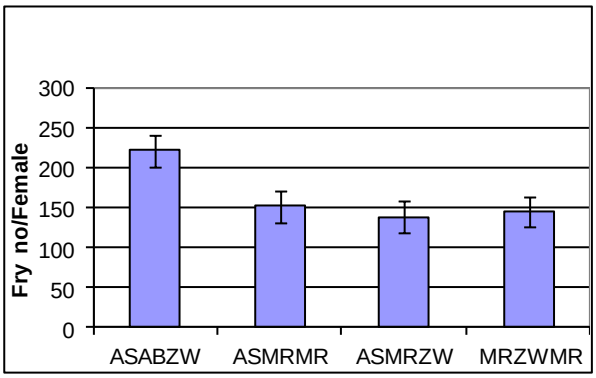

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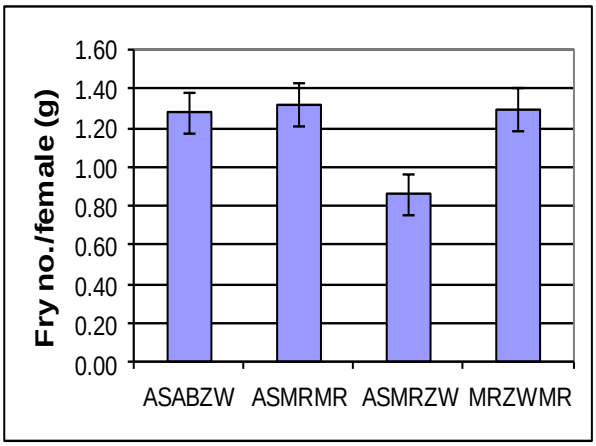

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Fig.(3). ***Showing mean fry weight (A), fry no. female (g) (b) and fry no. female for three ways crosses for AB, AS and ZW strains of O. niloticus***

Table (5). ***Heterosis for two and three ways crosses for some strains of O. niloticus tested parameters for reproduction***

Crosses	Fry no./female g	Mean fry weight	Fry no./Female
ASAB	**-27.417**	**29.730**	**-14.396**
ASMR	**-25.321**	**-21.231**	**-8.564**
ASZW	**-26.990**	**-25.000**	**-2.254**
ZWAB	**38.536**	**-34.545**	**27.834**
ZWAS	**45.718**	**-43.750**	**-3.440**
ZWMR	**32.089**	**-35.281**	**-45.551**
ASABZW	**48.985**	**-15.789**	**17.336**
ASMRMR	**130.902**	**-24.457**	**-19.719**
ASMRZW	**5.239**	**-31.034**	**-34.045**
MRZWMR	**59.264**	**290.244**	**-11.812**

normal level. The temperature as an important factor in reproduction and fry production of tilapia was 26^{o}C ± 2^{o}C which is optimal range. The mean fry weight showed significantly different (P>0.05) among the four strains. The highest mean fry weight ZW strain produced highest number and AB strain the lowest. The obtained results were in contrast with Kamel (1999) who reported that AB produced the highest fry no./female body weight from mass spawning in earthen ponds, while ZW was the lowest. The two and three ways crosses showed significant variation in all tested parameters. For example in two way crosses AS (sire) ZW (dam) gave lower fry no./female (g) while ZW (sire) AS (dam) produced higher fry no./female (g) which mentioned to the role of the maternal effect which agreed with Rezk and Kamel 2010. They reported that Maryout was the highest, for was recorded for both ZW and MR strains, while AS was recorded the lowest mean fry weight. For fry no./female (g) AS and ZW strains showed the highest fry no./female (g), in contrast to MR strain gave the lowest. In regards to the fry no./female maternal effect while the Abbassa strain was ranked as the lowest of all the strains. Some strains performed better when used as sires or dams in reciprocal crosses. On the other hand ZWMR two way crosses produced the lowest fry no./female, same results were represented by Kamel (1999) for the same strain but in mass spawning and mentioned that MR strain was more heterozygous compared to ZW strain.

Four populations (strains) strain of Nile tilapia were collected from Ivory Coast, Egypt, Saganal and Lake Victoria differed in relative fecundity

(seed/g female) and Ivory Coast strain giving eight times more fry per kg of female brooder used than the Lake Victoria strain (Osure & Phelps, 2006).

Ridha (2010) reported that the tilapia (GIFT) strain cross had the highest values for spawning performance and seed production followed by the *O. spilurus*. The decrease in the spawning performance observed in the reciprocal hybrids is due to the lower social compatibility between the males and females compared with that of the pure parents.

The variation in the results of this investigation among the four strains may be due to genetic variation for strains originated from area with geographical isolation. This is in accordance with Kamel (1999) who recorded that the genetic characterization of the strains collected from different area showed genetic variation for AB, MR and ZW strain. The collected strains may be affected by the inbreeding and crossbreeding in the nature or under the hatcheries conditions Dunham and Smitherman (1984) reported that strain differences, inbreeding and crossbreeding can affect reproductive performance in cultured fishes. Large strain differences were evident for reproductive performance in channel catfish.

Positive correlation coefficient was recorded for fry no./female & fry no./female (g) for the four strains ranged from absolute in AS strain , moderate for MR strain , strong for AB and ZW strains. However, Broussard *et al*. (1983) reported that there was no correlation between size of tilapia and fingerlings production under pond condition. Also, Cisse (1988) found no significant correlation between the weight and the number of eggs per spawning.

Even though negative correlation was recorded for the four strains for female weight & fry no./female (g) Kamel and Badawy (2005) reported no significant correlation between the averages weight of females and number of fingerlings produced was found. The correlation coefficient was negative (-0.11295) between females weight and fingerlings total weight in tilapia genotypes and their combination. Phenotypic correlations observed between female body weight at first spawning with the number of eggs produced, 0.64 to 0.76. Overall, the correlations between these traits were significant (P<0.05) for growth and reproduction of individually tagged Nile tilapia (*Oreochromis niloticus*) of different strains (Bolivar *et al*., 1993)

The differences in the spawning parameters among the four genotypes

from hybridization between *Oreochromis spilurus* and the GIFT strain of the Nile tilapia *Oreochromis niloticus* were not statistically significant (Ridha, 2010). Fecundity is apparently influenced by genetic factors, as well as by environmental conditions, especially those influencing the nutritional status of the fish (Tsadik & Bart, 2007).

In Case of fry no./female (g) ZW strain sires with AS strain dam gave highest positive heterosis while ZW dam with AS sire showed negative heterosis; this indicated the role of both paternal and maternal combination effect.

CONCLUSION

Over all, the variation in the results of fish strains in this study could be due some genetic effects and environmental effect as well as the interaction between them. Some genes found the environment which helps in express their action.

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تقيم الكفاءة التناسلية لسلالات من اسماك البلطى النيلى وبعض الهجن الثنائى والثلاثى من العائلات بينهم

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المعمل المركزى لبحوث الثروة السمكية بالعباسة أبوحماد شرقية–مركز البحوث الزراعية

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تم تقيم اربع سلالات من البلطى النيلى وبعض الهجن الثنائي والثلاثى من العائلات بينهم وذلك لدراسة الكفاءة التناسلية من خلال التزاوج الفردى للافراد لتفريخة واحدة. وسجلت سلالة الزاوية اعلى متوسط وزن للزريعة اما سلالة اسوان فقد كانت الاقل وزنا.

وتم المقارنة بين عدد الزريعة للجرام من وزن الأم وكانت سلالة اسوان الاعلى بينما سلالة مريوط اقلهم عددا.

اما بالنسبة لعدد الزريعة بالنسبة للام فقد اعطت منطقة الزاوية اعلى عدد بينما الاقل كان من مناطق العباسة، الزاوية ومريوط.

وجدت علاقة ارتباط موجب بين عددالزريعة للأم وعدد الزريعة للجرام من وزن الأم للسلالات الاربعة موضع الدراسة. كما وجدت علاقة ارتباط موجب بين عددالزريعة للأم وعدد الزريعة للجرام من وزن الأم للسلالات الاربعة ، تراوحت من مطلقة فى سلالة اسوان و متوسطة لمريوط و قوية لكلا من العباسة والزاوية. بينما كان

علاقة ارتباط موجب مطلق لسلالة اسوان وسالب لمريوط بالنسبة لمتوسط وزن الزريعة وعدد الزريعة للام.

اما الهجن ثنائى العائلا ت فقد أعطت سلالة الزاوية كذكور مع العباسة كاناث اعلى معدلات عدد زريعة للام بينما اقل عدد الزريعة كان مع سلالة مريوط أمهات .

كان هناك معامل ارتباط ايجابى لثنائى الهجن بين عدد الزريعة للام ووزن الام عند استخدام سلالة اسوان كذكور مع اناث المناطق الاخرى.

بالنسبة للهجن ثلاثية العائلات فقد كان استخدام ذكور هجن بين مريوط والزاوية مع سلالة مريوط اناث قد سجل اعلى متوسط وزن للزريعة مع وجود فروق معنوية ($P>0.0001$). بينما كان اقل متوسط وزن قد سجل لسلالة الزاوية مع ذكور هجن بين سلالتى اسوان ومريوط. كان هناك ارتباط موحب قوى بين جميع الهجن الثلاثية بين السلالات بالنسبة لعدد الزريعة للام ووزن الام.

اظهرت قوة الهجن فى حالة التزاوج ثنائى العائلات ان سلالة اسوان اعطت قوة هجين سلبية لكل العناصر فى هذه الدراسه بينما سلالة الزاوية اظهرت قوة هجين موجبة وكان اعلاها بالنسبة لعدد الزريعة للجرام من وزن الام مع سلالة اسوان.

وقد كانت قوة الهجن فى حالة التزاوج ثلاثى العائلات موجبة لكل التزواجات المستخدمة وذلك لعدد الزريعة بالنسبة للام.

فإن الاختلاف في النتائج بين سلالات الاسماك في هذه الدراسة يكون بسبب بعض التأثيرات الجينية و البيئية ، فضلا عن التفاعل بينهما لبعض الجينات ,إن وجدت البيئة والتي تساعد في التعبير عن عملها.