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GENETIC EVALUATION OF *OREOCHROMIS NILOTICUS* STRAINS IN A COMPLETE DIALLEL CROSSES

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ABSTRACT

Four strains of *Oreochromis niloticus* namely, Abbassa (AB), Aswan (AS), Maryout (MR) and Zawia (ZW) were collected from four different geographical locations in Egypt and used to produce a complete diallel crosses. Sixteen combinations from pure strains and their reciprocal crosses were produced by individual mating.

A total of 2170 individuals tagged fingerlings from seventy two full-sib and half sib families were communally stocked in earthen pond for a growth period of 120 days during winter. Strain additive genetic, total heterosis and general reciprocal effects were studied.

The mean body weight for pure strains and their crosses at harvest were significantly different (P<0.0001) and showed coefficient of variation ranged from 46.1% to 70.8 %. Aswan pure strain had the highest growth rate, while Zawia pure strain was the lowest.

Although, Abbassa and Zawia gave the lowest growth rate as pure strains, their crosses (AB, sire and ZW, dam) gave the highest mean body weight. While, in spite of Aswan being the best strain for body weight at harvest, its cross with Abbassa was the worst (AS, as sire and AB, as dam).

The survival rates varied between the pure strains and their crosses. The highest survival rates from stocking to harvest in pure strains were recoded for Aswan, in contrast to Abbassa which had the lowest survival rate. The crosses between Zawia (sire) and Maryout (dam) presented the highest survival rates followed by Maryout (sire) and Abbassa (dam).

Positive and strong genetic correlations were recorded between the initial weight and age of fingerlings of pure strains Aswan, Abbassa, Maryout and some of their crosses. The correlation between the age and survival rate in the pure strains varied from weak in Aswan to strong in Maryout. On the other hand, no correlation was recorded for Zawia between age and Initial weight or survival and age or initial weight and survival. Aswan was the highest of all other strains for additive genetic effect, while Zawia strain showed the lowest rank. The highest rank for additive genetic effects of the crosses was recorded for Aswan & Maryout, whereas, the lowest was recorded for the cross of Abbassa & Zawia.

All strains showed negative heterosis lower than the mean of the two parental strains, except for Abbassa & Zawia cross which showed significant positive heterosis of 16% more than the mean of the pure strains. The average and general heterostic effects for harvest body weight were negative and lower than the mean pure strains. In general Maryout was the highest, for 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.

INTRODUCTION

Tilapia is a popular species in most countries in the world. Although, it originated in Africa, tilapias are farmed in at least 85 countries, with most production coming from the developing countries of Asia and Latin America (Eknath *et al.,* 2007).

Consequently, with the popularity tilapia has gained among consumers, tilapias have become the world's second most popular farmed fish, after carps. Global production of farmed tilapias was about 2 121 009 metric tones in2007, which valued about 2 632 978 U$ (FAO, Statistics 2007).

Local and international markets for farmed tilapias, especially Nile tilapia (*Oreochromis niloticus*) have been growing in the face of declining marine and inland captured fisheries, growth of human populations in developing countries and increases in wealth and health consciousness (Brummett and Ponzoni , 2009).

The differences in growth performance of the base population for GIFT Tilapia between strains were highly significant and Egyptian strains of tilapia were the best (Eknath *et al.,* 1993). The adaptability and tolerance of tilapia species to a wide range of environments as the result of genetic variations between and within the Tilapia strains (Kamel, 1999).

An alternative approach to improving the productivity of cultured stocks is via crossbreeding (intraspecific crossbreeding or interspecific hybridization) to exploit potential heterosis (hybrid vigour) in crossbred offspring (Thanh *et al.,* 2009). Using different strains crosses can improve the productivity by producing superiority than the pure strain. Crossbreeding has been used to transfer favorable traits among strains and crossbreeding can be a relative simple and inexpensive method for improving local strains (Fjalestad, 2005). The requirements and benefits of such a crossbreeding program should be compared with those of purebreeding programs utilizing repeated selection to improve the additive genetic performance (Gjedrem, 1985; Bentsen, 1990; Bentsen and Gjerde, 1994)

The need for a systematic effort to secure and to improve further the genetic quality of farmed stocks of Nile tilapia is widely recognized. The long-term goal should be to supply the tilapia farming industry with domesticated breeds that perform as well as the traditional breeds of terrestrial farm animals when compared to their wild ancestors (Bentsen, 1990; Bentsen *et al.* 1998 and Eknath *et al.,* 1991)

The growth rates of different strains of Nile tilapia and their crosses were superior to pure strains under various rice field conditions (Circa *et al.,* 1994).

Heterosis or hybrid vigour occurs when the performance of offspring surpass the average of its parents or the best parental strain for one or more traits. Crossing inbred lines or unrelated populations leads to heterozygosity, increased fitness and higher productivity. Non-additive genetic effects are primarily responsible for heterosis, with the dominance component playing a major role. The high degree of heterozygosity that usually results from crossbreeding tends to produce a high frequency of dominance effects (Gjedrem and Baranski, 2009)

Heterosis and full diallel cross experiment involving strains of Nile tilapia was conducted to study components for growth traits (Bentsen *et al.,* 1998) ; for four strains of *Oreochromis shiranus* to evaluate the harvest body weight (Maluwa & Gjerde, 2006 a) and for red tilapia to study the heterosis, direct and maternal genetic effects on body traits (Nguyen *et al.,* 2009) .

The superiority of crosses were reported in different fish species e.g., for common carp (Hulata, 1995; Nielsen, 2010), for Rohu carp (Gjerde *et al.,* 2002); for tilapia (Bentsen *et al.,* 1998; Kamel ,1999 ; Maluwa & Gjerde, 2006 a&b)and for red tilapia (Nguyen *et al.,* 2009).

The differences between reciprocal crosses of strains or species are largely attributable to maternal effects, which must be accounted for when evaluating heterosis and the success of hybridization or crossbreeding activities. These effects can involve cytoplasmic inheritance from mitochondrial DNA, or more direct influences which may have genetic bases, such as egg size or quality. Inherent skill in caring for eggs or fry, as might be observed in tilapia (Lutz, 2001)

The ranking of the strain contributions depended on whether the genes of the strain were inherited from a sire or a dam. Unlike the ranking of the additive genetic contributions from sires, Egyptian strain was ranked significantly lower than the Kenyan and Taiwan strains when used as dams, and Israel strain was ranked significantly higher than Ghana, Singapore and Thailand strains when used as dams (Bentsen *et al.,* 1998).

Almost all traits included in breeding goals are quantitative in nature and they are controlled by a large number of genes with additive effects (Gjedrem and Baranski, 2009)

In Egypt, few studies explained the variations in growth performance of different strains of tilapia (kamel, 1999, Rezk *et al,* 2002).

The aim of the present study was to assess the growth of a complete diallel crosses, heterosis and additive and maternal genetic effects of four strains of tilapia to initiate selection breeding program.

Material and methods

Fish collection

The fish were collected from four different geographical locations in Egypt; Maryout (MR) -Alexandria at North Coast of Egypt (Which has lower temperature), Zawia (ZW) - Kafer El Sheikh at the Delta region (which has saline soil) and Abbassa (AB) area at the middle of Delta and were described by Kamel (1999) and Rezk *et al.*(2002) In addition to Aswan (AS) strain, which was collected from Upper Egypt, where the temperature is high. The experiments were carried out at Abbassa ponds at Worldfish Center (formerly, Central Laboratory for Aquaculture Research, CLAR).

The broodstocks per strain used in the present study was taken at random from a pool of progeny originating from a mass spawning of a large number of fish (140 females & 140 males).

Mating design and rearing of fry

One male and two females were stocked per hapa (1x1x1 m) suspended in concrete tanks and were fed twice a day with a fish pellet 25 protein at 10% of the body weight. Two weeks after stocking the breeders, all hapas were inspected and fry spawning dates (Spawning was assumed to have occurred when the dam had eggs or yolk-sac fry in her mouth) were recorded over a period of 1-2 days.

Male breeders that had spawned were removed from the breeding hapas, to a new hapa to spawn with unspawned female for producing the paternal half sibs (Table 1A). To prevent multiple spawning, the male was removed immediately after occurrence the spawning.

The spawned females were removed from hapas after two weeks and fry number were reduced to 100 fry per hapa for rearing. Seventy two successful mating only from one hundred and sixty pairing were obtained which represented fifteen full –sibs and fifty seven half sibs. Each full-sib and half sib families were reared separately in hapas and fed a powder fry diet (40% protein) until tagging.

Table 1A. Diallel crosses mating design involving four strains of tilapia

Sire \ Dam	**AB**	**AS**	**MR**	**ZW**
AB	AB AB	AB AS	AB MR	AB ZW
AS	AS AB	AS AS	AS MR	AS ZW
MR	MR AB	MR AS	MR MR	MR ZW
ZW	ZW AB	ZW AS	ZW MR	ZW ZW

As soon as the fry reached suitable tagging size, 40 randomly chosen fry from each full and half -sibs families were individually tagged with Floy® tags and returned into the respective hapas until stocking.

Individual body weights and lengths were recorded for equal numbers of fingerlings from each strain and their cross combinations. Then 2170 from seventy two full and half-sibs families tagged fingerlings were communally stocked in 1000 m^2 earthen ponds with 1 m water depth for growth and thirty fingerlings from each family were used. The average weight of stocked fingerlings was 2.8 ± 1.3 g.

During the first week, the died fish were removed from the earthen pond and replaced with tagged fish from the same family.

Fish were feed with sinking fish feed pellet 25% protein in this experiment ad libitum

After a growth out period of about 90 days, the pond was drained, and body weight was recorded on every fish with tags.

Data analysis

Body weights at harvest were analyzed using the generalized linear model GLM. SAS Institute, 1990

$Y_{dfgi} = \mu + I_{th} + C_d + A_f + C_d * I_{th} + C_d * I_{th} * A_f + e_{dfgi}$

Where

Y_{dfgi} = body weight of the *g*th individual

μ= is the over all mean

I_{th}= is the Initial weight of an I_{th} individual

A_f = is a covariate effect of age at harvest

C_d=is the fixed effect of the d_{th} strain combination (d=1, 2, ...,16)

e_{dfgi}= is the random residual error

This statistical model was used to estimate the additive genetic and heterosis effects

$y_{ij} = \mu + \Sigma \alpha_i a_i + \Sigma \alpha_{ij} h_{ij} + \Sigma \beta_i r_i + s + e_{ijk}$

where, α_i is the proportion of genes contributed by the n^{th} individual originating from the i^{th} strain (α_i =0.0, 0.5 or 1.0 and $\Sigma\ \alpha_i$ =1.0); a_i is the additive genetic effect of genes originating from the i^{th} strain; α_{ij} is the coefficient of the total heterostic effect for the cross between the i_{th} and j_{th} strains α_{ij} =0.0 or 1.0; i≠j and ij≠ji and $\Sigma\ \alpha_{ij}$ =1.0); h_{ij} is the total heterosis effect for the cross between the ith and jth strains (i≠j and ij≠ji); β_i is the coefficient of the general reciprocal effect for the ith strain β_i =0 for purebreds and −0.5 for male strain and 0.5 for female strain, for the crossbreds and $\Sigma\ \beta_i$ =1.0); r_i is the general reciprocal effect of the i_{th} strain; *s* is the random effect of full-sib group; and e_{ijk} is the random residual error for the I_{th} individual.

The additive genetic effects were restricted $\Sigma\ \alpha_i$ =0.0 The coefficients of the general reciprocal effects set in the present study assume that the additive genetic effects of a given strain are similar regardless of gender of parental breeders (Table 1B).

Table 1B.Genetic analyses of diallel, maternal genetic effects (g^M) and heterosis (h^I)

Sire \ Dam	A	B	C	D
A	g^I_A g^M_A 0	$(g^I_A+g^I_B)/2$ g^M_B h^I_{AB}	$(g^I_A+g^I_C)/2$ g^M_C h^I_{AC}	$(g^I_A+g^I_D)/2$ g^M_D h^I_{AD}
B	$(g^I_B+g^I_A)/2$ g^M_A h^I_{BA}	g^I_B g^M_B 0	$(g^I_B+g^I_C)/2$ g^M_C h^I_{BC}	$(g^I_B+g^I_D)/2$ g^M_D h^I_{BD}
C	$(g^I_C+g^I_A)/2$ g^M_A h^I_{CA}	$(g^I_C+g^I_B)/2$ g^M_B h^I_{CB}	g^I_C g^M_C 0	$(g^I_C+g^I_D)/2$ g^M_D h^I_{CD}
D	$(g^I_D+g^I_A)/2$ g^M_A h^I_{DA}	$(g^I_D+g^I_B)/2$ g^M_B h^I_{DB}	$(g^I_D+g^I_C)/2$ g^M_C h^I_{DC}	g^I_D g^M_D 0

A:Abbassa **B:Aswan** **C: Maryout** **D: Zawia**

Total heterosis for a cross between two strains was partitioned as

$h_{ij} = h + h_i + h_j + s_{ij}$,

where h is the average heterostic effect for all strains involved in the diallel cross, h_i and h_j are the general heterosis effects for the i_{th} and j_{th} stock, respectively, and s_{ij} is the specific heterosis effect of strains.

Results

Growth rate and survival:

The number of fish per strain or cross combination at harvest, mean body weight and survival rates in this study were shown in (Table 2). The fish lost their tags were ignored from recording because it was not possible to distinguish them. The mean body weight for pure strains and their crosses at harvest showed coefficient of variation ranging from 46.1% to 70.8 %. The mean body weight for pure strains at harvest were significantly different (P<0.0001). Aswan pure strain had the highest growth rate (23.8 g), while Zawia pure strain was the lowest (15.5g) (Table 2).

Table .2 Strains and cross combinations of *O.niloticus*, mean weight, standard deviation (SD), coefficient of variation (CV, %) and survival (%) at harvest

Strains and cross combination	Family No.	Fry No.	Mean	SD	CV%	Survival
AB	4	61	15.8 fgh	8.6	54.2	50.8
AB x AS	5	78	17.3 def	9.8	58.0	51.7
AB x MR	6	108	16.1 efg	10.3	64.9	60.0
AB x ZW	3	49	20.3 bc	11.0	55.3	54.4
AS x AB	6	79	13.6 h	6.3	46.1	43.8
AS	7	153	23.8 a	14.3	60.2	65.2
AS x MR	7	106	19.9 bc	13.9	70.8	50.5
AS x ZW	4	55	17.1 def	10.3	59.9	45.7
MR x AB	2	37	16.0 efg	10.3	64.2	61.7
MR x AS	5	78	18.9 cd	12.5	67.6	52.0
MR	3	52	21.5 b	11.0	51.0	57.8
MR x ZW	4	64	14.6 gh	7.2	49.1	53.3
ZW x AB	3	52	17.1 def	11.3	66.2	57.5
ZW x AS	6	99	15.1 fgh	8.9	59.9	55.0
ZW x MR	6	115	18.2 cde	11.6	64.0	63.9
ZW	1	17	15.5 fgh	7.8	50.4	56.7

Rows with different letters are significantly difference

Although, Abbassa and Zawia gave the lowest growth rates as pure strains, their cross (Abbassa sire and Zawia dam) gave the highest growth rate (20.3g). Some strains performed better when used as sires or dams.

On the contrary, Aswan had the best growth rate over all pure strains or crosses, its cross with Abbassa (Aswan sire and Abbassa dam) gave the lowest weight (13.6g)

The survival rates varied between the pure strains and were significantly different (P >0.0001).

The highest survival rate from stocking to harvest in pure strains was recoded for Aswan, (65.2%) in contrast, Abbassa had the lowest survival rate (50.8%).

The cross between Zawia (sire) Maryout (dam) presented the highest survival rate (63.9%) followed by Maryout (sire) and Abbassa (dam) 61.7%.

The lowest survival rate were recorded for Aswan as sires with Maryout, Zawia and Abbassa, respectively

Table3. The correlation coefficients for the pure strains and their crosses among age, survival rate and initial weight.

Pure strain or Crosses	Initial weight and age	Age and survival rate	Initial weight and survival rate
AB	0.66	0.64	0.36
ABAS	0.25	0.01	0.55
ABMR	0.69	0.58	-0.01
ABZW	0.4	0.14	0.96
ASAB	0.1	-0.1	0.52
AS	0.69	0.3	0.54
ASMR	0.85	0.37	0.35
ASZW	0.44	0.02	0.61
MRAB	1	1	1
MRAS	0.22	-0.42	0.73
MR	0.61	1	0.55
MRZW	0.07	-0.59	0.25
ZWAB	0.29	0.79	0.81
ZWAS	-0.31	-0.03	0.46
ZWMR	0.81	0.45	0.76
ZW	0	0	0

Genetic correlations among age, initial weight and survival rate.

Positive and strong genetic correlation was recorded between the initial weight and age of fingerlings of pure strains Aswan, Abbassa and Maryout (0.69, 0.66, and 0.61, respectively). On the other hand, Maryout and Abbassa gave positive and strong correlation between the survival rate and age (Table 3).

The crosses resulted from Maryout as dams revealed strong correlations between age and initial weight with sires from either Abbassa, Aswan or Zawia (0.69, 0.85 and 0.81, respectively).

The correlation between the age and survival rate in the pure strains varied from weak in Aswan to strong in Abbassa. While, complete correlation between Maryout sires and Abbassa dams for initial weight and age was recorded. The genetic correlation between initial weight and survival in pure strains were weak in Abbassa and moderate in Aswan and Maryout. Crosses between Maryout and Abbassa showed complete correlation for initial weight and survival, at the same time as, positive and strong in crosses Abbassa & Zawia, Maryout &Aswan and Zawia & Abbassa (0.96, 0.73 and 0.81, respectively).

On other hand, no correlation was recorded for Zawia between age and Initial weight or survival and age or initial weight and survival

Additive genetic effects

The strain additive genetic effects for harvest body weight are shown in table (4). Aswan was higher (22.9 %) than the other strains for additive genetic effect followed by Maryout, while Zawia pure strain ranked the lowest and represented 22.2 lower than the mean performance of pure strains.

The highest rank for additive genetic effects of the crosses was recorded for Aswan & Maryout, whereas, the lowest was recorded for the crosses of Abbassa & Zawia.

Total heterosis effect for strains

The heterosis effect for body weight at harvest for each strain and crosses were shown (Table 5). All strains showed negative heterosis for body weight lower than the mean of two parents' strains, except Abbassa& Zawia which was higher by 16.02 % than the mean of pure strains. The average and general heterosis for body weight were negative and lower than the mean of pure strains.,

The correlation coefficient between heterosis and additive genetic effect was negative.

Table 4. Estimates of additive genetic effects for body weight of the pure strains (*O.niloticus)* and strain crosses as deviations from the mean of the purebred strains

Strain or crosses	Estimate	%
Mean of pure strains	**19.10**	
Total heterosis		
AB	-0.98	-5.13
AS	4.38	22.93
MR	0.84	4.40
ZW	-4.24	-22.20
Crosses between the strains		
AB x AS	1.70	8.90
AB x MR	-0.07	-0.4
AB x ZW	-2.61	-13.66
AS x MR	2.61	13.66
AS x ZW	0.07	0.37
MR x ZW	-1.70	-8.90

Table5. The total, average and general heterosis effects for body weight of the six strain cross combinations of *O.niloticus* measured as deviations from the mean of the pure strain (in g and %)

Strain or crosses	Estimate	%
Mean of pure strains	**19.10**	
Total heterosis		
AB x AS	-4.36	-22.83
AB x MR	-2.64	-13.82
AB x ZW	3.06	16.02
AS x MR	-3.19	-16.70
AS x ZW	-3.49	-18.27
MR x ZW	-2.13	-11.15
Average heterosis	-2.12	-11.10
General heterosis		
AB	-0.98	-5.13
AS	-2.76	-14.45
MR	-1.99	-10.42
ZW	-0.64	-3.35

Table 6. Genetic maternal effect and genetic value for *O. niloticus* pure strain

Parameter	Strain			
	AB	**AS**	**MR**	**WZ**
Maternal genetic effect	-2.4	0.3	1.6	0.5
Genetic value	-1.0	4.4	0.8	-4.2

For the maternal genetic effect, the results were opposite to those of the additive genetic effect. Zawia was the worst for additive value while was higher than Aswan for maternal genetic effect (Table 6). In general, the maternal effect for Maryout was the highest, while the Abbassa strain was ranked as the lowest of all the strains. Aswan pure strain gave the highest genetic value whereas, Zawia gave the lowest.

DISCUSSION

Some fish lost their Floy tags during the growth period which was common and was reported for tilapia by Bentsen, et al., 1998; Maluwa, and Gjerde, 2006 (a&b),

The variation in the genetic background among the tilapia strains were probably originated from area with geographical isolation, influenced relative growth performance of purebred strains and cross combinations in this study. Also, some genes were found to express themselves in the suitable environment as genetic environment interaction which agreed with Kamel (1999).

The mean body weight for pure strains at harvest were significantly different (P<0.0001). Aswan pure strain had the highest growth rate, while Zawia pure strain was the lowest. Zawia gave better growth rates in other studies than Abbassa which can be attributed to the contribution of Zawia in this study which was represented by only one family and may be affected by the low number of breeders and offspring. This is result in contradiction with Kamel (1999), who reported that Abbassa of the lowest growth rate than Zawia. The variation between tilapia strains was reported for other strains of tilapia, for example Shire was the best and the Chiuta was the poorest performing strain for growth (Maluwa & Gjerde, 2006a); Egyptian strain of tilapia was the best for growth rates when compared to other eight strains of *Oreochromis niloticus* from African and Asia tilapia (Bentsen *et al.*, 1998; Eknath *et al.*, 1993)

Some strains performed better when used as sires or dams in reciprocal crosses showing significant reciprocal effects. Although, Abbassa and Zawia gave the lowest growth rates as pure strains, their crosses (AB, sire and ZW, dam) gave the highest growth rate. However, although Aswan being the best strain for growth rate, its cross with Abbassa was the worst (AS, sire and AB, dam).

The same result was reported in tilapia (Bentsen et al., 1998, Kamel ,1999; Maluwa & Gjerde, 2006,a&b); for common carp (Hulata, 1995; Nielsen, 2010) and for Rohu carp (Gjerde *et al.*, 2002). The growth performances of cross combinations in general, were better or not significantly different from that of pure strains in a diallel cross of three strains of giant freshwater prawn (Thanh *et al.*, 2009)

The survival rates were different between the pure strains and their crosses. The highest survival rate from stocking to harvest in pure strain was recoded for Aswan, in contrast, Abbassa had the lowest in survival rate.

The crosses between Zawia as sire and Maryout as dam recorded the highest survival rate followed by Maryout as sire and Abbassa as dam. This result is in full agreement with Bentsen et al. (1998); Kamel (1999) ; Maluwa & Gjerde, (2006,a&b) for tilapia. The differences between the strains with respect to survival rate was clearly significant for common carp (Nielsen *et al.*, 2010).

The survival interaction effect between production environment and stock combination was highly significant for Rohu carp (Gjerde *et al.,* 2002). No significant difference was detected for total relative survival among strains giant freshwater prawn (Thanh, *et al.*2009)

Positive and strong genetic correlation was recorded between the initial weight and age of fingerlings of pure strains Aswan, Abbassa, Maryout and some of their crosses. The correlation between the age and survival rate in the pure strains varied from weak in Aswan to strong and complete in Maryout. On the other hand, no correlation was recorded for Zawia between age and Initial weight or survival and age or initial weight and survival rate.

The present results disagreed with Bentsen et al., (1998) who reported negative correlation coefficient between the overall LSM of body weight at harvest and mortality for tilapia; Thanh *et al.* (2009), who observed no strong evidence for age or initial size at stocking effect on harvest body weight of giant freshwater prawn and low correlation for survival for Rohu carp stock combinations in monoculture and polyculture (Gjerde et al., 2002). The genetic correlations between weight and survival rate were low and non-significant for W2 but high and significant for W3 (Nielsen *et al.*, 2010).

All strains and cross combinations showed negative heterosis lower than the mean of two parental strains, except Abbassa& Zawia cross which showed significant positive heterosis more than the mean of the pure strains by 16%. The average and general heterostic effects for harvest body weight were negative and lower than the mean pure strains. The obtained results are in the same line with Yapi-Gnaore, (1996), who pointed out negative heterosis for all growth trait studied in the three strains of *Oreochromis spp.*; Maluwa and Gjerde (2006 b) who reported that all six possible two-way crosses gave negative individual heterostic effects, thus resulting in a negative average individual heterosis effect significantly different from zero; and Gjerde *et al.* (2002) who pointed out low or negative total heterosis for harvest weight, for each of the six stock crosses of 3×3 diallel crosses of rohu (*Labeo rohita*). While, the obtained results are in contradiction within a diallel cross between four strains of *Oreochromis shrinanus* in Malawi, the total heterosis effect accounted for 15.3% of the total variance for harvest body weight (Maluwa and Gjerde, 2006a) and Bentsen *et al.*, 1998 who mentioned that the estimates of heterosis vary widely from 5.2 to 14%. The effects are not systematic, suggesting that it is not possible to predict the magnitude of heterosis effects. The Egyptian strain had the highest heterostic effects overall other strains.

The present results may indicate that the non genetic and environmental effect are high which agreed with Wohlfarth (1993) who reported results from crossbreeding experiments with common carp that also suggested that the expression of non-additive genetic effects may be increased under environmental conditions causing low growth rates; Bentsen *et al.* (1998) suggest that the non-additive genetic component of growth performance in Nile tilapia may be more sensitive to environmental variation than the additive genetic component.

The maternal effect of Maryout was the highest, while the Abbassa strain was the lowest of all strains. This result indicated that Maryout is important strain when used in selective breeding program. The results in this study agreed with Yapi-Gnaor (1996) and Bentsen *et al.* (1998), they reported the role of maternal effect of tilapia in selective breeding program.

CONCLUSION

The present study indicated the variation in growth performance between tilapia strains which were originated from area with geographical isolation. The role of genetic environment interaction which was clear in the performance of introduced strain as expression of some genes in the new environment. Some crosses gave better growth than the pure strains.

Some strains performed better when used as sires or dams. Finally the study indicated the role of maternal, additive and genetic effects within tilapia strains.

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تقييم وراثى لاربع سلالات من البلطى النيلى من خلال تزاوج كامل لثنائى الاليل معدل المعيشة وقوة الهجين للنمو والتأثير الاموى

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الملخص العربى

تم تجميع عينات أربع سلالات من البلطى النيلى من مناطق جغرافية مختلفة فى جمهورية مصر العربية وهي العباسة وأسوان ومريوط والزاوية ثم اجرى التهجين بينها لاجراء الهجن الدائرية الكاملة وتم انتاج ٧٢ عائلة من الاشقاء، وانصاف الأشقاء عن طريق التزاوج الفردى، اخذ منها عينة مكونة من ٢١٧٠ اصبعيه مرقمة تم تخزينهم فى حوض ترابى للتقيم الجماعى لفترة نمو ١٢٠ يوما خلال فصل الشتاء. وتمت دراسة التأثيرات الوراثية التجميعية ، قوة الهجين والتأثيرات الامية.

ومن الصفات التى درست متوسط وزن الجسم فى السلالات النقية والهجن والهجن العكسية و الذى اظهر فروقا معنوية بين السلالات والهجن المختلفة (P < ٠,٠٠٠١) وأظهر معامل الاختلاف قيما متباينة تتراوح بين ٤٦,١ ٪ إلى ٧٠,٨ ٪. وقد اعطت اسوان كسلالة نقية أعلى معدل للنمو ، في حين أن سلالة الزاوية كان اقلها نموا.

وقد كان لبعض السلالات أداءا أفضل عند استخدامها اما اباء او امهات فى الهجن والهجن العكسية.

وعلى الرغم من ان العباسة والزاوية أعطى أدنى معدلات نمو فى السلالات النقية ، إلا أن هجنهم أعطى أعلى معدل للنمو. وعلى الرغم من ان أسوان كان أفضل سلالة لمعدل النمو لكن هجنه مع العباسة كان الاسوأ فى معدلات النمو

وقد تباينت معدلات البقاء على قيد الحياة بين السلالات النقية و الهجن بينهم ايضا حيث كان أعلى معدلات البقاء على قيد الحياة من التخزين للحصاد في السلالات النقية لسلالة أسوان بينما كان اقلها فى معدل البقاء على قيد الحياة سلالة العباسة اما بالنسبة للهجن فقد كان الهجن بين الزاوية كاباء و مريوط كامهات أعلى فى معدلات البقاء على قيد الحياة يليها الهجن بين مريوط كاباء و العباسة كامهات.

وقد وجد ارتباط وراثى موجب وقوى بين الوزن والعمر الأولي من السلالات النقية لإصبعيات أسوان، العباسة، مريوط، وبعض من هجنهم. وتباينت علاقة الارتباط بين العمر ومعدل البقاء

على قيد الحياة في السلالات نقية من ضعيف في سلالة أسوان إلى قوية في سلالة مريوط. و على الجانب الآخر، لم يكن هناك ارتباط بين العمر والوزن الأولي أو البقاء على قيد الحياة والعمر ، أو الوزن الأولي والبقاء على قيد الحياة فى سلالة الزاوية.

و قد اظهرت سلالة اسوان للتأثيرات الوراثية التجميعيه أعلى من السلالات الأخرى ، في حين كانت سلالة الزاوية في المرتبة الأدنى.

اما بالنسبة للهجن فقد كان الهجن بين سلالتى اسوان ومريوط اعلى الهجن مــن حيــث التــأثير الوراثى التجميعى بينما كان اقلها بين سلالتى العباسة والزاوية.

اما بالنسبة لقوة الهجين فقد كانت سلبية لجميع السلالات والهجن باستثناء هجن سلالتى العباسة و الزاوية التى أظهرت قوة هجن إيجابية هامة أكثر من المتوسط للسلالات النقيــة بنــسبة ١٦ ٪.

وكان متوسط قوة الهجين العامة لوزن الجسم عند الحصاد سلبية وأقل من السلالات النقية.

وبدراسة الفروق بين الهجن والهجن العكسية تم التوصل الى ان هناك تأثير للام ولكن كان اعلــى السلالات فى هذا هى سلالة مريوط بينما كان اقلها هى سلالة العباسة مما يمكن معــه تحديــد اى السلالات يمكن استخدامها فى التهجين كأم لاعطاء اعلى تأثير على النسل الناتج.