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EVALUATION OF HETEROSIS AND COMBINING ABILITIES FOR BODY WEIGHT TRAITS IN CHICKENS.

BY

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ABSTRACT

Two local breeds, namely Fayoumi (F) and Dandarawi (D) and two exotic ones named Rhode Island Red (R) and White Leghorn (L) were used in 4x4 diallel cross mating system. Thirty-two breeding pens were used. Two sires were mated to 16 dams in each breeding pen. Progeny of F_1 of all breed groups (16 groups) were produced in three hatches within two years. A total number of 7284 chicks were used to estimate purebreds, heterosis, general (GCA) and specific (SCA) combining abilities, maternal ability (MA) and reciprocal or sex-linked (SL) effects on body weight. Traits of body weight at hatch, 2, 4, 6 , 8 and 12 weeks of age were studied.

Results showed that RR had the heaviest body weight at all ages, followed by LL chickens. Differences between means of body weights of exotic and native breeds were significant (P<0.05). Most of crossbreds had higher body weights than purebreds. Heterotic effect was highly significant (P<0.01) on all the studied traits beyond BW0. Crossing between LL and FF gave the highest and positive heterosis estimates for most body weight traits. Significant (P<0.01) differences among purebreds and for the effect of MA, GCA, SCA and SL were obtained on all traits. The LL breed gave the highest and positive effect of GCA on all body weight traits, followed by RR breed. The RR had superior estimates for MA in most studied traits. Clearly, the RRxDD and LLxFF crosses gave the highest and positive estimates of SCA for most traits of body weight compared to the other crossbreds. The LLxFF cross had superior SL effects for most traits, followed by DDxLL cross. From the previous results, it could be conclude that LL sires (as an exotic breed) and FF dams (as a native breed) would be selected to produce heavy broilers in Egypt through crossbreeding programs.

Key words: Purebreds, heterosis, general and specific combining abilities, maternal, sex-linked effects and reproductive traits.

INTRODUCTION

Growth can be regarded as a direct fitness trait that increases productive efficiency and thereby decreases production costs. Crossing is one method that can improve growth performance in poultry. In Egypt, some workers (Hanafi *et al.*, 1991; Mohamed, 1997; Nawar and Abdou, 1999; Sabri *et al.*, 2000) crossed native breeds or strains of chickens with exotic adapted ones under Egyptian conditions. Most of these reports evidenced that crossing local breeds with either local or exotic ones was associated with the existence of heterotic effects. Because native chicken breeds had high non-additive genetic variance (Shebl *et al.*, 1990; Hanafi *et al.*, 1991; Sabri *et al.*, 2000). This would encourage the Egyptian breeders to improve local breeds through crossbreeding.

Nowadays, we need more workers for crossing Egyptian native breeds with exotic ones to determine the superior breeds, gains in performance from complementary breed effects and heterosis and to develop the superior new breeds through selecting the best combinations of several breeds. On the other hand, ignoring any source of variation (genetic or non-genetic effects) in the model would increase the sampling errors in genetic parameters (Dickerson, 1992). Some previous studies (e.g. Hanafi *et al.*, 1977; Hanafi *et al.*, 1991; Mohamed, 1997) ignored heterotic and purebred effects in the genetic model. This might increase biased in estimates of genetic parameters. Therefore, all source of variations should be considered in the genetic model (Harvey, 1979).

The objectives of this work were to: (1) evaluate genetically traits of body weight in 4x4 diallel mating system among two local (Fayoumi and Dandarawi) and two exotic (Rhode Island Red and White Leghorn) breeds, (2) identify superior breeds based on single crosses, (3) evaluate heterotic effect based on reciprocal crosses and (4) estimate constants for purebreds, general and specific combining abilities, maternal ability and reciprocals or sex-linked effects on body weight traits.

MATERIALS AND METHODS

Breeding plan and management

This study was carried out at El-Qanater Poultry Research Station, Animal Production Research Institute, Ministry of Agriculture, Egypt. Two local breeds namely Fayoumi (F) and Dandarawi (D) and two exotic ones named Rhode Island Red (R) and White Leghorn (L) were used in 4x4 diallel mating system.

All possible purebreds (4 groups) and crossbreds (12 groups) were made among the four breeds. Thirty-two breeding pens were used. In each breeding pen, two sires were mated to 16 dams to constitute a particular cross which was repeated twice. All eggs produced from each breeding pen were individually recorded according to breed group and collected daily for a ten days period. Progeny of F_1 of all breed groups (16 groups) were produced in three hatches within two years. On day of hatch, all chicks were wings banded to keep their breed groups. The chicks were brooded and reared from hatch up to 12 weeks of age at the floor and fed *ad libitum* using ration contained 22.4 % crude protein, 4.8 % fat and 6.8 % fibers. All chicks were medicated and subjected to the same managerial conditions.

Data and statistical analysis

Body weight of 7284 chicks were individually recorded (in grams) at hatch (BW0), 2 (BW2), 4 (BW4), 6 (BW6), 8 (BW8) and 12 (BW12) weeks of age. Data of body weight traits were analyzed using SAS program under windows (SAS, 1996) according to the following linear models:

$$y_{ijklm} = \mu + G_i + H_j + S_k + Y_l + (GH)_{ij} + (GS)_{ik} + (HS)_{jk} + (GHS)_{ijk} + e_{ijklm} \qquad Model\ (1)$$

where y_{ijklm}= the m^{th} observation on the bird hatched in the l^{th} year of the k^{th} sex in the j^{th} hatch of the i^{th} breed group, μ= the overall mean, G_i= the fixed effect of the i^{th} breed group, H_j= the fixed of the j^{th} hatch, S_k= the fixed effect of the k^{th} sex, Y_l= the fixed effect of the l^{th} year, $(GH)_{ij}$= the fixed effect of interaction between i^{th} breed group and j^{th} hatch, $(GS)_{ik}$= the fixed effect of interaction between i^{th} breed group and k^{th} sex, $(HS)_{jk}$= the fixed effect of interaction between j^{th} hatch and k^{th} sex, and $(GHS)_{ijk}$= the fixed effect of interaction among i^{th} breed group, j^{th} hatch and k^{th} sex, and e_{ijklm}= the random error of the m^{th} bird assumed to be independently randomly distributed $(0,\ \sigma_e^2)$.

Genetic analysis

Data adjusted for the fixed effects were analyzed using the following model suggested by Kidwell *et al.* (1960):

$$y_{hijk} = \mu + a_h + p_{ii} + g_i + g_j + m_j + c_{ij} + r_{ij} + e_{hijk} \qquad (Model\ 2)$$

where y_{hijk}= the k^{th} observation on the individual bird produced from the i^{th} breed of sire and the j^{th} breed of dam in the h^{th} type of breeding (purebred or crossbred), μ= the overall mean, a_h= an effect common to progeny of the h^{th} type of breeding, P_{ii}= the effect common to all progeny of a mating between of the i^{th} breed of sire and the i^{th} breed of dam, $g_i(g_j)$= the effect of general combining ability (GCA) of the $i^{th}(j^{th})$ breed, m_j= the effect of maternal ability (MA) for the j^{th} breed of dam, c_{ij}= the effect of specific combining ability (SCA) of the ij^{th} or ji^{th} cross $(i \neq j)$, r_{ij}= the sex-linked or reciprocal effect (SL) of the ij^{th} cross $(i \neq j)$ and e_{hijk}= random error.

This model was used to test the significance and to estimate the effects of heterosis, purebreds, maternal, GCA, SCA and SL by applying the restrictions suggested by Harvey (1979).

RESULTS AND DISCUSSION

Means of genetic groups

Least-squares means of body weight traits in purebred and crossbred of chickens are presented in Table 1. For purebreds, means showed that RR had the heaviest body weight at all ages, followed by LL chickens. On the contrary, the other two local breeds were lighter in body weights. The differences between means of body weight of exotic and local breeds were significant ($P<0.05$). Moreover, effects of breed group were highly significant ($P<0.01$ or $P<0.001$) on all the studied traits (Tables 2 & 4). Means of body weights of purebreds in this work were higher than those reported by Sabri *et al.* (2000) for DD and FF. On the other hand, it was lower than those reported by Hanafi *et al.* (1991) and Mohamed (1997) for LL and FF. However, DD chickens had heavier body weight at early ages (from hatch to 4 weeks) than FF while at later ages (from 6 to 12 weeks) the reverse was observed (Table 1). This might be due to the maternal effects of FF were better than DD at the early ages (averaged –2.25 vs –0.65 during the period from hatch to 4 weeks) as found in Table 5..

For crossbreds, least-squares means in Table 1 indicated that LLxFF cross gave the highest weight at 2, 4 and 12 weeks of age. When comparing purebreds with crossbreds, most of crossbreds were higher in body weight than purebreds (Table 1). This is in agreement with what reported by Sabri *et al.* (2000) in this concern. Moreover, least-squares constants in Table 5 showed that cross increased the overall mean by 0.058, 1.8, 6.42, 16.16 22.92, and 37.10 grams in BW0, BW2, BW4, BW6, BW8 and BW12, respectively. Several Egyptian reports (Hataba, 1980; Kosba *et al.*, 1981; Hanafi *et al.*, 1991; Sabri *et al.*, 2000) have confirmed the superiority of crossbreds over purebreds, but some others (Shawer and Khalifah, 1976; El-Turky, 1981; Hanafi and Iraqi, 2001) found a reverse trend or no effect of crossing on body weight traits.

Heterosis

Heterosis estimates (computed as a percent increase of the crossbreds above their parental breeds) based on single crosses (superiority) and on each two reciprocal crosses for body weights are given in Table 3. Heterosis recorded highly significant ($P<0.01$) effect on all body weight traits beyond BW0 (Table 4). Similarly, Manglik *et al.* (1980), Singh *et al.* (1983) and Sabri *et al.* (2000) found significant heterotic effects ($P<0.01$) on body weights. On the contrary, Hanafi and Iraqi (2001) found non-significant heterotic effects on body weight at 8 weeks of age.

When combining each two reciprocal crosses, percentages of heterosis (H%) show that crossing between exotic (LL) and native (FF) breeds gave the highest and positive heterotic estimates for body weight at early ages (from hatch to 6 weeks) also crossing between LL and DD (as native breed) gave the highest heterotic effects for body weight at the later ages (BW8 and BW12, at marketing age). Estimates of H % ranged from –6.5 to 26.2% for body weights. Most of the reviewed Egyptian studies (Hanafi *et al.*, 1991; Mohamed, 1997) showed that crossbreds (obtained from crossing between exotic and local breeds) were

Table 1. Least-squares means and standard errors for body weight (grams) traits in different breed groups of chickens.

Breed group*	BW0	BW2	BW4	BW6	BW8	BW12
Purebreds:						
RR	37.7±0.28 a	95.3±1.7 cde	167.0±2.1 f	263.8±3.1 g	381.1±4.6 f	632.0± 7.6 d
LL	33.3±0.54 d	91.5±2.7 ed	156.6±4.0 f	247.5±6.2 g	364.7±8.8 f	595.8±14.2 e
FF	27.8±0.28 ij	82.4± 1.8 g	139.7±2.2 g	222.3± 3.6 h	330.9± 5.2 h	579.9± 9.8 f
DD	28.5±0.35 ghi	90.1±2.4 ed	145.6± 2.6 h	219.1±4.1 i	321.8±5.8 h	535.1± 9.3 g
Crossbreds++:						
RR-LL	30.0±0.41 f	85.6±3.0 f	156.8±3.0 def	266.4±4.8 de	384.6±6.8 ed	651.4±11.2 c
LL-RR	36.4±0.31 b	93.8±2.1 bcd	162.4± 2.6 ef	261.7± 3.7 e	386.0± 5.1 e	644.8± 9.3 c
RR-FF	28.0±0.23 ij	88.4±1.5 ef	158.9±1.7 cde	260.3±5.1 e	385.3±3.9 e	660.5± 6.3 b
FF-RR	34.2±0.26 c	97.8±1.4 ab	169.5±1.9 cde	273.8±3.3 cd	400.7±4.3 cd	700.3± 6.9 a
RR-DD	28.9±0.38 g	96.5±2.8 ef	170.3±2.8 c	282.2±7.0 de	393.1±6.4 f	660.5±12.6 d
DD-RR	35.7±0.54 b	97.6±2.9 ab	166.4±4.0 cd	256.9±6.1 f	407.8±8.9 cd	695.1±14.4 a
LL-FF	34.3±0.34 e	99.0±2.0 ed	179.1±2.6 b	296.8±4.2 a	430.9±5.8 cd	714.2± 9.2 b
FF-LL	35.1±0.38 d	93.5±2.7 a	169.5±2.8 a	290.9±5.4 b	400.1±6.4 c	654.9±10.7 b
LL-DD	27.7±0.35 gh	96.9±2.0 abc	167.5±2.6 ef	284.9±4.0 c	443.2±6.0 a	674.3± 9.8 a
DD-LL	36.2±0.33 c	96.6±2.1 ab	178.6±2.5 a	297.4±6.5 a	423.4±5.5 b	694.2± 8.9 a
FF-DD	29.1±0.26 f	91.8±1.8 de	154.1±1.9 g	237.4±3.7 g	347.1±4.4 g	592.4± 7.1 e
DD-FF	27.8±0.30 hij	83.5±2.1 f	148.2±2.2 g	237.2±4.0 g	343.6±5.0 g	577.3± 8.3 ef

* RR = Rhode Island Red; LL = White Leghorn; ; FF = Fayoumi; DD = Dandarawi.

++ First letters denoted to breed of sire and second denoted to breed of dam.

Means with different letters in each column are significantly different ($P < 0.05$).

Table 2. F-ratios of least-squares analysis of variance of factors affecting body weights (Model 1).

Source of	BW0		BW2		BW4		BW6		BW8		BW12	
variation	d.f.	F-ratio	d.f.	F-ratio	d.f.		d.f.	F-ratio	d.f.	F-ratio	d.f.	F-ratio
Breed group (BG)	15	146.99^{***}	15	13.37^{***}	15	22.41^{***}	15	34.9^{***}	15	40.09^{***}	15	33.24^{***}
Sex	1	4.74^{ns}	1	16.69^{**}	1	57.32^{***}	1	100.4^{***}	1	153.17^{***}	1	226.21^{***}
Hatch (H)	2	99.76^{***}	1	110.70^{***}	2	1100.70^{***}	2	114.7^{***}	2	39.87^{***}	2	70.98^{***}
Year (Y)	1	222.82^{***}	1	46.06^{***}	1	3936.90^{***}	1	509.4^{***}	1	441.23^{***}	1	427.99^{***}
BG*Sex	15	1.31^{ns}	15	1.67^{*}	15	1.50^{ns}	15	1.65^{ns}	15	2.0^{**}	15	2.12^{***}
BG*H	30	21.25^{***}	15	11.37^{***}	30	8.78^{***}	30	8.75^{***}	30	13.42^{***}	30	6.31^{***}
Sex*H	2	1.14^{ns}	1	9.86^{**}	2	2.20^{ns}	2	0.13^{ns}	2	4.70^{***}	2	7.30^{***}
BG*Sex*H	30	1.34^{ns}	15	2.34^{**}	30	1.99^{***}	30	1.36^{ns}	30	2.41^{***}	30	1.87^{**}
Remainder d.f.	**7188**		**5124**		**6375**		**4890**		**5630**		4720	
Remainder M.S.		**18.164**		**261.56**		**972.57**		**2256.06**		**4843.20**		**11981.97**

^{ns}=non-significance; *= P<0.05; **= P<0.01; ***= P<0.001.

associated with positive heterotic effects on body weights. When considering single-crosses, results in Table 3 indicated that crossing between LL sires and FF dams gave superior performances (superiority averaged 19.79% for all body weight traits) for most body weights compared to the other crossbreds. Thus, one can recommend poultry breeders in Egypt to utilize LL sires (as foreign breed) and FF dams (as native breed) to produce heavy broilers through crossbreeding programs. On the contrary, the RRxLL cross gave the lowest heterotic effects on body weights (superiority averaged -2.25% for all traits).

Table (3): Estimates of heterotic percentages (%) for body weights at different ages.

Breed group*	BW0	BW2	BW4	BW6	BW8	BW12
Single-cross⁺:						
RR-LL	-15.49	-8.35	-3.09	4.21	3.14	6.11
LL-RR	2.54	0.43	0.37	2.37	3.50	5.03
RR-FF	-14.50	-0.51	3.62	7.10	8.23	9.00
FF-RR	4.43	10.07	10.53	12.65	12.56	15.57
RR-DD	-12.69	4.10	8.96	16.88	11.85	13.16
DD-RR	9.01	9.85	8.51	5.70	14.55	14.71
LL-FF	12.27	13.86	20.89	26.35	23.89	21.49
FF-LL	14.89	7.53	14.41	23.84	15.04	11.41
LL-DD	-10.36	6.72	10.85	22.12	29.12	19.22
DD-LL	17.15	6.39	18.20	27.48	23.35	22.74
FF-DD	3.38	6.44	8.03	7.57	6.36	6.232
DD-FF	-1.24	-3.19	3.89	7.48	5.29	3.524
Combined two crosses⁺⁺:						
RR-LL	-6.48	-3.96	-1.36	3.29	3.32	5.57
RR-FF	-5.04	4.78	7.08	9.88	10.39	12.29
RR-DD	-1.84	6.97	8.73	11.29	13.20	13.93
LL-FF	13.58	10.70	17.65	25.10	19.47	16.45
LL-DD	3.40	6.55	14.53	24.80	26.23	20.98
FF-DD	1.07	1.62	5.96	7.52	5.82	4.88

*First letters denoted to breed of sire and second denoted to breed of dam.
⁺Heterosis (superiority) percent= [(single cross – midparent)/midparent] x 100.
⁺⁺Heterosis percent= [(cross – midparent)/midparent] x 100.

General combining ability (GCA)

The estimates of GCA reflect the importance of additive gene effects of breeds on body weight at different ages. Results in Table 4 showed highly significant ($P<0.01$) effects of GCA on all body weight traits. Similarly, Hanafi, *et al.* (1977), Hanafi *et al.* (1991), Sabri *et al.* (2000) found significant effects of GCA on body weight traits. Estimates of least-squares constants in Table 5 showed that LL gave the highest (best) positive effect of GCA for all body weight traits, and FF gave the lowest estimates of GCA. This could be encourage the poultry breeders utilizing the LL as a sire breed in crossbreeding programs. In general, estimates of GCA ranged from -17.75 to 30.30 grams. These results are in agreement with those of Hanafi *et al.* (1991) and Sabri *et al.* (2000) with crosses among exotic and native chicken breeds in Egypt.

Maternal ability (MA)

Effect of MA effect was significant (P<0.05 or P<0.01) on BW0, BW2, BW8 and BW12, but non-significant on BW4 and BW6 (Table 4). This indicated that mothering ability is very important on body weights which is thought to expressed through egg size, egg shape, egg contents and egg shell thickness (Shebl and Soliman, 1999; Vick *et al.*, 1993). Some Egyptian studies (e.g. Hanafi *et al.*, 1977; Hanafi *et al.*, 1991; Sabri *et al.*, 2000; Hanafi and Iraqi, 2001) and some non-Egyptian ones (Manglik *et al.*, 1980; Singh *et al.*, 1983) found significant effects of maternal ability on body weight at different ages. Also, results in Table 5 showed that RR recorded the superior estimates of MA on most studied traits as compared to the other three breeds of the study. This would reveal that among the four breeds used, RR chickens exhibited the best maternal ability. Thus, it could be recommended that RR breed is to be used as a dam breed in crossbreeding programs using local and exotic breeds of the study (Sabri *et al.*, 2000)

Specific combining ability (SCA)

Effect of SCA was highly significant (P<0.01) different on all body weight traits (Table 4). Most of Egyptian studies (e.g. Shebl *et al.*, 1990; Hanafi *et al.*, 1991; Sabri *et al.*, 2000; Hanafi and Iraqi, 2001) found significant effect of SCA on body weights. Conversely, other studies (e.g. Hanafi *et al.*, 1977 and Jain *et al*, 1981) found non-significant effects of SCA on body weights when crossed among exotic breeds.

Estimates of least-squares constants of SCA are given in Table 5. These constants revealed that RRxDD and LLxFF crosses gave highest positive estimates of SCA for most body weight traits compared to the other crosses. Also, RRxFF and LLxDD scored the highest positive estimates of SCA for BW8 and BW12. This indicates that non-additive genetic effects (e.g. dominance, over-dominance and epistasis) of those crossbreds were high on body weight traits. Thus, utilization of such crosses that exhibited high non-additive gene effects on commercial broilers production is quite possible. Hanafi *et al.* (1991) and Sabri *et al.* (2000) concluded the same results.

Reciprocals or sex-linked effect (SL)

Results in Table 4 show that the effect of SL on all body weight traits was significant (P<0.01). This indicate that SL genes played an important role in affecting body weights of chickens, consequently, the choice of sire breed and dam breed would be important in planning crossbreeding programs. Similarly, Manglik *et al.* (1980), Singh *et al.* (1983) and Hanafi *et al.* (1991) found significant differences in body weights caused by sex-linkage effect. While, Sharma (1978), Sabri *et al.* (2000) and Hanafi and Iraqi (2001) showed non-significant effect for SL on body weight traits.

Table 4. F-ratios and significance of least-square analysis of factors affecting body weight traits at different ages (Model 2).

Source of	BW0		BW2		BW4		BW6		BW8		BW12	
Variation	d.f.	F-value	d.f.	F-value	d.f.	F-value	d.f.	F-value	d.f.	F-value	d.f.	F-value
TM	1	0.71^{ns}	1	20.41**	1	83.08**	1	210.0**	1	[illegible]**	1	[illegible]**
PB	3	527.2**	3	25.67**	3	33.77**	3	42.82**	3	48.02**		[illegible]**
GCA	3	106.96**	3	7.84**	3	8.34**	3	24.3**	3	[illegible]**	3	11.91**
MA	3	505.34**	3	20.24**	3	1.74^{ns}	3	1.92^{ns}	3	7.34**	3	4.73*
SCA	2	136.36**	2	44.04**	2	54.77**	2	38.1**	2	149.25**	2	86.67**
SL	3	88.941**	3	5.22**	3	7.95**	3	10.0**	3	[illegible]**	3	11.66**
ERROR d.f.	7269		5173		6456		4971		5708		4800	
ERROR M.S.		23.184		503.233		2139.09		4228.3		6611.03		19332.2

++ TM= Type of mating; PB= Purebreds; GCA= General combining ability; SCA= Specific combining ability; MA= Maternal ability; SL= Sex-linked.

ns = non-significance; * = $P<0.05$; ** = $P<0.01$.

Table 5. Least-squares constants (Con.) and standard error (S.E.) for body weights at different ages.

Item*	BW0	BW2	BW4	BW6	BW8	BW12
	Con. ±S.E.	Con. ±S.E.	Con. ±S.E.	Con. ±S.E.	Con. ±S.E.	Con. ±S.E.
μ	31.883 ±0.06	91.62 ±0.31	158.64 ±0.57	254.33 ±0.90	372.54 ±1.07	622.88 ±2.00
Type of mating:						
Pure	-0.058 ±0.11	-1.80 ±0.60	-6.42 ±1.12	-16.16 ±1.69	-22.92 ±2.13	-37.10 ±4.00
Cross	0.058 ±0.07	1.80 ±0.36	6.42 ±0.67	16.16 ±1.06	22.92 ±1.24	37.10 ±2.32
Purebreds:						
RR	5.875 ±0.21	5.47 ±1.15	14.78 ±2.06	25.63 ±2.88	31.48 ±3.79	46.23 ±7.22
LL	1.475 ±0.33	1.68 ±2.02	4.38 ±3.31	9.33 ±5.02	15.08 ±5.95	10.02 ±10.7
FF	-4.025 ±0.18	-7.43 ±0.99	-12.53 ±2.00	-15.88 ±3.41	-18.73 ±4.07	-5.88 ±7.85
DD	-3.325 ±0.21	0.28 ±1.17	-6.62 ±2.14	-19.08 ±3.11	-27.83 ±4.03	-50.37 ±7.37
GCA:						
RR	-2.038 ±0.09	-2.54 ±0.49	-3.15 ±0.90	-3.35 ±1.44	-7.76 ±1.65	4.71 ±3.09
LL	1.650 ±0.10	2.98 ±0.58	6.40 ±1.06	17.38 ±1.68	30.30 ±1.98	22.55 ±3.70
FF	0.238 ±0.09	-0.10 ±0.48	-2.09 ±0.89	-5.66 ±1.44	-17.75 ±1.66	-15.66 ±3.06
DD	0.150 ±0.10	-0.33 ±0.52	-1.16 ±0.96	-8.36 ±1.48	-4.79 ±1.80	-11.60 ±3.36
MA:						
RR	4.850 ±0.13	4.68 ±0.68	2.97 ±1.29	-4.12 ±2.08	7.85 ±2.37	16.95 ±4.40
LL	0.725 ±0.15	-3.49 ±0.88	-1.03 ±1.57	2.82 ±2.42	-13.02 ±2.94	-8.17 ±5.52
FF	-2.100 ±0.12	-3.05 ±0.64	-1.60 ±1.19	-1.95 ±2.00	2.98 ±2.24	1.10 ±4.15
DD	-3.475 ±0.14	1.87 ±0.78	-0.35 ±1.39	3.25 ±2.07	2.20 ±2.56	9.88 ±4.77
SCA:						
RR-LL	-1.142 ±0.15	-4.74 ±0.89	-9.68 ±1.60	-19.82 ±2.55	-30.16 ±2.99	-43.53 ±5.80
RR-FF	-0.417 ±0.14	1.51 ±0.78	3.44 ±1.44	8.61 ±2.46	17.64 ±2.62	22.35 ±4.75
RR-DD	1.558 ±0.17	3.23 ±0.89	6.24 ±1.66	11.21 ±2.54	12.52 ±3.04	21.18 ±5.72
LL-FF	1.558 ±0.19	3.23 ±1.01	6.24 ±1.89	11.21 ±3.14	12.52 ±3.54	21.18 ±6.44
LL-DD	-0.417 ±0.22	1.51 ±1.17	3.44 ±2.15	8.61 ±3.19	17.64 ±3.95	22.35 ±7.22
FF-DD	-1.142 ±0.14	-4.74 ±0.78	-9.68 ±1.42	-19.82 ±2.21	-30.16 ±2.71	-43.53 ±5.09
Reciprocal:						
RR-LL	-1.138 ±0.22	-0.01 ±1.28	-0.80 ±2.32	-1.13 ±3.59	9.79 ±4.49	15.86 ±9.01
LL-RR	1.138 ±0.22	0.01 ±1.23	0.80 ±2.19	1.13 ±3.74	-9.79 ±4.00	-15.86 ±7.59
RR-FF	0.375 ±0.19	-0.84 ±1.08	-2.76 ±1.94	-7.81 ±3.18	-5.26 ±3.52	-11.98 ±6.39
FF-RR	-0.375 ±0.22	0.84 ±1.12	2.76 ±2.14	7.81 ±3.79	5.26 ±3.92	11.98 ±7.09
RR-DD	0.762 ±0.23	0.85 ±1.32	3.56 ±2.28	8.96 ±3.85	-4.53 ±4.15	-3.89 ±7.86
DD-RR	-0.762 ±0.24	-0.85 ±1.20	-3.56 ±2.42	-8.96 ±3.76	4.53 ±4.46	3.89 ±8.34
LL-FF	1.013 ±0.24	2.53 ±1.26	5.09 ±2.47	5.34 ±4.40	7.40 ±4.66	24.96 ±8.54
FF-LL	-1.013 ±0.30	-2.53 ±1.68	-5.09 ±2.95	-5.34 ±4.61	-7.40 ±5.43	-24.96 ±9.81
LL-DD	-2.150 ±0.31	-2.54 ±1.58	-5.89 ±3.00	-6.46 ±4.30	2.39 ±5.64	-9.10 ±10.5
DD-LL	2.150 ±0.32	2.54 ±1.75	5.89 ±3.09	6.46 ±4.92	-2.39 ±5.55	9.10 ±9.96
FF-DD	1.388 ±0.22	1.69 ±1.24	2.33 ±2.16	-2.50 ±3.07	2.14 ±3.99	12.99 ±7.31
DD-FF	-1.388 ±0.17	-1.69 ±1.00	-2.33 ±1.88	2.50 ±3.27	-2.14 ±3.70	-12.99 ±7.10

* First letters refer to breed of sire and second refer to breed of dam.

Estimates of SL in Table 5 show that LLxFF single crosses had superior performance for most body weight traits, followed by DDxLL crosses. This indicate an existence of better maternal ability for these crossbreds. Conversely, DDxFF cross gave the lowest and negative estimates of SL for most body weight traits.

CONCLUSION

Results of heterotic effects indicated that crossing between LL sires and FF dams as well as between DD sires and LL dams gave the highest heterotic effect on body weight traits. This could be encouraging the poultry breeders in Egypt to utilizing these breeds in crossbreeding programs. Based on highly significant effects of purebreds, GCA, SCA, MA and SL on body weights, therefore, these effects should be considered before planning any crossbreeding program. Generally, crossing among native and exotic breeds of chicken, usually, are associated with high heterotic effects on body weight traits. This indicates that our local breeds had high non-additive genetic effects. Therefore, we need more crossbreeding programs in Egypt using native breeds (or newly improved strains) and exotic ones to expansion of superior breeds and to develop of superior strains from selected combinations.

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تقييم قوة الهجين وقدرات توافق صفات وزن الجسم فى الدجاج .

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استخدم فى هذه الدراسة نوعين من الدجـــاج المحلـــى همـــا الفيومـــى و الدندراوى ونوعين من الدجاج الأجنبى هما الرودأيلانـــد الأحمـــر واللجـــهورن الأبيض فى نظام خلط تبادلى ٤ x ٤ . وقد استخدم ٣٢ عش تزاوج حيث وضـــع ديكين مع ١٦ دجاجة فى كل عش ، وتم انتاج نسل الجيل الأول لكل المجـــاميع الوراثية (١٦ مجموعة) فى ثلاث تفريخات متتالية خلال عامين . وقد اســـتخدم ٧٢٨٤ كتكوت فى تقدير قوة الهجين وتأثير كل مـــن الأنـــواع النقيـــة وقدرتـــى التوافق العامة والخاصة والمقدرة الأمية ، والارتباط بالجنس أو التزاوج العكســـى على وزن الجسم . وكانت الصفات المدروسة هى وزن الجسم عند عمر الفقـــس ، ٢ ، ٤ ، ٦ ، ٨ ، ١٢ أسبوع . وقد أظهرت النتائج ما يلى :-

١-أن دجاج الرودأيلاند الأحمر كان الأثقل وزنا عند كل الأعمار يليها دجـــاج اللجهورن الأبيض .

٢-كانت الاختلافات بين متوسطات وزن الجسم للسلالات المحلية والأجنبيـــة معنوية (عند مستوى ٥ %) ، كما كانت معظم الخلطان أعلى وزنا عـــن الأنواع النقية .

٣-كانت قوة الهجين عالية المعنوية (عنـــد مســـتوى ١ %) لكـــل الصفـــات المدروسة باستثناء صفة وزن الجسم عند عمر الفقس .

٤-أعطى الخلط بين ذكور اللجهورن واناث الفيومى أعلى تقدير موجب لقـــوة الهجين لمعظم صفات وزن الجسم .

٥-كانت الفروق بين السلالات النقية وتأثير كل من المقـــدرة الأميـــة ، قـــدرة التوافق العامة وقدرة التوافق الخاصة والارتباط بـــالجنس معنويـــة (عنـــد مستوى ١ %) لكل الصفات المدروسة .

٦-أعطت سلالة اللجهورن الأبيض أعلى تأثير موجب فى قدرة التوافق العامـــة لكل صفات وزن الجسم ، يليه دجاج الرودأيلاند الأحمر .

٧-تفوقت سلالة الرودأيلاند الأحمر فى تقديرات المقدرة الأمية لمعظم صفـــات وزن الجسم .

٨-أعطى خليط (الرودأيلاند الأحمر x الدندراوى) وخليط (اللجهورن الأبيض x الفيومى) أعلى تقديرات موجبة فى قدرة التوافق الخاصة لمعظم صفات وزن الجسم بالمقارنة بالخلطان الأخرى ، بينما تفوق خليط (اللجهورن الأبيض x الفيومى) فى الارتباط بالجنس لمعظم الصفات ، يليه خليط (الدندراوى x اللجهورن الأبيض).

٩--من النتائج السابقة يمكن استنتاج أن ذكور اللجهورن (كسلالة أجنبية) واناث الفيومى (كسلالة محلية) قد تنتخب لانتاج دجاج لحم أثقل وزنا فى مصر من خلال برامج التربية بالخلط .