Estimation of Heterosis and Combining Ability for Some Weaning and Post-Weaning Traits in Three Different Breeds of Rabbits

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Abstract: The aim of the present study was to investigate the effect of breed on some weaning and post-weaning performance traits as well as estimation of heterosis and combining ability for these traits. Two bucks and five does from each of New Zealand White, Californian and Gray Giant Flander breeds were used as parents to produce 183 progeny. Significant differences were observed among different progeny genotypes for body weight, average daily gain (ADG) and relative growth rate (RGR) at weaning and post-weaning growing period. New Zealand White x Flander rabbits recorded the heaviest weaning weight (668.18 g). On the other hand, Californian x New Zealand White recorded the heaviest market weight at 12th week of age (2278.52 g) and the highest ADG at the age periods from 4-6 weeks (45.29 g) and 10-12 weeks (24.01 g). New Zealand White x Californian recorded the highest RGR at the age period of 4-6 weeks (72.50%). Californian x New Zealand White rabbits recorded the highest positive estimates of heterosis for body weight at all ages studied (22.69, 17.60, 6.76, 4.50 and 7.60 % for weaning, 6th , 8th , 10th , and 12th week of age; respectively), also the highest positive estimates for ADG at the age period from 4-6 weeks (12.77 %), while Californian x Flander rabbits recorded the highest positive estimates at 10-12 weeks of age (42.27 %). In general, effect of general combining ability (GCA) was non-significant (p>0.05) on body weight, ADG and RGR at most of ages studied, while effect of specific combining ability (SCA) were highly significant (p<0.01) on body weights at most of ages studied, but non-significant on ADG and RGR at most of age intervals studied. In conclusion, we recommended the use of Californian as a sire breed to improve body weights and body weight gains of fryer rabbits and crossing of Californian males with New Zealand White females will improve body weights and body weight gain due to heterotic effect. Gray Giant Flander does is better mothers than Californian and New Zealand White which is reflected by higher weaning weights of progeny of Gray Giant Flander does. Moreover, Gray Giant Flander breed and specifically, crossing of New Zealand White with Californian are the best to improve body weights of fryer rabbits during weaning and post-weaning period.

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1. Introduction

The domestic rabbit when compared with other livestock animals is characterized by early sexual maturity, high prolificacy, relatively short gestation length, short generation interval, high productive potential (number of progeny produced per doe per year), rapid growth, relatively high meat production, good ability to utilize forages and fibrous plant materials and agricultural by-products (i.e. it does not need a lot of concentrate in its diet), more efficient in feed conversion, low cost per breeding female and by its profitability for small-scale systems of production and in backyards (***Taylor, 1980; Schlolaut, 1982; Lebas, 1983***). Therefore, rabbit production might play a considerable role in solving the problem of meat shortage in Egypt. Crossbreeding implies the mating together of animals from two distinct and pure, or relatively pure, breeds. Crossbreeding offers two distinct advantages over purebreeding: heterosis and breed complementarity. Heterosis or "hybrid vigor" is the superiority of crossbred offspring to their purebred parents. Mathematically, heterosis is the percentage increase in a specific trait that progeny have over the average performance of their parents. Heterosis is highest for traits that do not respond well to selection, e.g. fitness and reproductive traits, and lowest for traits that respond well to selection, e.g. carcass and fleece characteristics. General combining ability variance component may reflect additive effects and additive interactions, while specific combining ability variance components may reflect dominance and epistasis, plus components of additive epistasis (***Rojas and Sprague, 1952***). Studies on combining ability are useful to understand the nature of genetic variance. They help the breeder to choose suitable parents for developing either hybrids or varieties. The concepts of general and specific combining ability were introduced by ***Spraque and Tatum (1942)*** who designated general combining ability (GCA) as the average performance of a line in hybrid combinations. The term specific combining ability (SCA) was applied to those cases where certain hybrid combinations did relatively better or worse than would be expected on the basis of the average performance of the lines involved. The aim of this study was to investigate the effect of breed on some weaning and post-weaning performance traits as well as, estimation of heterosis and combining ability for these traits were also carried out.

2. Material and Methods

This study was conducted at the rabbit project belonging to the Department of Animal Wealth Development, Faculty of Veterinary Medicine, Zagazig University, through the period from January 2011 to April 2012.

1. Flock foundation and management:

The flock composed of three rabbit breeds. Two bucks and five does from each breed were used in the experiment. These breeds are New Zealand White, Californian and Flander which obtained from San-El-Hagar Agricultural Company Farm, Sharkiya Governorate. All males are about 6 months and all females 5 months of age..

Rabbits were housed in an open sided house. Breeding animals were kept individually in triangular galvanized wire Cages (40 x 60 x 50 cm) provided with nipple system for watering and manual feeder. Metal nest box (40 x 40 x 40 cm) was attached to the doe's cage.

Litters were weaned, weighed to the nearest grams, ear tagged and separated in fattening cages at 4 weeks of age. Moreover, they weighed biweekly tell the marketing age (12 weeks of age). They were raised identically under the same managerial and nutritional conditions.

Each litter was examined just after kindling and dead kits were removed after that it continued daily till weaning at 4 weeks of age.

Rabbits of all ages were fed commercial pelleted ration obtained from Al-Musrrayia Company. The chemical analysis (%) of the ration as mentioned in the recommendation sheets by company were crude protein (not less than19 %), crude lipid (not less than2.2-2.5 %), crude fiber (not more than15-16 %) and digestible energy (not less than2300-2500 k cal / kg diet).

Clean fresh water was available all times to rabbits. Pregnant, lactating does and fryer rabbits fed ad-libitum, while empty does and bucks have a restricted feeding to avoid over fattening and consequently poor reproductive performance. Mature bucks and does were mated in a full 3 x 3 diallel cross design.

2. Traits recorded:

- Body weight at weaning, 6, 8, 10, and 12 weeks of age.
- Average daily gain:
- Relative growth rate: It was calculated according to *Broody (1945)*.

3. Data handling and statistical analysis:

Data were analyzed using SAS statistical analysis system package *(SAS, 2002)*. One way ANOVA were carried out.

Least Squares Means (LSM) ± standard errors were calculated and tested for significance using "T" test *(Steel and Torrie, 1960)*.

The data were analyzed using the following statistical model:

$$Y_{ij} = \mu + G_i + e_{ij}$$

Where:

Y_{ij} = any observed value.

μ = overall mean.

G_i = effect of genotype (i = 1, 2 …. 9, i.e. NN, CC……..FC).

e_{ij} = random deviation due to unexplained source.

Heterosis (Hybrid Vigor) for weaning and post-weaning performance traits:

Heterosis or hybrid vigor will be estimated for the different crossbreds and reciprocal crossbreds based on the following formula *(Legates and Warwick, 1990).*

General and specific combining abilities for weaning and post-weaning performance traits:

General and specific combining abilities for Body weight at different ages, Average daily gain and Relative growth rate at different age intervals were estimated according to Griffing's method II, model 1 *(Griffing, 1956).*

3. Result and Discussion

Breed effect on weaning and post-weaning performance traits:

A. Body Weight (BW):

Table (1) cleared that breed effect was highly significant (p<0.01) on body weight at (weaning, 6th, 8th, 10th and 12th) week of age. Flander x New Zealand White rabbits recorded the heaviest weaning weight (688.18 g). On the other hand, Californian x New Zealand White recorded the heaviest market weight at 12 weeks of age (2278.52 g). Flander rabbits showed superiority at 8th and 10th week of age (1676.66 and 1982.85 g). *Eady (2003)* observed similar significant breed difference for weaning weight in a crossbreeding experiment involved New Zealand white, Californian and Flemish Giant. *Rania Hassan (2005)* worked with Gray Giant Flander in a crossbreeding experiment and observed that, it was the heaviest at 8th and 10th week of age. The superiority of Flander x New Zealand White rabbits for weaning weight indicate that New Zealand White is better to be used as doe breed and these results match those observed by *Prayaga and Eady (2002)*. The superiority of Californian x New Zealand White rabbits for market weight indicated that Californian is better to be used as sire breed than New Zealand White and Flander to improve market weight of fryer rabbits (*Abdel-Hamid, 2007; Eman, 2011)* observed that, New Zealand White x Californian (2086.15 g) perform better than Californian x New Zealand White (2004.66 g) for body weight at 12th week of age.

B. Average Daily Gain (ADG):

Table (2) showed that, breed effect was highly significant (p<0.01) on ADG at 6-8, 8-10, and 10-12 weeks of age intervals, but it was non-significant (p>0.05) at 4-6weeks. The overall means of purebreds were significantly differed from those of crossbreds for ADG at 4-6 and 6-8 weeks of age intervals. Californian x New Zealand White rabbits recorded the highest ADG at the age periods of 4-6 weeks (45.29 g) and 10-12 weeks (24.01 g), while the Californian rabbits recorded superiority at 6-8 weeks (38.11 g). *Eman (2011)* observed similar significant breed difference for ADG in a crossbreeding experiment involved New Zealand white, Californian and Bouscat rabbits and recorded superiority of Californian x New Zealand White for ADG at 8-10 (35.32 g) weeks of age. *Abdel-Hamid (2007)* recorded superiority of Californian x New Zealand White (18.14 g) over New Zealand White x Californian (13.07) at 10-12 weeks of age, while at 6-8 weeks of age the Californian showed marked superiority (52.53 g).

C. Relative Growth Rate (RGR):

Table (3) cleared that breed effect was highly significant (p<0.01) on RGR at 6-8, 8-10, and 10-12 weeks of age intervals. New Zealand White x Californian recorded the highest RGR at the age period of 4-6 weeks (72.50%), while the Californian rabbits recorded superiority at 6-8 weeks (40.36 %). The New Zealand White showed the highest RGR at 10-12 weeks (16.00%). *Abdel-Hamid (2007)* recorded superiority of New Zealand White x Californian (70.97%) over Californian x New Zealand White (54.22%) at 4-6 weeks of age, while at 6-8 weeks of age the Californian showed marked superiority (52.53 g/d). On the contrary, *Eman (2011)* observed superiority of Californian x New Zealand White (52.71%) over New Zealand White x Californian (47.56%) at 4-6 weeks of age and observed significant breed difference for RGR.

2. Heterotic effect on weaning and post-weaning performance traits:

Table (4) showed that, Californian x New Zealand White rabbits recorded the highest positive estimates of heterosis for body weights at all ages studied (22.69, 17.60, 6.76, 4.50 and 7.60 % for weaning, 6th, 8th, 10th and 12th week of age; respectively). *Abdel-Hamid (2007)* estimated positive estimate of heterosis % for Californian x New Zealand White rabbits for body weight at weaning and 6th week of age. On the other hand, *Zaghlool (1997)* and *Eman (2011)* estimated negative heterosis % for Californian x New Zealand White rabbits at weaning.

Californian x New Zealand White rabbits recorded the highest positive estimates of heterosis % for ADG at the age period from 4-6 weeks (12.77 %). At the age period from 6-8 and 8-10 weeks, most of heterosis estimates were negative. On the contrary, Californian x Flander rabbits recorded the highest positive estimates (36.82 %) at 10-12 weeks of age. *Abdel-Hamid (2007)* recorded positive estimates of heterosis % for Californian x New Zealand White rabbits for ADG at 4-6 weeks of age. On the contrary, *Eman (2011)* estimated high negative heterosis % for Californian x New Zealand White rabbits for ADG at 4-6 weeks of age (-31.60 %).

Most of heterosis estimates were negative for RGR at the age period from 4-6, 6-8 and 8-10 weeks. On the other hand, Californian x Flander rabbits recorded the highest positive estimates of heterosis (42.27 %) at 10-12 weeks of age. *Eman (2011)* estimated high positive heterosis % for Californian x Bouscat rabbits for RGR at 10-12 weeks of age (40.21 %). *Abdel-Hamid (2007)* estimated high positive heterosis % for Californian x New Zealand White rabbits for RGR at 10-12 weeks of age (64.40 %).

3. General and specific combining abilities for weaning and post-weaning performance traits:

A. Body Weight (BW):

From the analysis of variance for general and specific combining ability for body weights at different ages that showed in Table (6). It was cleared that, effect of general combining ability (GCA) was non-significant (p>0.05) at different ages except at 10th week of age. On the contrary, the effect of specific combining ability (SCA) was highly significant at different ages except at 12th week of age. *Hemeda et al. (1992), Eman (2011)* and *Abdel-Hamid (2007)* reported similar results. *El-Shiehk et al. (1992)* found that effect of GCA on market weight was non-significant. On the other hand, the effect of SCA was highly significant.

Non-significant effect of GCA would be due to that these traits being affected mainly by dominance, overdominance and epistatsis, thus crossing of these breeds may improve or disimprove the traits under consideration according to the magnitude and direction of general combining ability. Highly significant effects of SCA denote that dominance may play a role in the inheritance of these traits.

In general, Flander and New Zealand White x Californian rabbits recorded high and positive estimates of GCA and SCA for body weights at all ages studied. On the contrary, New Zealand White x Flander and Californian x Flander rabbits recorded high negative estimates of SCA at all ages studied (Table 5). *Abdel-Hamid (2007)* recorded that Al-Gabali rabbits showed the highest positive GCA at 6, 8, 10 and 12 weeks of age. Moreover, Al-Gabali x V-Line showed very high positive estimates of the specific combining ability for body weight at all ages studied. On the contrary, *Eman (2011)* recorded negative estimate of SCA, but GCA values for Californian rabbits at weaning, 6th and 8th week of age were positive.

B. Average Daily Gain (ADG) and Relative Growth Rate (RGR):

In general, effects of GCA and SCA were non-significant (p>0.05) on ADG and RGR at all age intervals studied except at 6-8 weeks of age (Table 6). Contradicted results obtained by *Hemeda et al. (1992)*, *Abdel-Hamid (2007)* and *Eman (2011)*. They reported that effects of SCA were highly significant on ADG and RGR at most age intervals studied.

Estimates of GCA for ADG and RGR at most of age intervals studied were positive. On the contrary, SCA estimate were negative. New Zealand White x Flander rabbit recorded the highest positive estimate of SCA for ADG at 8-10 weeks (9.82) and RGR at 6-8 weeks of age (1.50) (Table 5). *Abdel-Hamid (2007)* recorded that, V-Line had high positive value of GCA for RGR at 8-10 (1.57), 10-12 (1.84) and 4-12 (4.14) weeks age intervals. Also, he found that Al-Gabali showed positive values For ADG at all age intervals. *Hemeda et al. (1992)* recoded that Californian breed showed high positive GCA for body gain at 8-10 weeks, while New Zealand White showed positive values at all age intervals. On the contrary, Baladi showed negative values. *Eman (2011)* estimated positive GCA values of RGR for Bouscat rabbits at all age intervals, while New Zealand White takes place Bouscat for ADG.

In conclusion, we recommended the use of Californian as a sire breed to improve body weight and body weight gain of fryer rabbits. Crossing of Californian males with New Zealand White females will improve body weights and body weight gains due to heterotic effect. In general, Gray Giant Flander does is better mothers than Californian and New Zealand White which is reflected by higher weaning weight of progeny of Gray Giant Flander does. Gray Giant Flander breed and specifically, crossing of New Zealand White with Californian are the best to improve body weight of fryer rabbits during weaning and post-weaning period.

Table (1): Least Square Means ± Standard Errors (LSM ± SE) of body weight at different ages for first generation rabbits due to crossing of New Zealand White, Californian and Flander breeds.

Trait		Body weight				
Genotype	N	4th week (weaning)	6th week	8th week	10th week	12th week
NN	22	546.36 ± 27.83 bc	1128.18 ± 27.06 bcd	1520.22 ± 27.44 bc	1791.81± 33.58c	2102.27±36.38bc
CC	18	520.83 ± 37.94c	1063.61 ± 31.56 cd	1597.22 ± 34.04 ab	1925.55 ± 34.70ab	2132.77±28.78bc
FF	21	596.42 ± 28.90abc	1188.33 ± 43.65 abc	1676.66 ± 30.73 a	1982.85 ± 52.69a	2189.52± 48.34 ab
Overall mean		556.06±18.16 A	1129.83±20.87B	1596.80±19.29A	1897.04±25.97A	2141.31±22.96A
NC	17	531.17 ± 21.29c	1134.70 ± 28.51bcd	1551.76 ± 27.45 bc	1850.58 ± 36.83 bc	2069.41± 47.91bc
NF	22	668.18± 24.34a	1095.90 ± 50.00 bcd	1523.63 ± 44.64 bc	1831.81 ± 40.95 bc	2113.63 ± 51.41 bc
CF	19	630.52 ± 17.84a	1218.42 ± 39.29 ab	1669.47 ± 39.23 a	1858.42 ± 52.18 bc	2141.57 ± 38.06 bc
CN	17	654.70 ± 31.30a	1288.82 ± 25.13 a	1664.11 ± 30.60 a	1942.35 ± 25.93 ab	2278.52 ± 40.80 a
FN	20	530.75 ± 48.99 c	1133.50 ± 52.69 bcd	1577.00 ± 45.90 abc	1850.50 ± 38.59 bc	2071.25 ± 33.50 bc
FC	27	534.25 ± 24.18c	1047.66 ± 37.75d	1475.00 ± 31.94 c	1829.25 ± 36.97bc	2033.33 ± 29.38 c
Overall mean		589.18±13.13A	1142.76±18.21A	1567.82±16.58A	1856.47±16.34A	2110.08 ± 17.54A

* Means with different superscripts (small letters) within the same column are significantly different ($p < 0.05$).
* Overall means with different superscripts (capital litters) within the same column are significantly different ($p < 0.05$).

Table (2): Least Square Means ± Standard Errors (LSM ± SE) of Average daily gain at different age intervals for first generation rabbits due to crossing of New Zealand White, Californian and Flander breeds

Trait		Average daily gain			
Genotype	N	4-6 weeks	6 -8 weeks	8-10 weeks	10 -12 weeks
NN	22	41.55 ± 2.92 [ab]	28.00 ± 1.06[c]	19.39 ± 2.02 [ab]	22.17 ± 1.04 [a]
CC	18	38.76 ± 3.54 [ab]	38.11 ± 2.17[a]	23.45 ± 1.66[a]	14.80 ± 1.52 [b]
FF	21	42.27 ± 2.63[ab]	34.88 ± 3.15[a]	21.87 ± 2.49[a]	14.76 ± 0.89 [b]
Overall mean		40.98±1.86[A]	33.35±1.40[A]	21.44±1.22[A]	17.44±0.79[A]
NC	17	43.10 ± 21.29[a]	29.78 ± 1.70[ab]	21.34 ± 3.02 [a]	15.63 ± 1.44 [b]
NF	22	30.55 ± 3.89[b]	30.55 ± 1.32 [ab]	22.01 ± 1.58[a]	20.12 ± 1.46 [a]
CF	19	41.99 ± 3.25 [ab]	32.21 ± 1.36 [ab]	13.49 ± 3.15 [b]	20.22 ± 2.19 [a]
CN	17	45.29 ± 3.32[a]	26.80 ± 1.36 [c]	19.87 ± 1.53[ab]	24.01 ± 1.50 [a]
FN	20	43.05 ± 5.91 [a]	31.67 ± 1.65 [ab]	19.53 ± 1.68[ab]	15.76 ± 1.02 [b]
FC	27	36.67 ± 3.30 [ab]	30.52 ± 1.46 [ab]	25.30 ± 1.80[a]	14.57 ± 1.20 [b]
Overall mean		39.54±1.63[B]	30.36±0.61[B]	20.61±0.92[A]	18.11±0.66[A]

* Means with different superscripts (small letters) within the same column are significantly different ($p < 0.05$).
* Overall means with different superscripts (capital litters) within the same column are significantly different ($p < 0.05$).

Table (3): Least Square Means ± Standard Errors (LSM ± SE) of relative growth rate at different age intervals for first generation rabbits due to crossing of New Zealand White, Californian and Flander breeds

Trait		Relative growth rate			
Genotype	N	4-6 weeks	6 -8 weeks	8-10 weeks	10 -12 weeks
NN	22	70.29± 5.16 [a]	29.82± 1.28 [bc]	16.34± 1.67 [ab]	16.00± 0.76[a]
CC	18	70.21± 7.05[a]	40.36± 2.38 [a]	18.72± 1.30 [ab]	10.32± 1.08[c]
FF	21	65.39 ± 6.30[a]	35.22± 4.47 [ab]	16.29± 1.79 [ab]	10.14± 0.74[c]
Overall mean		68.58±3.48[A]	34.79±1.81[A]	17.03±0.94[A]	12.31±0.60[A]
NC	17	72.50± 4.38[a]	31.25± 1.99[bc]	17.45± 2.41 [ab]	11.03± 0.93 [c]
NF	22	51.59± 7.17[a]	33.87± 2.22 [ab]	18.69± 1.45 [ab]	14.17±0.91[ab]
CF	19	66.18± 6.17[a]	31.65± 1.73 [bc]	10.47± 2.44 [c]	14.56± 1.72[a]
CN	17	69.60± 6.02[a]	25.45± 1.27 [c]	15.54± 1.30 [b]	15.81± 0.83 [a]
FN	20	70.08± 11.32 [a]	33.72± 2.18 [ab]	16.31± 1.48 [ab]	11.42± 0.83[bc]
FC	27	66.23± 6.63[a]	34.97 ± 2.22 [ab]	21.48 ± 1.49[a]	10.83± 1.03[c]
Overall mean		65.56±3.05 [A]	32.21±0.87[A]	17.03±0.77[A]	12.83±0.47[A]

* Means with different superscripts (small letters) within the same column are significantly different ($p < 0.05$).

Table (4): Heterosis percentages of body weight, average daily gain and relative growth rate at different age intervals for Crossbred rabbits of three different breeds (New Zealand White, Californian and Flander)

Trait / Genotype	Body Weight					Average Daily Gain				Relative Growth Rate			
	4th week	6th week	8th week	10th week	12th week	4-6 weeks	6-8 weeks	8-10 weeks	10-12 weeks	4-6 weeks	6-8 weeks	8-10 weeks	10-12 weeks
NC	- 0.45	3.54	- 0.44	- 0.43	-2.27	7.33	-9.88	- 0.37	-15.45	3.20	-10.93	- 0.49	-16.19
NF	16.93	-5.38	- 4.68	-2.94	-1.50	-27.11	-2.83	6.677	8.99	-23.94	4.15	14.57	8.46
CF	12.86	8.21	1.98	- 4.90	- 0.90	3.62	-11.72	- 40.44	36.82	-2.38	-16.23	- 40.15	42.27
CN	22.69	17.60	6.76	4.50	7.60	12.77	-26.55	-7.24	29.87	- 0.92	-27.47	-11.32	20.09
FN	-7.11	-2.13	-1.34	-1.95	-3.47	2.70	0.75	-5.32	-14.62	3.30	3.67	- 0.016	-12.63
FC	- 4.36	- 4.40	-9.89	- 6.39	-5.91	-9.50	-16.36	11.66	-1.38	-2.31	-7.46	22.70	5.82

Table (5): General and specific combining ability for body weight, average daily gain and relative growth rate at different age intervals for first generation rabbits due to crossing of New Zealand White, Californian and Flander breeds

Trait / Genotype		Body Weight					Average Daily Gain				Relative Growth Rate			
		4th week	6th week	8th week	10th week	12th week	4-6 weeks	6-8 weeks	8-10 weeks	10-12 weeks	4-6 weeks	6-8 weeks	8-10 weeks	10-12 weeks
G.C.A	NN	11.93	9.50	-5.45	-8.11	22.59	0.98	-1.88	-0.19	2.19	1.30	-3.16	0.17	1.53
	CC	-2.55	-5.93	27.59	37.45	31.11	0.89	1.57	0.70	-0.45	3.07	1.48	0.46	-0.50
	FF	25.36	3.30	34.88	38.12	22.83	-0.41	1.43	0.23	-1.09	-1.96	1.58	-0.02	-0.67
S.C.A	NC	4.30	63.85	17.74	12.18	15.72	2.38	-2.47	-0.40	0.25	0.46	-3.85	-0.77	-0.28
	NF	-15.33	-42.45	-47.17	-43.79	-57.53	-3.72	0.48	9.82	-0.98	-4.73	1.50	0.71	-0.63
	CF	-19.67	-8.67	-58.29	-86.67	-71.04	-1.11	-2.72	-2.03	1.12	-1.13	-2.35	-1.10	1.19

Table (6): The analysis of variance for General and specific combining ability for body weight, average daily gain and relative growth rate at different age intervals for first generation rabbits due to crossing of New Zealand White, Californian and Flander breeds

S.O.V	D.F	Body Weight					Average Daily Gain				Relative Growth Rate			
		4th week	6th week	8th week	10th week	12th week	4-6 weeks	6-8 weeks	8-10 weeks	10-12 weeks	4-6 weeks	6-8 weeks	8-10 weeks	10-12 weeks
G.C.A	2	0.084	2.64	5.40	42.04**	8.54	1.04	18.75*	0.36	1.19	2.05	5.73	0.25	1.56
S.C.A	3	152.79**	870.08**	430.40**	28.75**	4.48	4.54	82.84**	1.95	0.38	4.80	21.60*	2.03	0.23
Error	3	7235.76	9054.28	8881.81	1603.36	9540.65	31.56	2.17	24.62	20.2	58.39	7.45	21.74	7.39

* Significant at level (0.05) ** Highly significant at level (0.01)

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References

Abdel-Hamid, T.M (2007): Genetic studies on some productive, reproductive and immunological traits in rabbits. M.Sc. Thesis, Faculty of Veterinary Medicine, Zagazig University, Egypt.

Broody, S. (1945): Bioenergetics and growth. Reinhold Pub Crop N.Y., U.S.A.

Eady, S. J. (2003): Farmed rabbits in Australia. A report for the Rural Industries Research January 2003 RIRDC Publication No 02/144 RIRDC Project No CSU-1A. Page 9-10.

El-Sheikh, A.I., El-Bayomi, KH. M. and Hemeda, Sh.A. (1992): Combining ability and heterosis for slaughter performance and meat quality in three breed diallel crosses of rabbits. Proc. Fth Sci. Conf. Fac. Vet. Med. Assiut Univ. Nov. 8-10, 1992, Egypt. 171- 178.

Eman, A. M. (2011): Heterosis and combining abilities of growth and carcass traits in different breeds of rabbits. M.Sc. Thesis, Fac. Vet. Med., Benha. Univ. Egypt.

Griffing, B. (1956): Concept of general and specific combining ability in relation to diallel crossing systems. Aust. J. Biol. Sci. 9: 463-493.

Heba, I. Basha (2004): Biochemical genetic variations due to crossing of rabbit. M.Sc. Thesis, Fac. Vet. Med., Alex. Univ. Egypt.

Hemeda, Sh.A., El-Sheikh, A.I and El-Bayomi, KH, I (1992): Evaluation of combining ability and heterosis for weaning weight and post-weaning growth performance in rabbit crosses. Proc. Fth Sci. Conf. Fac. Vet. Med. Assiut Univ. Nov. 8-10, 1992, Egypt. 171- 178.

Lebas, F. (1983): Small-scale rabbit production. Feeding and management systems. World Animal Review 4, 6: 11-17.

Legates, J.E. and Warwick, E.J. (1990): Breeding and Improvement of Farm Animals. 8th Ed, Cm (Mc Graw - Hill Publications in the Agricultural Sciences).

Prayaga, K. C. and Eady, S. J. (2002): Performance of purebred and crossbred rabbits in Australia: doe reproductive and pre-weaning litter traits. Australian Jor. Of Agricultural Research, 54 (2): 159-166.

Rania, A. Hassan (2005): Effect of crossing on productive performance of rabbits. MSc .Thesis, Faculty of Vet. Med. Suez Canal Univ. Egypt.

Rojas, B. and G.F. Sprague. 1952. A comparison of variance components in corn yield trials: 111. General and specific combining ability and their introduction with locations and years. Agronomy Journal. 44: 452-466.

SAS (2002): SAS/STAT users guide. SAS Institute INC, Cary, NC 27513, USA.

Schlolaut, W. (1982): The nutrition of the rabbit. Roche, Animal Nutrition Department, Switzerland.

Spraque and L.A. Tatum. 1942. General vs. specific combining ability in single crosses of corn. J. Am. Soc. Agron. 34: 923-932

Steel, R.G.D. and Torrie, J.H. (1960): Principles and procedures of statistics Mc Graw- Hill Book Comp. Inc., New York.

Taylor, S.C. (1980): Live weight growth from embryo to adult in domestic mammals. Anim. Prod.3.1: 223-235.

Zaghlool, Y. F. A. (1997): Effect of crossbreeding on the performance of rabbits. M.Sc. Thesis, Fac. Vet. Med., Alex. Univ. Egypt.

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