GENETIC EFFECTS ON THIGH AND HIND LEG LENGTHS OF NATIVE BALADI RED RABBITS ON ACCOUNT OF CROSSING WITH NEW ZEALAND WHITE RABBITS

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ABSTRACT

Data on 591 weaning rabbits which consists of 314 straight-bred and 277 cross-bred individuals, produced through a crossbreeding experiment, from two breeds, one exotic, New-Zealand White (NZW) and local breed, Baladi-Red (BR) as well as their reciprocal crosses. The study aimed at the evaluation of the heterotic and crossbreeding effects (i.e. Additive Direct and Maternal) of biweekly progeny thigh (hip) length (TL) and hind leg length (HL) measures from (weaning) at 6 weeks up to 12 weeks of age, as well as the estimation of the non-genetic factors affecting these traits.

Effect of month of birth (MOB) on TL demonstrated significance at 8 and 10 weeks of age and furthermore at 8,10 and 12 weeks of age for HL trait. Breed group affected significantly TL at 6 and 8 weeks of age whereas at 6, 8 and 12 weeks of age for HL measures. Feed type had significant effect on TL and HL at 10 and 12 weeks of age. Parity affect was significant on HL trait at 10th week of age only. Moreover, sex proved significant effect only for HL trait at 6th week of age.

The results showed that average regression coefficients of the studied traits (i.e. TL and HL) on their age respective body weight (BW) were highly significant at all ages considered, as well as partial regressions within BG at 8 weeks of age for TL and at 10 weeks of age for HL. However, the partial regressions on Litter size at birth (LSB) affected significantly HL at 8th week of age.

The positive and significant effects were detected for Values of direct heterosis (H^I) at 8th week of age for TL measures. Positive Direct additive effects for NZW was shown at 8, 10 and 12 weeks of age for TL, though significance was detected merely at 8 weeks of age whilst were significantly negative at 6, 8 and 12 weeks of age for HL. Maternal NZW additive effect (G^m) on TL and HL measures was positive at 6 and 12 weeks of age for TL and 6, 8 and 10 weeks of age for HL measures. However significant G^m effects were detected at the 6 and 8 weeks of age for TL meanwhile at 6, 8 and 10 weeks of age for HL.

Key Words: Rabbit crossing, thigh length, Hind Leg Length, direct and maternal additive effect.

INTRODUCTION

A limited research work was carried out on linear type measures (e.g. conformation measures) in native rabbits compared with standard ones (Ahmed et al., 2002 and Hassan et al., 2002). The importance of these traits is easily recognized but it is not well documented in the scientific literature. Therefore, these secondary traits may have a role in classic breeding programs. Ayyat et al., (1995) reported that live body weight to thigh length index could be used for classification of rabbits for production to different grades both at marketing and breeding. Crossbreeding is one of the fast tools offered to the breeder for improving many traits in farm animals through the utilization of the non-additive genetic variance.

Conformation traits in rabbits can be employing as early indicator for their longevity; for characterizing offspring morphologically and to detect obvious deficiencies of animals which may result in severe problems to cope with their environment (e.g. leg problems) or present troubles to farmer. Hind leg in rabbits plays an important role in supporting the body during resting and in movement. It also bears the whole body during most reproduction activities. Leg length traits could play an important role in the rabbit overall growth (i.e. heavier weights require stronger hind legs).

The objectives of the present study were to evaluate genetically thigh hip length (TL) and hind leg length (HL) traits in a crossbreeding experiment, involving a local breed (i.e. Baldi Red, BR) with an exotic one (i.e. New-Zealand White, NZW); to investigate some genetic effects (breeding group, direct and maternal additive) and non- genetic factors (feed type, month of birth, parity and sex) as well as direct heterotic effects.

MATERIALS AND METHODS

This experiment was carried out at Sakha research station, Kafr-El-Sheikh, Ministry of Agriculture, Egypt. Data were obtained from a total of 591, straight-bred (314) and cross-bred (277) weaned rabbits produced from a diallel crossing between two breeds, one acclimatized exotic (i.e. sires and dams of the exotic breed were descendents of the New Zealand White, NZW rabbits raised under the Egyptian conditions and the other is a local one (Baladi-Red, BR). The breeding plan permits the simultaneous production of the straight-bred and crossbred rabbits between the two investigated breeds. In the straight-bred group, bucks assigned at random to breed the dams, as in case of cross-bred ones, but with a restriction of avoiding half-sib, full sib and parent-offspring mating.

Measures of Right hind leg length (i.e. rear canon or crus from knee to ankle as cited by Bersenyi et al., 1998) and Hip (Thigh) length from the junction with the pelvic girdle till the hind eminence of the leg, were taken. Thigh hip length (TL) and right hind leg length (HL) measures were recorded biweekly from 6 (weaning) till 12 weeks of age. Rabbits of each breed group were divided randomly into two groups each was fed on one of two types of a commercial compound pelleted feed either intact or crumpled (re-grinded after pelleting), each containing approximately 16.1% protein, 2.39% crude fat and 12.8% crude fiber. Feed and water were afforded *ad libitum* all over the experimental period. Mixed Model Least Squares and Maximum Likelihood Computer Program (Harvey, 1990) was used for analyzing the data. The linear fixed model adopted for the analysis comprised the effects of breed group, BG (4 classes); sex (males and females); feed type (pelleted with 1 cm. Long and 4 mm diameter or crumpled); month of birth, MOB (7 classes) and parity (from the 1^{st} till the 3^{rd}); as well as the interactions between BG *sex and BG *feed type all as fixed effects. The model also incorporates litter size at birth, LSB (Total number born) and age-respective-body-weight in the statistical analysis as covariates (i.e. extracting the average and partial regression coefficients of thigh length and hind leg length on these covariates). Crossbreeding effects (Additive maternal G^M; direct additive G^I; direct heterotic H^I effects) on thigh length and hind leg length measures were derived applying a selected set of linear contrasts on breed group' least squares means (Dickerson, 1992).

RESULTS AND DISCUSSION

Means and coefficients of variation of uncorrected records

Number of observations, actual means, standard errors, and coefficients of variation (CV%) for all straight-bred and crossbred breed groups for TL and HL (from weaning at 6 till 12 weeks of age) are given in (Table 1). Coefficients of variation (CV%) of TL (Table 1) ranged between 11.86-15.21% in case of purebred rabbits, meanwhile it extended from 12.80-16.20 in crosses. Also, the corresponding ranges for HL trait were 8.50 - 12.24 and 8.25 - 11.82. However, these results are similar with those reported for TL trait, by Ahmed et al., (2002) with NZW, Baldi Black and Baldi Red rabbits.

Estimation of CV% given in (Table 1), showed a general trend indicating that TL and HL phenotypic variations decreased with advance of age in rabbits. These inferences coincide greatly with those reported by Ahmed et al., (2002) on TL.

However, the higher CV% for TL and HL measures at weaning than at marketing may be attributed to that these traits would become less sensitive to non-genetic factors such as maternal effects, which in general, diminish with advance of progeny age. Also, it might to be due to the consequence of the combination of non-genetic maternal environment and genetic factors (Falconer, 1989).

Month of birth

Month of birth differences were significant at 8, 10 weeks of age for TL and HL measures. (Table 2). Analogous to these results, Ahmed et al., (2002) reported that variations in TL caused by month of birth effect were significant at 8, 10 and 12 weeks.

Least squares means listed in (Table 3) show that there was an inconsistent trend for the effect of month of birth on TL and HL at different ages. Variations due to month of birth could be attributed to variations in climatic conditions (e.g. ambient temperature, relative humidity...) and day length from one month to another.

Table 1: Actual means (mm.); standard errors (±SE) and coefficients of variability (CV) for thigh and hind leg length traits in New Zealand White (NZW); Baladi Red (BR) rabbits and their crosses from 6 up to 12 weeks of age.

	6 Weeks			8 Weeks			10 Weeks			12 Weeks		
	N	Mean±SE	CV%	N	Mean±SE	CV%	N	Mean±SE	CV%	N	Mean±SE	CV%
Thigh Length (TL)												
Overall	591	84.19±0.52	14.96	498	93.86±0.55	13.09	445	100.45±0.60	12.69	411	107.65±0.74	13.93
Sex												
Male	278	84.14±0.78	15.53	230	95.22±0.75	11.91	200	101.45±0.85	11.84	186	108.23±0.95	11.98
Female	313	84.23±0.69	14.46	268	92.69±0.79	13.98	245	99.63±0.85	13.33	225	107.18±1.10	15.39
Straight-bred												
NZW	237	84.70±0.79	14.31	206	95.80±0.84	12.56	184	103.59±0.91	11.86	176	111.59±1.08	12.90
BR	77	84.87±1.27	13.10	64	91.17±1.51	13.28	59	98.22±1.546	12.10	54	103.61±2.15	15.21
Cross-bred												
NZW x BR	70	80.71±1.46	15.15	57	94.30±1.72	13.76	55	98.82±1.86	13.94	49	106.53±2.26	14.88
BR x NZW	207	84.52±0.95	16.12	171	92.37±0.93	13.15	147	98.03±1.03	12.80	132	104.45±1.22	13.41
Hind Leg Length (HL)												
Overall	591	80.41±0.37	11.33	498	90.48±0.39	9.67	445	98.16±0.41	8.87	411	104.94±0.43	8.38
Sex												
Male	278	80.02±0.55	11.39	230	91.11±0.57	9.43	200	98.55±0.62	8.88	186	105.08±0.62	8.02
Female	313	80.75±0.51	11.27	268	89.94±0.54	9.85	245	97.84±0.55	8.88	225	104.82±0.61	8.68
Straight-bred												
NZW	237	80.74±0.55	10.57	206	90.92±0.63	9.96	184	257.07±1.72	9.06	176	105.23±0.67	8.50
BR	77	81.49±1.03	11.09	64	90.70±0.92	8.09	59	248.39±3.96	12.24	54	105.56±1.10	7.68
Cross-bred												
NZW x BR	70	76.43±1.06	11.58	57	87.54±1.08	9.29	55	95.36±1.17	9.13	49	105.31±1.24	8.25
BR x NZW	207	80.97±0.66	11.82	171	90.85±0.68	9.83	147	98.81±0.78	9.52	132	104.17±0.78	8.58
Live Body Weight (LBW)												
Overall	591	516.55±6.80	32.02	498	713.87±8.76	27.37	445	899.56±10.74	25.18	411	1104.33±13.12	24.08
Sex												
Male	278	527.81±9.39	29.66	230	733.65±11.51	23.79	200	913.90±14.54	22.51	186	1055.08±19.16	24.44
Female	313	506.55±9.75	34.06	268	696.88±12.86	30.20	245	887.86±15.46	27.25	225	1091.38±18.89	25.96
Straight-bred												
NZW	237	559.01±10.80	29.74	206	760.15±13.85	26.15	184	957.66±15.54	22.01	176	1171.31±19.85	22.49
BR	77	502.14±16.28	28.45	64	709.06±19.54	22.05	59	884.83±27.73	24.07	54	1051.11±35.06	24.51
Cross-bred												
NZW x BR	70	472.93±18.44	32.62	57	693.60±24.44	26.60	55	873.45±29.28	24.86	49	1105.71±32.64	20.66
BR x NZW	207	488.04±11.54	34.03	171	666.67±15.04	29.50	147	842.52±19.70	28.34	132	1036.29±23.17	25.69

Litter Size at Birth (LSB)

	Mean±SE	CV%
Overall	6.73 + 0.07	27.00
Sex Male	6.83 + 0.11	27.00
Female	6.65 + 0.10	26.98
Straight-bred		
NZW	6.51 + 0.10	24.78
BR	6.42 + 0.15	20.60
Cross-bred		
NZW x BR	6.39 + 0.23	30.08
BR x NZW	7.23 + 0.14	28.43

Parity

No significant effects were detected for parity on TL and HL measures at all studied ages except at 10th week of HL trait only (Table 2). However, Ahmed et al., (2002) observed that variation in TL caused by month of birth effect was significant at 8th week of age.

The results obtained (Table 3) for TL portray a clear trend for increase TL with advance of parity at all ages studied except at 6th week of age. Also, Least squares means revealed a general trend indicating that HL at different ages increased with advance of parity and till 2nd parity. In this respect, Ahmed et al., (2002) recorded a general trend indicating that TL at different ages increased with advance of parity and as a consequence it was virtually greatest at the 3rd parity. Effect of parity on TL and HL may be due to changes in the aspects of physiological efficiency of the rabbit dam, especially those related to its stage of maturity and the effect of this stage on intra-uterine environment during pregnancy, milk production and the maternal ability of the doe to nurse its progeny, which may advance with parity (Afifi and Emara, 1984).

Sex (S)

Results in (Table 3) revealed that the effect of sex was non- significant on TL and HL of rabbits at all post-weaning ages studied except at 6th week of age for HL trait. In this respect, Ahmed et al., (2002) reported a significant effect of sex on TL at 6th week of age only. Luzi et al. (2000) found no significant differences according to sex amongst body measurements (body length; rump length; abdomen circumference; thigh circumference and chest circumference) of live animals till 120 days of age using commercial crossbred rabbits.

The results in (Table 3) revealed inconsistent trend for affected TL by sex at the different ages. However Ahmed et al., (2002) showed that female were somewhat better than males with small differences between them. From another hand, the results obtained indicated that females were somewhat greater than males in HL least square means at all studied ages except 10 weeks of age. However, other investigators indicated that female rabbits tended to have higher records in growth traits than males (e. g. Afifi, 1971; Khalil, 1980; Mahajan et al., 1980 and Khalil et al., 1987).

Table 2: F-ratio of least squares analysis of variance of different factors affecting thigh and hind leg length traits from 6 up to 12 weeks of age in New Zealand White (NZW); Baladi Red (BR) rabbits and their crosses

Sources of variations	df	6 Weeks	8 Weeks	10 Weeks	12 Weeks	6 Weeks	8 Weeks	10 Weeks	12 Weeks
		Thigh Length (TL)				Hind Leg Length (HL)			
		F- Values				F- Values			
BG	3	3.27*	3.51*	0.43	1.25	7.36****	2.99*	2.55	6.88***
SEX	1	3.18	0.15	1.87	0.001	5.75*	0.27	2.84	0.10
FEED TYPE	1	0.31	0.04	20.99****	23.27****	1.24	1.96	28.83****	20.87****
PARITY	2	2.36	1.28	0.88	0.29	2.92	1.21	5.66**	2.24
MOB	6	0.61	15.15****	2.78*	2.03	0.39	9.01****	7.13****	2.79*
BG X SEX	3	1.37	2.05	0.60	0.78	0.48	1.55	0.34	0.62
BG X FEED	3	2.70*	5.48**	0.54	1.92	2.12	1.06	0.98	4.44**
REGRESSORS									
BW	1	133.78****	742.45****	1028.44****	691.03****	109.84****	500.50****	477.78****	386.21****
BG *BW	3	0.45	3.71*	3.09	1.19	0.94	0.71	2.66*	1.16
LSB	1	0.27	0.17	0.13	0.38	0.03	1.18	0.09	3.31
BG *LSB	3	0.85	0.44	1.07	3.76	1.01	4.10**	0.10	1.16
REMAINDER-DF		563	470	417	383	563	470	417	383
REMAINDER-MS		105.41	34.71	30.19	56.35	57.08	21.25	24.66	27.21
R SQUARED		0.37	0.78	0.83	0.77	0.34	0.74	0.70	0.67

* = Significance at ($P\leq 0.05$); ** = Significance at ($P\leq 0.01$); *** = Significance at ($P\leq 0.001$); **** = Significance at ($P\leq 0.0001$).
BG = Breed group, MON= Month of birth, BW= Body weight, LSB= Litter size at birth.

Table 3. Least squares means (±Standard Error, SE) of different factors affecting thigh and hind leg length traits, mm. from 6 up to 12 weeks of age in New Zealand White (NZW); Baladi Red (BR) rabbits and their crosses.

Factors		6 weeks		8 weeks		10 weeks		12 weeks	
		N	Mean±SE	N	Mean±SE	N	Mean±SE	N	Mean±SE
Thigh Length (TL)									
Overall Mean		591	84.31±0.67	498	94.99±0.43	445	100.39±0.43	411	107.55±0.62
Straight	NZW	237	82.91±0.86	206	95.03±0.54	184	100.56±0.55	176	108.75±0.78
Breed	BR	77	86.24±1.42	64	93.21±0.87	59	99.73±0.85	54	107.49±1.22
	Av.	314	84.58±0.88	270	94.12±0.55	243	100.14±0.55	230	108.12±0.79
Crossbred	NZW x BR	70	82.43±1.45	57	97.00±0.92	55	100.95±0.88	49	106.71±1.24
	BR x NZW	207	85.65±0.82	171	94.73±0.53	147	100.33±0.55	132	107.26±0.78
	Av.	277	84.04±0.85	228	95.86±0.54	202	100.64±0.53	181	106.99±0.76
Sex	Male	278	83.40±0.86	230	94.87±0.56	200	100.82±0.57	186	107.57±0.80
	Female	313	85.22±0.82	268	95.12±0.52	245	99.96±0.50	225	107.54±0.73
Feed type	Pelted	269	83.98±0.89	214	95.06±0.57	181	98.78±0.56	167	105.15±0.80
	Crumbled	322	84.64±0.89	284	94.93±0.55	264	102.00±0.55	244	109.96±0.79
Parity	1st	278	83.31±0.98	248	94.12±0.62	221	99.84±0.60	208	106.87±0.86
	2nd	235	85.78±0.89	193	94.62±0.55	176	99.98±0.54	161	107.53±0.78
	3rd	78	83.84±1.61	57	96.24±1.06	48	101.36±1.03	42	108.26±1.49
Month	Mar.	70	83.02±1.80	65	100.94±1.10	59	102.99±1.06	56	109.26±1.51
Of	Apr.	98	85.40±1.63	87	93.36±1.00	70	102.08±0.98	66	109.94±1.38
Birth	May	128	84.75±1.28	122	92.86±0.78	117	99.32±0.75	110	105.93±1.06
	June	57	84.01±1.52	45	90.62±0.99	41	99.76±0.98	39	106.15±1.41
	July	139	83.73±1.02	108	93.32±0.67	98	99.76±0.64	89	106.40±0.91
	Aug.	69	83.26±1.49	50	95.76±1.00	45	100.08±1.00	38	106.98±1.43
	Sep.	30	85.98±2.15	21	98.09±1.47	15	98.75±1.58	13	108.22±2.28
Hind Leg Length (HL)									
Overall Mean		591	80.08±0.49	498	91.21±0.34	445	98.58±0.39	411	105.45±0.42
Straight	NZW	237	79.15±0.63	206	91.32±0.43	184	98.40±0.50	176	103.44±0.54
Breed	BR	77	82.44±1.04	64	91.44±0.68	59	98.06±0.77	54	107.06±0.85
	Av.	314	80.80±0.65	270	91.38±0.43	243	98.23±0.50	230	105.25±0.55
Crossbred	NZW x BR	70	77.18±1.07	57	89.86±0.72	55	98.02±0.79	49	105.91±0.86
	BR x NZW	207	81.52±0.60	171	92.23±0.41	147	99.85±0.50	132	105.41±0.54
	Av.	277	79.35±0.62	228	91.04±0.43	202	98.94±0.48	181	105.66±0.53
Sex	Male	278	79.17±0.64	230	91.08±0.44	200	99.06±0.51	186	105.36±0.56
	Female	313	80.98±0.60	268	91.34±0.41	245	98.10±0.45	225	105.55±0.50
Feed type	Pelted	269	79.60±0.65	214	90.81±0.45	181	96.88±0.51	167	103.87±0.55
	Crumbled	322	80.56±0.66	284	91.61±0.44	264	100.28±0.50	244	107.04±0.55
Parity	1st	278	79.43±0.72	248	90.46±0.48	221	97.56±0.54	208	104.14±0.59
	2nd	235	81.31±0.65	193	91.43±0.43	176	99.75±0.49	161	105.63±0.54
	3rd	78	79.48±1.19	57	91.75±0.83	48	98.44±0.93	42	106.59±1.03
Month	Mar.	70	80.80±1.32	65	86.95±0.86	59	94.06±0.96	56	102.69±1.05
Of	Apr.	98	80.89±1.20	87	87.84±0.78	70	96.36±0.88	66	106.20±0.99
Birth	May	128	80.82±0.94	122	90.03±0.61	117	96.88±0.68	110	105.50±0.74
	June	57	79.13±1.12	45	90.67±0.78	41	99.01±0.89	39	105.68±0.98
	July	139	79.51±0.75	108	91.57±0.52	98	98.87±0.58	89	107.09±0.64
	Aug.	69	79.32±1.09	50	94.70±0.78	45	102.94±0.90	38	105.57±0.99
	Sep.	30	80.05±1.58	21	96.74±1.14	15	101.95±1.42	13	105.44±1.58

Feed type (F)

Significant effects were detected for feed type on TL and HL measures at 10, 12 weeks of age. (Table 2). In agreement with results on TL Ahmed et al (2002) detected significant effect for feed type at 10, 12 weeks of age.

Least squares means for TL and HL measures (Table 3) revealed that the values of crumpled feed were somewhat greater than pelleted feed at all ages studied except at 10th week of age for TL trait. Also, Ahmed et al., (2002) reported a general trend of an advantage for the crumpled feed over pelleted one, on post-weaning TL measures.

Breed group (BG)

Breed group differences (Table2) were significant at 6 and 8 weeks of age for TL measures and at 6,8 and 12 weeks of age for HL measures. Likewise, breed group effect was reported to be a significant source of variation at 6, 8 and 12 weeks of age for TL by Ahmed et al (2002).

Least squares means presented in (Table 3) revealed that values of the crosses sired by BR bucks (i.e. BR*NZW) excelled its reciprocal cross which sired by NZW males for TL measures at 6 and 12 weeks of age only and at ages considered except at 12th week of age for HL trait.

Interactions

Effect of (BG X Sex) interactions on TL and HL were not significant at all ages studied, while (BG X F) interaction proved significant effect at 6, 8 weeks of age for TL measures and at the 12th week of age for HL measures (Table2). However, Ahmed et al. (2002) showed that TL measures were affected significantly at the 6th week of age by the interaction between breed group and sex, Also the interaction between breed group and feed type was significant for TL measures at the 8th week of age.

Straight-bred differences

Results of linear contrasts given in (Table 4) revealed a general superiority of NZW rabbits over BR rabbits for TL at all ages studied except at the 6th week of age. These results are equivalent with those reported by Ahmed et al. (2002). In the contrary, results observed a general superiority of BR rabbits over NZW for HL at all ages studied except at 10 weeks of age

Direct heterotic effect (H^I)

Estimates of direct heterosis (H^I), calculated in actual units (mm.) and as percentage (%)(Table 4) were positive for the crosses between NZW and BR at 8 and 10 weeks of age for TL trait and at 10, 12 weeks for HL trait. These positive direct

Table 4: linear function, mm. (±Standard error, SE) of straight-bred differences and crossbreeding effects pertaining thigh (TL) and Hind Leg Length (HL) traits from 6 up to 12 weeks of age in New Zealand White (NZW); Baladi Red (BR) rabbits and their crosses.

Effect	Trait		Age per week			
			6	8	10	12
Straight-bred difference:						
NZW vs Baladi Red	Thigh Length		-3.33±1.538*	1.83±.94	0.83±0.92	1.27±1.31
	Hind Leg length		-3.30±1.13**	-0.11±0.07	0.34±0.08	-3.619±0.09***
Direct heterosis						
NZW · BR	Thigh Length	(Units)	-0.53±1.099	1.74±.67**	.50±.0.66	-1.13±0.93
		(%)	-0.63	1.85	0.49	-1.05
NZW · BR	Hind leg length	(Units)	-1.45±0.81	-0.34±0.05	0.71±0.06	0 .41±.0.65
		(%)	-1.79	-0.37	0.72	0.39
Direct additive						
NZW	Thigh Length		-3.27±1.11**	2.05±.0.70**	0.73±0.68	0.36±.0.96
NZW	Hind leg length		-3.82±0.82***	-1.24± 0.54*	-0.74±0.61	-1.56±.0.67*
Maternal additive						
NZW	Thigh Length		3.217±1.636*	-2.27±1.03*	-0.63±1.00	0.54±1.40
NZW	Hind leg length		4.34±1.20***	2.37± 0.08**	1.82±0.90*	-0.50±0.97

* = Significance at ($P \leq 0.05$). ** = Significance at ($P \leq 0.01$); *** = Significance at ($P \leq 0.001$).

Straight-bred difference: (NZW x NZW) - (BR x BR) = $\{(G^I_{BR} + G^m_{BR}) - (G^I_{NZW} + G^m_{NZW})\}$

Direct heterotic (units): H^I_{BRxNZW} = 0.5 x {(BR x NZW) + (NZW x BR)} - 0.5 x {(BR x BR) + (NZW x NZW)}

Direct additive (for NZW): $(G^I_{NZW} - G^I_{BR})$ = {(NZW x NZW) + (NZW x BR)} - {(BR x BR) + (BR x NZW)}

Maternal additive (for NZW): $(G^m_{NZW} - G^m_{BR})$ = {(NZW x BR) - (BR x NZW)}

Where NZW = New Zealand White and BR = Baladi-Red Rabbits.

G^I and G^m are direct additive and maternal additive of the subscripted breeds, respectively.

Table (5): Partial regression coefficients , b (± Standard Error, SE) of thigh length, TL and hind leg length, HL on litter size at birth and live body weights of New Zealand White (NZW) and Baladi-Red (BR) rabbits and their crosses from 6 up too 12 week of age.

Covariate	Trait	Breed Groups	6th week b	6th week ± SE	8th week b	8th week ± SE	10th week b	10th week ± SE	12th week b	12th week ± SE
Live Body Weight	TL	NZWxNZW	-0.003361	± 0.004960	-0.008021	± 0.002711	-0.002642	± 0.002179	-0.002805	± 0.002534
		NZW x BR	-0.004790	± 0.007488	0.008558	± 0.004160	0.009231	± 0.003267	0.006116	± 0.004166
		BR x NZW	0.002019	± 0.005181	-0.004773	± 0.002812	-0.004503	± 0.002210	-0.004198	± 0.002822
		BR x BR	0.006132	±0.00776	0.004236	± 0.004462	-0.002086	± 0.003183	0.000887	± 0.003751
	HL	NZWxNZW	-0.000870	± 0.003650	0.002680	± 0.002121	0.001018	± 0.001969	-0.000240	± 0.001761
		NZW x BR	-0.008109	± 0.005510	-0.002532	± 0.003255	0.004039	± 0.002953	0.001932	± 0.002895
		BR x NZW	0.001547	± 0.003812	0.001904	± 0.002200	0.002869	± 0.001997	0.002462	± 0.001961
		BR x BR	0.007432	± 0.005711	-0.002053	± 0.003491	-0.007927	± 0.002876	-0.004154	± 0.002606
Litter Size at Birth	TL	NZWxNZW	0.066593	± 0.490569	-0.232175	± 0.310627	-0.396336	± 0.290181	1.274725	± 0.394617
		NZW x BR	-1.010654	± 0.659849	-0.052020	± 0.429149	0.551016	± 0.389982	-0.605419	± 0.512995
		BR x NZW	-0.085818	± 0.506815	-0.250871	± 0.305271	-0.044950	± 0.287771	-0.180629	± 0.396650
		BR x BR	1.029880	± 0.861443	0.535066	± 0.531454	-0.109730	± 0.484853	-0.488676	± 0.666323
	HL	NZWxNZW	0.135850	± 0.360987	0.477792	± 0.243055	0.131277	± 0.262248	0.413793	± 0.274213
		NZW x BR	-0.764341	± 0.485552	-0.672232	± 0.335795	-0.056727	± 0.352442	-0.096237	± 0.356473
		BR x NZW	-0.175503	± 0.372942	-0.447352	± 0.238865	-0.044990	± 0.260070	-0.282042	± 0.275626
		BR x BR	0.803993	± 0.633895	0.641792	± 0.415845	-0.029560	± 0.438181	-0.035513	± 0.463017
Regression Equations	TL	NZWxNZW	84.31 - 0.003 Xi+0.067 Xj		94.99 - 0.008 Xi - 0.232 Xj		100.39+0.003 Xi - 0.396 Xj		107.55 - 0.003 Xi+1.275 Xj	
		NZW x BR	84.31 - 0.005 Xi - 1.011 Xj		94.99+0.009 Xi - 0.052 Xj		100.39+0.009 Xi+0.551 Xj		107.55+0.006 Xi - 0.605 Xj	
		BR x NZW	84.31+0.002 Xi - 0.086 Xj		94.99 - 0.005 Xi - 0.251 Xj		100.39 - 0.004 Xi - 0.045 Xj		107.55 - 0.004 Xi - 0.181 Xj	
		BR x BR	84.31+0.006 Xi+1.030 Xj		94.99+0.004 Xi+0.535 Xj		100.39 - 0.002 Xi - 0.110 Xj		107.55+0.001 Xi - 0.489 Xj	
	HL	NZWxNZW	80.08 - 0.001 Xi+0.136 Xj		91.21 - 0.003 Xi+0.478 Xj		98.58+0.001 Xi+0.131 Xj		105.45 - 0.000 Xi+0.414 Xj	
		NZW x BR	80.08 - 0.008 Xi - 0.764 Xj		91.21 - 0.003 Xi - 0.672 Xj		98.58+0.004 Xi - 0.057 Xj		105.45-0.002 Xi - 0.096 Xj	
		BR x NZW	80.08+0.002 Xi - 0.176 Xj		91.21+0.002 Xi - 0.447 Xj		98.58+0.003 Xi – 0.045 Xj		105.45+0.002 Xi - 0.282 Xj	
		BR x BR	80.08+0.007 Xi+0.804 Xj		91.21 - 0.002 Xi+0.642 Xj		98.58 - 0.007 Xi - 0.030 Xj		105.45 - 0.004 Xi - 0.036 Xj	

Xi = Live Body Weight at the respective week; Xj = Litter Size at Birth.

heterosis estimates were significant at 8th week of age for TL trait only. In the same pattern, Ahmed et al (2002) with TL reported positive and significant direct heterosis estimates at the same age. These findings lead to state that crossbreeding the Baladi Red rabbits with NZW was associated with an improvement in TL measures at these ages.

Direct additive effect (G^i)

Crossing exploits genetic variations in two ways. Characters with considerable non-additive genetic variation (Dominance and Epistasis) are most likely to show heterosis. In relation to complementarity, crossing exploits differences in average performance between populations (i.e. differences in additive effects between populations).

Direct NZW additive effects were positive at 8, 10 and 12 weeks of age for TL trait only, though significance was detected at 8 weeks of age for TL and were significantly negative (i.e. in favor of BR) at 6, 8 and 12 weeks of age for HL (Table 4). Ahmed et al., (2002) recorded positive direct additive effect for TL trait at 8th week of age without any significant effect. However, Hassan et al., (2002) reported a negative direct additive effect at all ages studied with significant effect at 6th week of age for HL trait. The negative records regarding direct additive effects suggest that the use of NZW rabbits as a sire breed in crossbreeding programs would be non-useful in improving TL and HL and using Baladi-Red for this purpose would be more beneficial especially at ages when direct additive effects were significant.

Lewczuk et al. (1996) investigated the effect of terminal sires of Danish White rabbits on body measurements (i.e. body length; thigh length; chest circumference and loin width) and revealed that most of these measurements, disregarding loins width, were to great extent similar at the sire groups.

Maternal additive effect (G^m) Maternal effect consists mainly from additive maternal and cytoplasmic-inheritance. However, the maternal effect herein could be confounded with the reciprocal effect (i. e. sex linkage) due to additive effects of the genes concerned and carried on the sex chromosomes. In this respect, certain crosses show much more complementarity than others depending on the extent to which the crossed populations differ in reproductive performance and in production characters, and also on the direction of the cross. It is clearly obvious that there would be far greater complementarity when the most prolific population is used as a source of dams rather than of sires (maternal additive).

Results in (Table 4) proved that maternal NZW additive effect (G^m) were positive at 6, 12 weeks of age for TL and at 6,8 and 10 for HL traits, though significance was detected for TL and HL at 6 and 8 weeks of age. Ahmed et al., (2002) and Hassan et al (2002) reported a similar results on TL and HL measures, respectively. These results lead to state that NZW rabbits were better for post weaning TL and HL measures than Baladi-Red rabbits to be used as dams in simple crossing programs including these two breeds.

Regression Coefficients and Prediction Equations

Table 5 represents Partial Regression Coefficients, b (± Standard Error, SE) of post-weaning conformation traits on Litter size at birth and live body weights of different rabbit breeding groups from 6 through 12 week of age. Data revealed that BW and LSB partial regression coefficients of the NZW pures were generally of no consistent trend for TL or HL. However, the two regression coefficients of the two covariates LBW and LSB were generally opposite to each other (regarding the negative and positive signs), in both of the conformation traits in NZW pures. Regarding the effect of LSB on HL was persistently positive in NZW pures, negative in crosses. However in BR straight-bred rabbits, the aforementioned parameters were positive at the earlier stages (i.e. 6 and 8 wks of age) and subsequently negative. The same trend was obvious in BR rabbits when regarding the association between LSB and TL. Considering crosses, the relationship between LSB and TL was negative at most of the ages taken into account.

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REFERENCES

Afifi, E. A. (1971). A study of some economical and productive characters in some strains of rabbits and their crosses. Ph. D. Thesis, Faculty of Agriculture, Ain Shams University, Egypt.

Afifi, E. A. and Emara, M. E. (1984). Litter weight in local Egyptian and exotic breeds of rabbits and their crosses. 3rd World Rabbit Congress, Rome, Italy, 4-8 April, pp: 126-135.

Ahmed, E. G.; Elshennawy, M.A; Abdel-Ghany, A. M and Hassan, N. S. (2002). Thigh length of two Egyptian native breeds and their single crosses with New Zealand White rabbits. El-Minia J. of Agriculture Research and Development. Special Issue 22 (2D): 2125-2138. Proceedings of Minia 1st Conference for Agriculture and Environmental Sciences (MCAES 1st); March 25-28/2002 El-Minia, Egypt.

Ayyat, M. S.; Marai, I. F. M. and El-Sayed Gh. A. (1995). A trial to grade New Zealand White rabbits for broiler production at marketing and breeding. World Rabbit Science, 3 (2): 75-84.

Bersenyi, A.; Fodor Kinga; Fekete, S.; Eszes F.; Gaspardy A. and Zoldag L. (1998). Influence of feeding intensity on the growth of different body measurements. 6th World Rabbit Congress, Toulouse, France, (vol. 2): 8-17.

Dickerson, G. E. (1992). Manual for evaluation of breeds and crosses of domestic animals. Publication division, FAO, Rome, Italy.

Falconer, D. S. (1989). Introduction to quantitative genetics. Third Edition. Longman, UK.

Harvey, W. R. (1990). Use's Guide for LSMLMW. Mixed model least squares and maximum likelihood computer program. PC-

Hassan N. S.; A. M. Abdel-Ghany; Youssef, Y.M.K and Ahmed, E. G. (2002). Genetic effects on foot length in crosses between New Zealand White and Egyptian Native Breed rabbits. 7th WPSA Asian Pacific Federation Conference in Conjunction with 12th Australian Poultry and Feed Convention; 6-10 October 2002, Australia.

Khalil, M. H. (1980). Genetic and environmental studies on some productive traits in rabbits. M.

Sc. Thesis, Faculty of Agriculture at Moshtohor, Zagazig University, Banha Branch, Egypt

Khalil, M.H., Owen, J.B. and Afifi, E.A. (1987). A genetic analysis of litter traits in Bauscat and Giza White rabbits. Anim. Prod., 45 : 123-134.

Lewczuk, A.; Rymkiewicz, J.; Bochno, R. and Janiszewska, M. (1996). The effect of sire slaughter value of progeny of Danish White rabbits. 6th World Rabbit Congress, Toulouse, France, (vol. 2) 309-313

Luzi, F.; Lazzaroni, C.; Barbieri, S.; Pianetta, M.; Cavani, C. and Crimella, C. (2000). Influence of type of rearing, slaughter age and sex on fattening rabbit ... Productive performance. 7th World ... Congress, Valencia, Spain, 1-7.

Mahajan, J. M.; Sastry, V. R ... Dash, P. K. and Lahiri, S. S. (1980). ... ...land White rabbits for meat and pelt. Ind. ... ming, 3(9): 30-32.

الملخص العربي

التأثيرات الوراثية على صفتى طول الفخذ والأرجل الخلفية للأرانب البلدي الاحمر كنتيجة للتهجين مع أرانب النيوزيلندى الأبيض

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تم الحصول على نتائج الدراسة الحالية من عدد إجمالي من الأرانب المفطومة حيل الأول منها ٣١٤ أرنب نقى و ٢٧٧ أرنب خليط ناتجة من التهجين بين نوعين من الأرانب ... دة قياسية هى النيوزيلندى الأبيض، والثانية من الأنواع المحلية وهى البلدى الأحمر).

هدفت الدراسة إلى تقييم تأثيرات التهجين (التأثير التجمعي والأمي المباشرين) و ... ة الهجين لصفتي طول الفخذ و طول الأرجل الخلفية من عمر ٦ وحتى عمر ١٢ أسبوع ، أيضا ... التأثيرات غير الوراثية (ترتيب البطن وجنس الخلفة و شهر الميلاد وشكل العلف المقدم) .

أظهر شهر الميلاد تأثيرا معنويا عند كل من الأسبوع الثامن والعاشر من ال... على صفة طول الفخذ و عند الأسابيع الثامن والعاشر والثانى عشر من العمر لصفة طول الأرجل الخلفية. كما أثرت مجموعة التربية معنويا على صفة طول الفخذ عند الأسبوع السادس والثامن م... ر وعلى طول الأرجل الخلفية عند الأسابيع السادس والثامن والثانى عشر من العمر. هذا بينما ... كل العلف المقدم بصورة معنوية على الصفتين محل الدراسة عند الأسبوع العاشر والثانى عشر ... عمر. وقد أظهر ترتيب البطن تأثيرا معنويا على صفة طول الأرجل الخلفية عند عمر ١٠ أسابيع ... بينما فشل في إظهار أى تأثير معنوى على صفة طول الفخذ. أظهر جنس الخلفة تأثيرا معنويا ... صفة طول الأرجل الخلفية عند الأسبوع السادس من العمر فقط.

أوضحت النتائج أيضا أن القيمة المتوسطة لمعامل إعتماد صفتي طول الفخذ ... الأرجل الخلفية على وزن الجسم عند عمر الدراسة كانت معنوية عند كل الأعمار محل الدر... وبالنسبة لمعامل الاعتماد الجزئى داخل مجاميع التربية على وزن الجسم الحى كان معنويا عند ... أسبوع لصفة طول الفخذ وعند عمر ١٠ أسابيع لصفة طول الأرجل الخلفية. وعند النظر ... معامل الاعتماد الجزئى داخل مجاميع التربية على حجم البطن عند الميلاد فقد أظهر تأثيرا مع... عند عمر ٨ أسابيع لصفة طول الأرجل الخلفية.

ظهرت التأثيرات الموجبة والمعنوية لقوة الهجين المباشرة عند الأسبوع الثامن م... ر لصفة طول الفخذ.كما أوضحت النتائج أن التأثير التجمعى المباشر لسلالة النيوزيلندى كان م... ى معظم الأعمار المدروسة لصفة طول الفخذ ولم تظهر المعنوية إلا فى الأسبوع الثامن من العم... الصفة. هذا وقد كان التأثير التجمعى المباشر لسلالة النيوزيلندى سالبا ومعنويا (فى صالح ... الأحمر) لصفة طول الأرجل الخلفية عند الأعمار ٦ و ٨ و ١٢ أسبوع من العمر. وبالنسبة ... الأمى المباشر لسلالة النيوزيلندى على صفة طول الفخذ كان موجبا عند الأسبوع السادس ... ى عشر بينما كان موجبا عند الأسبوع السادس و الثامن و العاشر على صفة طول الأرجل الخ... مع ذلك سجل التأثير الأمى المباشر المعنوية عند كل من الأسبوع السادس والثامن لصفة طول ال... عند كل من الأسبوع السادس والثامن والعاشر على صفة طول الأرجل الخلفية.