POST-WEANING BODY AND TRANSVERSE CHEST LENGTH MEASURES OF BALADI RED RABBITS ON ACCOUNT OF CROSSING WITH NEW ZEALAND WHITE RABBITS

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(*Received, April 23,2003*)

ABSTRACT

A total of 591 F_1 straight-bred (314) and cross-bred (277) weaning rabbits, produced from two breeds, one exotic, New-Zealand White (NZW) and a local one, Baladi-Red (BR) as well as their reciprocal crosses. The study aimed at the evaluation of the crossbreeding effects (i.e. Additive Direct and Maternal) and heterotic effect of biweekly progeny body (BL) and transverse chest length (CL) 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.

Tests of significance revealed that month of birth (MOB) succeeded to prove significance at all ages studied except at 6 week age for BL and CL traits. Significance also was detected for breeding group (BG) on BL and CL traits except at 12th week of age for CL trait. Feed type affected BL and CL insignificantly at all ages except that at 8 weeks of age for BL traits. Parity affected significantly BL trait at all age studied except at 10 weeks of age, while failed to prove any significant effect for CL trait. Sex affected BL and CL insignificantly at all ages except at 6th week of age for BL traits.

Average regressions of BL and CL on their age respective body weight (BW) were significant at all ages considered, as well as partial regressions within BG on BW at 8 and 12 weeks for BL and 10 weeks for CL, also on litter size at birth (LSB) at 8 weeks of age for BL traits. Values of direct heterosis (H^I) were positive only at 10 and 12 weeks of age for BL and were positive and significance for CL trait at 8 and 10 weeks of age. Direct additive effect of NZW on BL and CL at most ages studied were negative in favorBR, though significance was detected at early age stages at 6 and 8 weeks of age for BL and CL traits. Maternal additive effects (G^m) for BL trait were positive and significant at all ages except at 12th weeks of age, while for the CL trait were positive at most ages studied but without significance effect.

Key Words: Rabbit crossing, body length, transverse chest length, direct and maternal additive effect.

INTRODUCTION

A limited research work was carried out on linear type traits (e.g. conformation measures) in native rabbits compared with standard ones (Abdel-Ghany et al; 2001; Hassan et al., 2001). Though of the relatively slight attention, these type traits may explain a relatively undersized, but potentially important amount of variability in measures of growth in rabbits. The importance of these traits is easily recognized but it is not well documented in the scientific literature. 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. Live animals body length (BL) constitutes the frame upon which meat would be deposited. Chest circumference measures could play an important role in the rabbit's overall tidal air during breathing which in turn affect its healthiness; fitness; vigor and strength. However, no data were available in the literature on development of body measurements in rabbits (Bersenyi et al., 1998).

The objectives of the present work were to evaluate genetically body length (BL) and transverse chest length (CL) traits in a crossbreeding experiment, involving one 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.

Live animals body length were measured from the atlas vertebra to the 7th lumber vertebra, i.e. dorsal length as cited by Ouhayon and Blasco (1992) and Paci et al. (1997) which was to some extent compatible to carcass trunk length as cited by Blasco et al., (1992). Transverse chest length is the arc that extends between the two dorsal diapophysis on both sides of the third thoracic vertebra (tubercular facit) under the scapulae.

Body length (BL) and transverse chest length (CL) 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 1st till the 3rd); as well as the interactions between BG *sex and BG *feed type all as fixed effects. The model also incorporates litter size at birth (Total number born) and age-respective-body-weight in the statistical analysis as covariates (i.e. extracting the average and partial regression coefficients of body length and transverse chest length on these covariates). Crossbreeding effects (Additive maternal G^M; direct additive G^I; direct heterotic H^I effects) on body length and transverse chest length traits were derived applying a selected set of linear contrasts on breed grsoup's 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 BL and CL (from weaning at 6 till 12 weeks of age) are given in (Table 1). Coefficients of variation (CV%) of BL (Table 1) ranged between 8.74 – 12.24% in case of straight-bred rabbits, meanwhile it extended from 9.31 – 14.85% in crosses. Also, the corresponding ranges for CL ranged between 12.37 – 16.8% in case of purebred rabbits, meanwhile it extended from 12.91-16.96 in crosses. However, these result are similar with those reported for BL trait by Abdel-Ghany et al; 2001 and Hassan et al., (2001) on CL trait with NZW, Baladi Balck and Baldi Red .

The values of CV% given in (Table1) showed a general trend indicating that BL and CL phenotpic variations decreased with advanced of age in rabbits. These inferences coincide greatly with those reported by Abdel-Ghany et al; 2001 and Hassan et al., (2001) on BL and CL traits, respectively .

The lower CV for BL and CL traits at 12th week of age than at weaning may be attributed to that maternal effects 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 in BL and CL measures were significant at the all ages studied except at the 6 weeks of age, (Table 2). Abdel-Ghany et al; (2001) with BL and Hassan et al., (2001) with CL measures reported that variations by month of birth effect were significant at different ages.

Least squares means listed in Table 3 show that there was an inconsistent trend for the effect of month of birth on BL and CL 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.

Parity

Significant effects were detected for parity on BL measures at all studied ages except at 10 weeks of age. However, Abdel-Ghany et al; (2001) reported significant effect for parity on BL at 8th week of age only. Parity differences in CL measures were non significant at all studied ages. These outcomes were in agreement with those reported by Hassan et al., (2001) in his study on CL with NZW, Baladi Black and Baldi Red rabbits.

Table 1: Actual means (mm); standard errors (±SE) and coefficients of variability (CV) for body length and transverse chest 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%
Body Length (BL)												
Overall	591	199.61±1.06	12.90	498	232.09±1.09	10.47	445	253.26±1.23	10.21	411	277.30±1.28	9.35
Sex												
Male	278	199.30±1.58	13.23	230	234.80±1.51	9.74	200	255.43±1.67	9.26	186	278.66±1.79	8.77
Female	313	199.89±1.43	12.62	268	229.76±1.54	10.99	245	251.49±1.75	10.92	225	276.19±1.81	9.82
Straight-bred												
NZW	237	202.28±1.57	11.94	206	234.61±1.63	9.99	184	257.07±1.72	9.06	176	279.77±1.84	8.74
BR	77	199.61±2.60	11.41	64	235.08±2.64	8.97	59	248.39±3.96	12.24	54	275.28±3.81	10.16
Cross-bred												
NZW x BR	70	188.86±3.35	14.85	57	225.96±3.10	10.37	55	246.45±3.56	10.73	49	280.82±3.74	9.31
BR x NZW	207	200.19±1.88	13.48	171	229.97±2.01	11.41	147	252.99±2.16	10.34	132	273.54±2.32	9.74
Transverse Chest Length (CL)												
Overall	591	94.31±0.64	16.46	498	109.10±0.66	13.45	445	119.31±0.77	13.55	411	130.22±0.86	13.38
Sex												
Male	278	94.06±0.96	16.95	230	110.15±0.87	12.04	200	119.90±1.015	11.98	186	131.34±1.18	12.30
Female	313	94.52±0.86	16.04	268	108.19±0.96	14.55	245	118.84±1.119	14.75	225	129.29±1.23	14.23
Straight-bred												
NZW	237	94.72±0.98	15.97	206	112.43±1.00	12.62	184	121.71±1.20	13.35	176	134.12±1.25	12.37
BR	77	95.78±1.77	16.18	64	103.83±1.70	13.12	59	115.85±2.06	13.63	54	125.92±2.45	14.29
Cross-bred												
NZW x BR	70	90.07±1.78	16.52	57	110.26±1.96	13.43	55	118.55±2.42	15.16	49	130.10±2.67	14.35
BR x NZW	207	94.71±1.12	16.96	171	106.67±1.12	13.76	147	117.99±1.26	12.91	132	126.82±1.47	13.30
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

Table 2: F-ratio of least squares analysis of variance of different factors affecting body length (BL) and Transverse chest length (CL) traits from 6 up to12 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
		Body Length (BL)				Transverse chest length (CL)			
		F- Values				F- Values			
BG	3	4.80**	3.70*	5.90****	5.09**	3.47*	4.42**	2.81*	0.73
SEX	1	5.65*	0.82	2.61	0.001	2.54	0.002	1.06	0.41
FEED TYPE	1	0.39	10.16**	1.94	0.08	.158	3.06	3.62	1.24
PARITY	2	4.14*	7.53***	1.83	5.41**	2.96	0.23	.370	1.10
MOB	6	0.44	5.06****	2.85**	2.81*	.554	16.36****	5.73****	4.64****
BG X SEX	3	0.94	0.98	0.05	0.34	1.29	0.48	2.71*	0.23
BG X FEED	3	2.47	0.82	0.90	1.85	.999	3.41*	5.07**	1.88
REGRESSORS									
BW	1	180.27****	817.47****	732.54****	616.95****	92.47****	444.83****	403.31****	496.06****
BG *BW	3	0.61	2.65*	1.63	5.92***	0.84	1.99	2.88*	2.26
LSB	1	0.05	.03	0.07	3.65	.015	2.30	1.72	1.31
BG *LSB	3	3.70	3.37*	1.59	2.40	0.91	1.29	1.152	0.41
REMAINDER-DF		563	470	417	383	563	470	417	383
REMAINDER-MS		377.51	117.91	177.27	171.47	182.74	66.99	95.54	91.16
R SQUARED		0.46	0.81	0.75	0.76	0.28	0.71	0.66	0.72

* = 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.

Least squares means, (Table 3) revealed a general trend indicating that BL at different ages increased with advance of parity till the 2nd parity. However, no consistent trend for CL measures with advance of parity rank was observed. Abdel-Ghany et al; (2001) and Hassan et al., (2001) recorded a trend showing that BL and CL at different ages increased with advance of parity and were virtually greatest at the 3rd parity.

Effect of parity on BL and CL 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. Such a conclusion was arrived at by Afifi and Emara, 1984 in case of growth traits.

Sex (S)

Results in Table 2 revealed that the effect of sex was not significant neither on BL nor CL of rabbits at all post-weaning ages studied except at 6 weeks of age on BL trait. In this respect, Abdel-Ghany et al; (2001) and Hassan et al., (2001) reported significant effect for sex on BL and CL at 6th week of age only. However, 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.

Least squares means of post-weaning BL and CL in (Table 3) showed that males were somewhat greater in BL than females. Abdel-Ghany et al; (2001) reported similar results on BL measures with NZW, Baldi Black and Baldi Red rabbits. Nevertheless, Luzi et al. (2000) couldn't detect sex consistent trend on live animals BL from weaning till 120 days of age. Hassan et al., (2001) reported an inconsistent trend for the effect of sex on CL at different ages considered. However, other investigators indicated that female rabbits tended to have higher records in growth measures than males (e. g. Afifi, 1971; Khalil, 1980; Mahajan et al., 1980 and Khalil et al., 1987).

Feed type (F)

No significant effect was detected for feed type on BL and CL measures except at 8th week of age for BL . (Table 2). In agreement with results on BL, Abdel-Ghany et al; (2001) detected significant effect for feed type on BL of rabbits at 8th week of age only. Hassan et al., (2001) reported that CL measures affected significant by feed type at 8 and 10 weeks of age.

Table (5): Partial regression coefficients , b (± Standard Error, SE) of body length, BL and transverse chest length, CL 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.

Cova-riate	Trait	Breed Groups	Age per weeks							
			6th week		8th week		10th week		12th week	
			b	± SE	b	± SE	b	± SE	b	± SE
Live Body Weight	BL	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	± 0.007761	0.004236	± 0.004462	-0.002086	± 0.003183	0.000887	± 0.003751
	CL	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	BL	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
	CL	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	BL	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	
	CL	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.

Table 3. Least squares means (±Standard Error, SE) of different factors affecting body length (BL), mm. and transverse chest length (CL), mm. traits from 6 (weaning) 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
Body length (BL)									
Overall Mean		591	198.15±1.27	498	235.50±0.79	445	253.03±1.05	411	279.88±1.08
Straight Breed	NZW	237	197.53±1.63	206	235.23±1.00	184	253.71±1.33	176	275.62±1.35
	BR	77	201.50±2.68	64	238.54±1.60	59	249.25±2.06	54	281.08±2.12
	Av.	314	199.52±1.67	270	236.89±1.02	243	251.48±1.33	230	278.35±1.37
Crossbred	NZW x BR	70	191.38±2.74	57	231.66±1.69	55	251.12±2.13	49	283.61±2.15
	BR x NZW	207	202.21±1.55	171	236.57±0.97	147	258.03±1.33	132	279.21±1.36
	Av.	277	196.79±1.61	228	234.11±1.00	202	254.58±1.29	181	281.41±1.33
Sex	Male	278	195.86±1.63	230	236.04±1.03	200	254.26±1.37	186	279.86±1.40
	Female	313	200.45±1.55	268	234.96±0.95	245	251.79±1.21	225	279.90±1.27
Feed type	Pelted	269	197.46±1.68	214	237.62±1.05	181	251.8±1.36	167	279.63±1.40
	Crumbled	322	198.85±1.69	284	233.39±1.02	264	254.21±1.33	244	280.13±1.37
Parity	1st	278	196.49±1.85	248	233.74±1.14	221	252.59±1.46	208	274.75±1.49
	2nd	235	201.98±1.68	193	232.56±1.01	176	255.07±1.30	161	279.44±1.37
	3rd	78	195.99±3.05	57	240.20±1.96	48	251.41±2.49	42	285.45±2.60
Month Of Birth	Mar.	70	196.96±3.39	65	231.74±2.02	59	249.53±2.57	56	282.53±2.63
	Apr.	98	199.32±3.09	87	228.31±1.85	70	248.40±2.37	66	282.11±2.41
	May	128	200.26±2.42	122	232.42±1.44	117	248.86±1.82	110	278.78±1.86
	June	57	197.36±2.88	45	233.87±1.83	41	256.37±2.38	39	277.76±2.45
	July	139	196.49±1.93	108	235.25±1.23	98	254.54±1.55	89	285.20±1.59
	Aug.	69	198.79±2.81	50	242.89±1.85	45	260.36±2.41	38	278.75±2.50
	Sep.	30	197.88±4.06	21	244.01±2.70	15	253.14±3.82	13	274.03±3.97
Transverse Chest Length (CL)									
Overall Mean		591	93.70±0.88	498	109.77±0.60	445	120.60±0.77	411	130.30±0.79
Straight Breed	NZW	237	91.81±1.13	206	110.68±0.76	184	120.13±0.98	176	130.85±0.99
	BR	77	96.14±1.87	64	106.40±1.21	59	118.37±1.51	54	130.18±1.55
	Av.	314	93.98±1.17	270	108.54±0.77	243	119.25±0.97	230	130.517±1.00
Crossbred	NZW x BR	70	91.20±1.91	57	111.37±1.27	55	121.05±1.56	49	128.83±1.57
	BR x NZW	207	95.64±1.08	171	110.64±0.73	147	122.83±0.97	132	131.35±0.99
	Av.	277	93.42±1.12	228	111.00±0.75	202	121.94±0.95	181	130.09±0.97
Sex	Male	278	92.63±1.14	230	109.79±0.78	200	121.18±1.01	186	130.67±1.02
	Female	313	94.77±1.08	268	109.75±0.72	245	120.01±0.89	225	129.94±0.92
Feed type	Pelted	269	94.01±1.17	214	110.65±0.79	181	121.79±1.00	167	131.01±1.02
	Crumbled	322	93.39±1.18	284	108.90±0.77	264	119.41±0.98	244	129.60±1.00
Parity	1st	278	93.17±1.29	248	110.37±0.86	221	119.64±1.07	208	131.91±1.09
	2nd	235	95.97±1.17	193	109.62±0.77	176	120.63±0.96	161	130.67±1.00
	3rd	78	91.95±2.13	57	109.33±1.48	48	121.53±1.83	42	128.33±1.90
Month of Birth	Mar	70	92.11±2.36	65	107.88±1.53	59	122.01±1.89	56	129.35±1.92
	Apr.	98	94.89±2.13	87	114.73±1.39	70	126.18±1.74	66	134.76±1.76
	May	128	95.33±1.69	122	104.37±1.09	117	117.39±1.33	110	128.09±1.35
	June	57	93.40±2.00	45	106.35±1.38	41	118.92±1.75	39	128.61±1.79
	July	139	93.145±1.34	108	108.23±0.93	98	117.52±1.13	89	126.63±1.16
	Aug.	69	94.29±1.96	50	107.62±1.39	45	118.50±1.77	38	131.62±1.82
	Sep.	30	92.72±2.82	21	119.23±2.04	15	123.66±2.80	13	133.08±2.90

Table 4: linear function, mm (±Standard error, SE) of straight-bred differences and crossbreeding effects pertaining body length (BL) and Transverse chest length (CL) traits from 6 up to 12 weeks of age.

Effect	Trait		Age per week			
			6	8	10	12
Straight-bred difference:						
NZW vs Baladi Red	Body length		-3.98±2.91	-3.32±1.73	4.46±2.23*	-5.47±2.28*
	Transverse chest length		-4.33±2.026*	4.29±10.31***	1.76±1.63	0.67±1.66
Direct heterosis						
NZW X BR	Body length	(Units)	-2.72±2.08	-2.77±1.24*	3.10±1.59	3.06±1.62
		(%)	-1.36	-1.17	1.23	1.10
NZW X BR	Transverse chest length	(Units)	-0.56±1.447	2.46±.93**	2.69±1.17*	-0.43±1.18
		(%)	-0.59	2.27	2.25	0.33
Direct additive						
NZW	Body length		-7.41±2.11***	-4.11±1.28***	-1.22±1.65	-0.53±1.67
NZW	Transverse chest length		-4.39±1.466**	2.51±.97**	-.01±10.21	-0.93±1.22
Maternal additive						
NZW	Body length		10.84±3.10***	4.91±1.89**	6.90±2.42**	-1.398±2.44
NZW	Transverse chest length		4.44±2.15*	-0.74±1.42	1.79±1.78	2.52±1.78

* = 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.

However, least squares means (Table 3) revealed that the values of crumpled feed were somewhat greater than pelleted feed for BL except at the 8th week of age. Abdel-Ghany et al: (2001) reported no obvious trend for the effect of feed type on post-weaning BL of rabbits. In the contrary, least squares means revealed that the values of pelleted feed were somewhat greater than crumpled feed for all CL measures. Hassan et al., (2001) revealed that CL of those fed pelleted feed transcended those on the crumpled one.

Breed group (BG)

Considering least squares analysis of BL and CL measures (Table 2), data revealed that breed group constituted a significant source of variation at all ages studied except at 12th week of age for CL traits. Similarly, breed group effect was reported to be a significant source of variation on BL and CL by Abdel-Ghany et al: (2001) and Hassan et al: (2001) at all ages studied, except at 6th week of age for CL trait.

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 genitored by NZW males for BL measures at ages considered except at 12th weeks of age and CL measures at 6 and 12 weeks of age only.

Interactions

Effects of (BG X Sex) or (BG X F) interactions on BL were not significant which were in agreement with those reported by Abdel-Ghany et al; (2001). However, results showed the presence significant effect for (BG X Sex) interaction on CL at 10th week of age only (Table 2), while (BG X F) interaction proved significant effect at 8, 10 weeks of age for CL measures. Also, Hassan et al. (2001) recorded significant effect for interaction between breed group and feed type on CL at 8 and 10 weeks of age.

These outputs may generaly indicate that the trend of response for each mating group was consistence in case of both feed type or Sex.

Straight-bred differences

Results of linear contrasts given in (Table 4) revealed a general superiority of BR rabbits over NZW for BL measures at all ages studied except at 10 weeks of age. However, these differences showed significance at 10 & 12 weeks of age. The present results are analogous with those reported by Abdel-Ghany et al: (2001). On the contrary, the results revealed a general superiority of NZW rabbits over BR rabbits for CL at all ages studied except at 6th week of age. However, these differences showed significance at 8th week of age for CL measures only. These results are equivalent with those reported by Hassan et al. (2001).

Direct heterotic effect (H^I)

Estimates of direct heterosis (H^I), calculated in actual units (mm.) and as percentage (%) were positive only for the cross between NZW and BR at 10 and 12 weeks of age for BL and were positive and significant for CL measures at 8 and 10 weeks of age. In the same pattern, Abdel-Ghany et al; (2001) with BL reported that direct heterosis estimates were positive at 10 and 12 weeks of age for NZW* Baldi Black and at 12th week of age for NZW*Baldi Red but non-significant effect was detected. Also, Hassan et al (2001) with CL reported positive and significant direct heterosis estimates at the same ages for NZW*Baldi Red, while observed positive direct heterosis without significance for NZW*Baldi Black rabbits at all age studied except 8th week of age.

These findings lead to state that crossbreeding the studied Baladi Red rabbits with NZW was associated with an improvement in CL only at these ages. However, reciprocal recurrent selection could have a role in magnifying the utilization of non-additive genetic effects for the studied traits.

Direct additive effect (G^I)

Contrasts of direct additive effect on BL and CL mm. at all ages studied were negative except at 8th week of age for CL trait, though significance was detected at 6, 8 weeks of age for BL and CL (Table 4). These results are in harmony with those of Abdel-Ghany et al; (2001) and Hassan et al; (2001). 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 BL and CL and using Baladi-Red for this purpose would be more obvious especialy 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 loins 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)

Results in Table (4) proved that NZW maternal additive effect (G^m) on BL measures were positive and significant at all ages except at 12th week of age. Abdel-Ghany et al; (2001) reported a comparable results on BL traits. From another hand, the results indicated that NZW maternal additive effect (G^m) were positive at 6, 10 and 12 weeks of age for CL with significant effect detected at the 6th week of age only. Hassan et al (2001) has reported a similar results on CL measures. These results may address the use NZW rabbits as maternal breed in simple crossing programs including these breeds.

Regression Coefficients and Prediction Equation

Table 5 represents Partial Regression Coefficients , b (± Standard Error, SE) of some post-weaning conformation measures (body length, BL and transverse chest length, CL) 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 negative for BL at different ages and at earlier ages (i.e. 6 and 8 wks of age) for crosses sired by NZW. The same relations were positive with BR pures considering BL. However, with the transverse chest length, CL the partial regression coefficient was generally positive considering LSB meanwhile negative with BW at most ages.

Acknowledgement

The author expresses his gratitude and gratefulness to Dr. N. S. Hassan, Ass. Prof.; Rabbit and Turkey Breeding Department; Animal Production Research Inst.; Giza; Egypt for supplying the raw data and prescribing the traits measured in the Material and Methods section.

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الملخص العربي

طول الجسم والطول العرضى للصدر بعد الفطام لأرانب البلدى الأحمركنتيجة للتهجين مع أرانب النيوزيلندى الأبيض

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البيانات الحالية مأخوذة على صفتى طول الجسم والطول العرضى للصدر كل أسبوعين بدءا من الأسبوع السادس وحتى الأسبوع الثانى عشر، على ٥٩١ خلفة أرانب مفطوم منها ٣١٤ أرنب نقـــى و ٢٧٧ أرنب خليط ناتجة من التهجين بين نوعين من الأرانب (واحدة قياسية هى النيوزيلندى الأبيض، و الثانية من الأنواع المحلية وهى البلدى الأحمر)

تهدف الدراسة إلى تقييم تأثيرات التهجين (التأثير التجمعى والأمى المباشرين) وكذا قوة الهجين لصفات طول جسم الخلفة والطول العرضى للصدر وأيضا التأثيرات غير الوراثية (ترتيب البطن وجنس الخلفة و شهر الميلاد وشكل العلف المقدم).

وجد أن شهر الميلاد قد أظهر تأثيرا معنويا فى كل الأعمار المدروسة ما عدا عند الأسبوع السادس من العمر على صفتى طول الجسم والطول العرضى للصدر. كما وجد أيضا أن تأثير مجموعة التربية كان معنويا على صفتى طول الجسم والطول العرضى للصدر فى كل الأعمار المدروسة ما عدا عند الأسبوع الثانى عشر من العمر على صفة الطول العرضى للصدر. هذا وقد أثر شكل العلف المقدم بصورة غير معنوية على الصفتين محل الدراسة ما عدا عند الأسبوع الثامن من العمر لصفة طول الجسم. وقد أعطى ترتيب البطن تأثيرا معنويا على صفة طول الجسم عند معظم الأعمار المدروسة (ما عدا ذلك عند عمر ١٠ أسابيع) بينما فشل فى إظهار أى تأثير معنوى على صفة الطول العرضى للصدر. أظهر جنس الخلفة تأثيرا معنويا على صفة طول الجسم عند الأسبوع السادس من العمر فقط.

كان القيم المتوسطة لمعاملات إعتماد صفتى طول الجسم والطول العرضى للصدر على وزن الجسم عند عمر الدراسة معنويا عند كل الأعمار محل الدراسة. وبالنسبة لمعاملات الإعتماد الجزئى داخل مجاميع التربية على وزن الجسم الحى كان معنويا عند عمر ٨ و ١٢ أسبوع لصفة طول الجسم وعند عمر ١٠ أسابيع لصفة الطول العرضى للصدر. وعند النظر لمعنوية معاملات الإعتماد الجزئى داخل مجاميع التربية على حجم البطن عند الميلاد فقد أظهرت تأثيرا معنويا عند عمر ٨ أسابيع لصفة طول الجسم.

بالنسبة لتأثير قوة الهجين المباشرة فقد كانت موجبة عند الأسبوع العاشر والثانى عشر لصفة طول الجسم بينما كانت موجبة ومعنوية لصفة الطول العرضى للجسم عند عمر ٨ و ١٠ أسابيع. التأثير التجمعى المباشر لسلالة النيوزيلندى كان سالبا فى معظم الأعمار المدروسة (فى صالح البلدى الأحمر) ولم تظهر المعنوية إلا فى الأعمار المبكرة بالنسبة لكلا الصفتين محل الدراسة. والتأثير الأمى المباشر لسلالة النيوزيلندى لصفة طول الجسم كان موجبا ومعنويا عند كل الأعمار ما عدا الأسبوع الثانى عشر بينما كان موجبا بدون معنوية فى معظم الأعمار على صفة الطول العرضى للصدر.