Applied Tropical Agriculture
Volume 21, No.1, 117-127, 2016.

Genotype and Parity Effects on Pre-Weaning Characteristics and Linear Body Measurements of Five Rabbit Breeds

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ABSTRACT

Rabbit meat is one of the cheapest and healthiest means of meeting human protein requirement in Nigeria. Several researches have been made on optimizing the desirable qualities of rabbits. This paper presents results of genotype and parity effects on pre-weaning performance characteristics of rabbit breeds and their crosses. The study is aimed at determining effects of genotype and parity on the pre-weaning body measurements of breeds of rabbits and their crosses in a tropical environment. Pre-weaning data on body weights and linear measurements such as ear length, chest girth, nose-to-shoulder length, trunk length, tail length, body length, abdominal circumference, and height at withers at weeks 1 to 4 were collected and analysed using general linear model of SAS (2008) while mean separation for significant effects was done using Duncan's multiple range tests. Genotype exerted significant ($P<0.05$) effect on the body weights and linear measurements for all the rabbit genotypes. Parity had significant ($P<0.05$) effect on traits at birth, individual kit weight at week 2 and linear traits studied at different pre-weaning ages. The interactions among genotype and parity significantly ($P<0.05$) influenced birth traits and body measurements studied. The result of this study showed that genotype and parity were important sources of variation in performance characteristics of rabbits at pre-weaning ages. Hence, breed manipulation to harness the additive genes for improved production traits for selection of animals for sustained post-weaning outstanding performance is feasible.

Key words: Rabbit, Genotype, Parity, Pre-weaning, Crosses

INTRODUCTION

Rabbits are known to be herbivores which can convert low-quality diets to high-quality proteins thus making management relatively cheap. In addition, the meat qualities of rabbits such as high protein, low sodium, low fat (DalleZotte, 2000; Baiomy and Hassanien, 2011) and cholesterol levels make them desirable for consumption (Hernández, 2008). In order to exploit the above qualities, commercial production of rabbits has been carried out for years in various parts of the world including Nigeria. However, rabbit production in Nigeria could be described as rudimentary when compared with nations like France and the United States. This is seen from the small rabbit keeping population and low consumption rate of rabbit meat, as well as premature death of fryers predators and marketing problems which limits the expansion of rabbit production (Onifade *et al*., 1999; Baruwa, 2014).

Various economic characters influence rabbit production and one of the qualities that make rabbit production desirable is litter size (Nofal *et al*., 2005). Rabbit production therefore continues to receive expanding public interest among which economic initiatives to source for alternative meat types and animal protein ranked the highest. Studies have been made in Nigeria on the selection and breeding of rabbits for optimal improvement of the animal. Chineke (2006) worked on evaluation of rabbit breeds and crosses for pre-weaning reproductive performance in humid tropics. In his study, crossbreds from select breeds namely New Zealand White, Chinchilla, Dutch belted and Croel breeds were assessed for effects of genotype and parity of dam on Individual kit weight, litter weight, average litter weight and litter size at birth. His results showed significant effects of both genotype and parity on all the reproductive traits at birth, 21 days and 28 days except in two instances where effects of parity were not significant on litter weight at birth and litter size at birth; as well as superior performance of crossbreds over purebreds.

Obike and Ibe (2010) also studied the effect of genotype on pre-weaning growth performance of the domestic rabbit in a humid tropical environment and while their study involved the use of three rabbit breeds, namely New Zealand White, Chinchilla and Dutch, significant differences were recorded among genotypes for pre-weaning growth performance at all the ages (21 to 56 days) studied. Also, an observed superiority of purebreds over crossbreds was recorded. While Chineke (2006) attributed the differences in genotype performance to set of genes received from parents and environmental effect, Obike and

Ibe (2010) attributed theirs to breed differences. However, factors affecting variation in performance rate of rabbits have been reported to include breed and nutrition (Szendro *et al.*, 2011; Pla, 2004; Balogun and Ekukude, 1991), as well as environment (Marai *et al.*, 2002). Among the breeds of rabbits, California White and New Zealand White are two breeds with outstanding qualities for meat production (Baruwa, 2014). However, other breeds like Rex and Dutch-belted make good meat producers in addition to the fact that Dutch-belted make excellent mothers and eat relatively less than others (David, 2011; Bunnyhugga, 2010). The disease-resistant quality of the locally-adapted breed also makes it advantageous in rabbit breeding (Chintsanya *et al.* 2004). It is therefore possible that the introduction of other breeds would influence the results obtained in their experiments. This study therefore aims at investigating the effects of genotype and parity on the pre-weaning body measurements of breeds of rabbits and their crosses in a tropical environment.

MATERIALS AND METHODS

Study Area

The Research was carried out at the Rabbit Unit of the Federal University of Technology Akure, Ondo state, Nigeria. Akure is located 350.52m above sea level at latitude 7.14 ^{o} N and at longitude 5.14 ^{o}E. It has a mean annual rainfall of about 1500mm; a bimodal rain period with a short break in August; mean annual relative humidity varying from 39.1% to 98.2% and temperature varying from 21.9^{o}c to 30.4^{o}c (Chineke, 2005; Akinbode *et al.*, 2008).

Management of experimental animals

A total of 300 kits representing 10 genotypes were generated from a foundation stock comprising 30 does and 10 bucks. The genotypes were New Zealand White (NZW), Rex (RX), Dutch-belted (DT), California White (CF), Locally-adapted breed (LAB) and their crosses. There were 23, 20, 21, 17 and 21 kits from the pure mating of NZW x NZW, RX x RX, DT x DT, CF x CF and LAB x LAB respectively; 18, 23, 18, 22 and 18 kits from cross mating of NZW x RX, DT x CF, LAB x NZW, CF x RX and DT x LAB respectively; and 22, 19, 19, 15 and 24 kits from reciprocal mating of RX x NZW, CF x DT, NZW x LAB, RX x CF and LAB x DT respectively. The animals were housed in individual hutches made of wood and wire mesh, fitted with feeders and drinkers. A formulated diet with proximate composition of 16.23% CP, 2280kcal/kg ME and 10.27% CF was fed to the animals. Sun-dried greens (*Aspilia Africana and Tridax procumbens*) were also fed to the rabbits in order to make up for the fibre requirement. Water was given *ad libitum* till animals are weaned at 4 weeks of age. Deworming and other routine management techniques were carried out as and when due.

Data collection and analysis

Data were collected on weights and linear measurements of the 300 kits used for this experiment. Individual kit weight (IKT), Litter weight (LWT), and Average litter weight (ALT) were taken at birth, 7, 14, 21 and 28 days of age using an electronic scale of 10kg capacity with 0.01kg accuracy. Ear length (EL), chest girth (CG), nose-to-shoulder length (NSL), trunk length (TRL), tail length (TLL), body length (BL), abdominal circumference (AC), and height at withers (HWT) were measured using measuring tape calibrated in centimetres except for HWT which was measured with a centimetre rule. The descriptions of the linear measurements are as follows:

Length of ear: The distance from the base of the attachment of the ear to the tip of the ear.
Heart girth: This is measured as body circumference just below the fore leg.
Nose-to-shoulder length: The distance from the nose to the point of the shoulder.
Trunk length: The longitudinal distance from the point of the shoulder to the tuberosity of the ischium.
Tail length: This is the distance from the tip of the tail to the end.
Body length: This is the distance from the nose through the shoulder to the posterior end.
Abdominal circumference: This is measured as body circumference just above the hind leg.
Height at withers: The dorsal midline at the highest point on the withers.
Data generated from this experiment were subjected to analyees using general linear model of SAS (2008). Mean separation for significant effects was done using Duncan's multiple range tests. The model used was:
For weight at birth, 7, 14, 21 and 28 days:

$$\boldsymbol{Y_{ijm} = U + B_i + P_j + (BP)_{ij} + E_{ij}}$$

Where Y_{ijm} = the observation of the dependent variable on the mth kit of the ith genotype of the jth parity
U = overall mean of all observations
B_i = effect of the ith genotype of kit, *i* = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 (NZW, RX, DT, CF, LAB, NZW_mxRX_f, DT_mxCF_f, LAB_mxNZW_f, CF_mxRX_f, DT_mxLAB_f, RX_mxNZW_f, CF_mxDT_f, NZW_mxLAB_f, RX_mxCF_f, LAB_mxDT_f)
P_j = effect of the jth parity, *j* = (1, 2, 3, 4, 5)
$(BP)_{ij}$ = effect of interaction between ith genotype and jthparity.
E_{ij} = random error normally, identically and independently distributed with zero mean and variance $\sigma^2 e$

RESULTS

Reproductive Birth Traits

Means for reproductive birth traits of the different genotypes, parities and genotype-parity interactions are shown in Table 1. Litter size at birth ranged from 6.20 to 9.40. Locally-adapted breed (male) x NZW_f had the highest least squares means for litter size at birth (LSB) (9.40 $\pm$ 0.30) while LAB and LAB_m x DT_f had the lowest (6.20 $\pm$ 0.25 and 6.20 $\pm$ 0.07 respectively). Genotype was the major source of variation with the highest means for litter size at birth (LSB) and gestation length (GSL) recorded for LAB_m x NZW_f and CF_m x REX_f respectively while CF_m x DT_f had the highest means for individual kit weight (IKT), litter weight at birth (LWT), and average litter weight (ALW). The LAB had the lowest means for LSB while CF, LAB and NZW_m x REX_f had the lowest mean values of 31.00 days and were not significantly different from one another. The lowest mean values for IKT, LWT and ALW (97.10$\pm$4.54, 582.60$\pm$20.71and 97.10$\pm$3.45g respectively) were recorded for CF_mx DT_f. Parity significantly ($P<0.05$) affected LSB, GSL, IKT, LWT and ALW where parity 3 recorded the highest means for LSB (7.47$\pm$0.14) and parity 4 the highest for GSL (30.33$\pm$0.09 days) which was not significantly different from parities 2, 3 and 5. However, parity 2 recorded the highest means for IKT, LWT and ALW (93.90$\pm$3.10, 563.40$\pm$13.78 and 93.90$\pm$2.30g respectively).

Body Weight (bdw)

Means of body weight for the fifteen genotypes are shown in Table 2. Genotype had significant ($P<0.05$) effect on body weight in weeks 1 – 4. Rex_m x NZW_f had the highest BDW in week 1; CF_m x DT_f in weeks 2 and 4 and NZW_m x REX_f in week 3. The lowest BDW were recorded by CF in weeks 1 and+ 2 and NZW_mx LAB_f in weeks 3 and 4. Parity had no significant effect on body weight across weeks 1 to 4 except in week 2 where significant differences were recorded. Parity 2 recorded the highest BDW (182.14 ± 9.29g) while parity 4 recorded the lowest (172.49 ± 11.07g). However, an inconsistent trend in changes in BDW due to parity was observed in all the weeks; there was an increase in BDW followed by a decrease and then an increase.

Linear Measurement

Means of ear length for the fifteen genotypes are given in Table 3. Genotype had significant effect on the linear body measurements studied. CF_m x REF_f had significantly ($P<0.05$) longer ears than other genotypes at weeks 1 and 3. Ears of LAB_m x DT_f progeny were longer at week 2 and REX_m x CF_f at week 4. Ear lengths of purebreds were not significantly different at week 3. However, the ear lengths of purebreds were significantly different from crossbreds across weeks 1 to 4 though not in all cases.There was significant ($P<0.05$) effect of parity on ear length in all the weeks except week 2. From weeks (1-4), ear length was longest at parity 3 although at week 1, same ear length was recorded for parity 5. Genotype and parity interaction had significant ($P<0.05$) effect on ear length from weeks 1 to 4. Means of trunk length for the fifteen genotypes are given in Table 4. Crossbred DT_m x LAB_f had significantly longer trunks at weeks 1 and 2 and Rex_m x CF_f at weeks 3 and 4.

Parity had significant ($P<0.05$) effect on trunk length in all the weeks except at week 2. Also, the changes in trend across parities 1 to 5 were inconsistent. There was decreasing and increasing trend in trunk length by parity. Means of chest girth are shown in Table 5. Genotype, parity and their interactions exerted significant ($P<0.05$) effect on chest girth in weeks 1 to 4. At week 1, the chest girth for the purebreds were not significantly ($P>0.05$) different from one another but the differences were significant ($P<0.05$) in other weeks. Parity had significant ($P<0.05$) effect on chest girth across the weeks except at week 2. Parity and genotype interactions also had significant effect on chest girth from weeks 1 to 4.

Table 6 shows means for height at withers. Genotype had significant effect on height at withers across weeks 1 to 4. At week 2, only DT and NZW purebreds were significantly different from each other and from other genotypes. At week 1, DT_m x LAB_f recorded the highest height at withers; Dutch-belted purebreds at week 2 and REX_m x CF_f at weeks 3 and 4.

Parity had significant ($P<0.05$) effect on height at withers in all the weeks except at week 2. Genotype and parity interactions also had significant effects on height at withers across the weeks.

Means for abdominal circumference are shown in Table 7. There existed significant differences among the genotypes at all ages. The crossbreds recorded larger abdominal circumference with DT_mx LAB_f having the largest circumference at weeks 1 and 2 and Rex_m x CF_f at weeks 3 and 4. Parity had significant ($P<0.05$) effect on abdominal circumference across weeks 1 to 4. Also, genotype and parity interactions had significant effects on the abdominal circumference across weeks 1 to 4.

Table 8 shows the means for body length. Genotype had significant ($P < 0.05$) effect on body length at all weeks. Longest body length was recorded for DT_m x LAB_f in weeks 1 and 2 and Rex x CF in weeks 3 and 4. Parity as well as genotype-parity interactions also had significant effects on body length.

Table 9 shows the means for nose-to-shoulder length for all genotypes. Genotype and parity as well as their interactions had significant ($P< 0.05$) effects on the nose-to-shoulder across the weeks. Higher values were recorded for DT x LAB at weeks 1 and 2 and for Rex x CF at weeks 3 and 4. For parity effect on nose-to-shoulder, the highest values were recorded at parity 3. Table 10 shows the means for tail length. The crossbreds had significantly ($P <0.05$) longer tails which ranged between 1.33 and 2.89cm from weeks 1 to 4 while the purebreds had relatively shorter tails ranging from 1.30 to 2.35cm. Longer tails were recorded at parity 3 at weeks 1 to 4 although tail length at parity 5 was same and not significantly different. The genotype-parity interaction also had significant ($P<0.05$) effect on tail length across the weeks.

Table 1: Least squares means for reproductive birth traits among the different rabbit genotypes

Parameters	LSB	GSL(g)	IKT(g)	LWT(g)	ALW (g)
Genotypes					
NZW	7.00 ± 0.20^{f}	30.60 ± 0.09^{bcd}	80.50 ± 2.76^{ed}	483.00 ± 8.95^{ed}	80.50 ± 1.49^{fe}
REX	7.00 ± 0.17^{f}	30.80 ± 0.27^{bc}	94.77 ± 5.84^{abc}	568.60 ± 25.97^{ba}	94.77 ± 4.33^{ab}
DT	6.80 ± 0.14^{g}	30.40 ± 0.09^{ecd}	74.70 ± 2.70^{e}	448.20 ± 6.56^{e}	74.70 ± 1.09^{f}
CF	6.93 ± 0.23^{f}	31.00 ± 0.17^{ba}	82.10 ± 2.65^{ed}	492.60 ± 12.07^{ed}	82.10 ± 2.01^{fe}
LAB	6.20 ± 0.25^{i}	31.00 ± 0.20^{ba}	87.73 ± 7.10^{abcd}	526.40 ± 20.05^{bdc}	87.13 ± 3.43^{bdec}
NZW$_m$ x REX$_f$	6.40 ± 0.32^{h}	31.00 ± 0.00^{ba}	81.13 ± 2.78^{ed}	486.80 ± 7.62^{ed}	81.13 ± 1.27^{fe}
DT$_m$ x CF$_f$	7.60 ± 0.22^{b}	30.2 0 ± 0.14^{efd}	81.40 ± 3.14^{ed}	488.40 ± 15.61^{ed}	81.40 ± 2.60^{fe}
LAB$_m$ x NZW$_f$	9.40 ± 0.30^{a}	31.40 ± 0.19^{a}	85.23 ± 2.84^{bcde}	511.40 ± 7.55^{dc}	85.23 ± 1.26^{dec}
CF$_m$ x REX$_f$	6.80 ± 0.14^{g}	29.80 ± 0.30^{f}	92.30 ± 5.77^{abcd}	553.80 ± 33.11^{bac}	92.30 ± 5.52^{bdac}
DT$_m$ x LAB$_f$	7.30 ± 0.25^{d}	30.80 ± 0.22^{bc}	93.13 ± 7.29^{ab}	576.80 ± 20.15^{ba}	96.13 ± 3.36^{a}
REX$_m$ x NZW$_f$	7.40 ± 0.15^{c}	30.80 ± 0.14^{bc}	84.60 ± 2.24^{bcde}	507.60 ± 10.55^{dc}	84.60 ± 1.76^{de}
CF$_m$ x DT$_f$	7.60 ± 0.15^{b}	31.00 ± 0.17^{ba}	97.10 ± 4.54^{a}	582.60 ± 20.71^{a}	97.10 ± 3.45^{a}
NZW$_m$ x LAB$_f$	6.40 ± 0.15^{h}	30.00 ± 0.17^{ef}	85.57 ± 2.47^{abcde}	513.40 ± 11.83^{dc}	85.57 ± 1.97^{dec}
REX$_m$ x CF$_f$	7.13 ± 0.22^{e}	30.40 ± 0.19^{ecd}	84.17 ± 2.17^{cde}	505.00 ± 7.15^{dc}	84.17 ± 1.19^{de}
LAB$_m$ x DT$_f$	6.20 ± 0.07^{i}	30.00 ± 0.17^{ef}	94.27 ± 6.96^{abc}	565.60 ± 21.46^{ba}	93.67 ± 3.70^{bac}
Parity					
1	7.11 ± 0.10^{c}	31.20 ± 0.13^{b}	85.28 ± 2.33^{b}	511.67 ± 10.57^{b}	85.08 ± 1.78^{b}
2	7.17 ± 0.13^{c}	30.53 ± 0.13^{a}	93.90 ± 3.10^{a}	563.40 ± 13.78^{a}	93.90 ± 2.30^{a}
3	7.47 ± 0.14^{a}	30.47 ± 0.09^{a}	85.06 ± 1.80^{b}	510.33 ± 6.23^{b}	85.05 ± 1.04^{b}
4	6.33 ± 0.16^{d}	30.33 ± 0.09^{a}	84.17 ± 2.73^{b}	505.00 ± 8.26^{b}	84.17 ± 1.38^{b}
5	7.31 ± 0.14^{b}	30.53 ± 0.09^{a}	85.50 ± 2.98^{b}	513.00 ± 11.30^{b}	85.30 ± 1.90^{b}
GenotypexParity	*		*		

Means with different superscripts in the same column (within variable groups) are significantly different ($P < 0.05$);
N.B.: NZW, New Zealand White; DT, Dutch-Belted; CF, California White; LAB, Locally-adapted Breed; LSB, Litter size at birth; GSL, Gestation length; ALW, Average litter weight; IBT, Individual kit weight; LWT, Litter weight; * = $P<0.05$

Table 2: Least squares means for body weights (g) of various rabbit genotypes at Weeks 1-4

Variables	Weeks			
	1	2	3	4
Genotypes				
NZW	122.63 ± 7.76^{edf}	185.32 ± 10.08^{b}	235.65 ± 4.82^{ba}	202.00 ± 12.74^{bdc}
REX	118.62 ± 8.20^{egf}	175.75 ± 6.00^{cebd}	231.78 ± 6.10^{bac}	193.96 ± 14.25^{ed}
DT	114.35 ± 7.97^{gf}	174.47 ± 6.66^{cebd}	224.20 ± 6.47^{bdac}	193.38 ± 14.54^{ed}
CF	108.70 ± 5.84^{g}	161.22 ± 4.36^{e}	215.65 ± 6.48^{dc}	181.22 ± 10.96^{ef}
LAB	125.73 ± 5.54^{edf}	171.82 ± 9.15^{cebd}	218.65 ± 9.87^{bdc}	191.69 ± 12.32^{ed}
NZW$_m$ x REX$_f$	116.27 ± 4.62^{gf}	163.88 ± 4.70^{ed}	237.72 ± 12.75^{a}	195.47 ± 15.30^{dc}
DT$_m$ x CF$_f$	128.95 ± 8.09^{edc}	174.80 ± 4.67^{cebd}	233.37 ± 6.37^{bac}	201.50 ± 2.60^{bdc}
LAB$_m$ x NZW$_f$	114.83 ± 4.62^{gf}	172.17 ± 4.23^{cebd}	212.40 ± 4.81^{d}	191.62 ± 7.59^{ed}
CF$_m$ x REX$_f$	134.38 ± 4.67^{bdc}	183.33 ± 4.57^{b}	240.63 ± 8.75^{a}	211.92 ± 8.38^{ba}
DT$_m$ x LAB$_f$	131.03 ± 3.25^{dc}	181.10 ± 7.30^{cb}	212.25 ± 7.28^{d}	197.55 ± 7.14^{dc}
REX$_m$ x NZW$_f$	148.03 ± 4.63^{a}	183.08 ± 4.88^{b}	215.52 ± 4.81^{dc}	205.93 ± 8.25^{bdc}
CF$_m$ x DT$_f$	143.83 ± 3.63^{ba}	202.02 ± 7.62^{a}	236.65 ± 12.96^{ba}	221.21 ± 5.62^{a}
NZW$_m$ x LAB$_f$	114.65 ± 4.62^{gf}	166.95 ± 5.21^{ced}	192.05 ± 5.74^{e}	177.06 ± 5.21^{f}
REX$_m$ x CF$_f$	140.38 ± 6.07^{abc}	177.18 ± 7.96^{cbd}	227.05 ± 4.82^{bdac}	209.00 ± 6.37^{bac}
LAB$_m$ x DT$_f$	177.30 ± 3.25^{egf}	177.67 ± 2.49^{cbd}	225.61 ± 5.65^{bdac}	201.09 ± 7.14^{bdc}
Parity				
1	124.37 ± 7.95	176.54 ± 9.42^{ab}	221.32 ± 10.67	265.47 ± 17.12
2	124.12 ± 7.22	182.14 ± 9.29^{a}	227.91 ± 7.51	265.19 ± 12.32
3	127.68 ± 8.69	176.72 ± 10.24^{ba}	224.17 ± 6.37	271.16 ± 12.70
4	123.80 ± 8.98	172.49 ± 11.07^{b}	222.49 ± 13.84	264.76 ± 20.78
5	126.60 ± 8.95	176.15 ± 10.94^{ba}	223.87 ± 9.38	269.67 ± 15.30
GenotypexParity	*	*	*	*

Means with different superscripts in the same column (within variable groups) are significantly different ($P < 0.05$)
N.B : NZW, New Zealand White; DT, Dutch-Belted; CF, Californian; LAB, Locally-adapted Breed; *= $P<0.05$;

Table 3: Least squares means for ear length (g) of various rabbit genotypes at Weeks 1-4

Variables	**Weeks**			
	1	**2**	**3**	**4**
Genotypes				
NZW	1.60 ± 0.11^{ef}	2.65 ± 0.15^{c}	3.82 ± 0.10^{ba}	3.21 ± 0.13^{e}
REX	1.61 ± 0.15^{ef}	2.79 ± 0.23^{cb}	3.95 ± 0.18^{ba}	3.31 ± 0.36^{ed}
DT	1.44 ± 0.12^{f}	2.62 ± 0.13^{c}	3.80 ± 0.03^{ba}	3.14 ± 0.41^{e}
CF	1.52 ± 0.32^{f}	2.77 ± 0.14^{cb}	3.84 ± 0.05^{ba}	3.24 ± 0.41^{e}
LAB	1.70 ± 0.20^{ef}	2.77 ± 0.25^{cb}	3.81 ± 0.20^{ba}	3.21 ± 0.34^{e}
NZW_m x REX_f	1.83 ± 0.11^{de}	2.86 ± 0.12^{cb}	3.83 ± 0.13^{ba}	3.25 ± 0.13^{e}
DT_m x CF_f	1.99 ± 0.14^{d}	3.10 ± 0.11^{b}	3.84 ± 0.09^{ba}	3.37 ± 0.29^{ed}
LAB_m x NZW_f	1.84 ± 0.21^{de}	3.09 ± 0.10^{b}	3.67 ± 0.12^{bac}	3.36 ± 0.13^{ed}
CF_m x REX_f	2.84 ± 0.16^{a}	3.47 ± 0.11^{a}	4.05 ± 0.10^{a}	4.01 ± 0.14^{bc}
DT_m x LAB_f	2.83 ± 0.20^{a}	3.53 ± 0.13^{a}	3.63 ± 0.05^{bc}	3.95 ± 0.11^{c}
REX_m x NZW_f	2.41 ± 0.06^{c}	2.80 ± 0.05^{cb}	3.64 ± 0.07^{bc}	3.62 ± 0.10^{d}
CF_m x DT_f	2.74 ± 0.10^{ba}	3.49 ± 0.09^{a}	3.97 ± 0.13^{ba}	4.10 ± 0.03^{bac}
NZW_m x LAB_f	2.50 ± 0.15^{bc}	2.96 ± 0.11^{cb}	3.36 ± 0.07^{c}	3.47 ± 0.12^{ed}
REX_m x CF_f	2.72 ± 0.13^{ba}	3.49 ± 0.07^{a}	3.96 ± 0.12^{ba}	4.40 ± 0.13^{a}
LAB_m x DT_f	2.57 ± 0.17^{bac}	3.57 ± 0.15^{a}	3.86 ± 0.11^{ba}	4.30 ± 0.06^{ba}
Parity				
1	2.05 ± 0.13^{b}	3.04 ± 0.21^{a}	3.46 ± 0.41^{b}	5.00 ± 0.63^{b}
2	2.14 ± 0.18^{ba}	3.09 ± 0.22^{a}	3.61 ± 0.16^{b}	5.10 ± 0.34^{b}
3	2.23 ± 0.20^{a}	3.16 ± 0.22^{a}	4.24 ± 0.20^{a}	5.85 ± 0.13^{a}
4	2.06 ± 0.24^{b}	3.00 ± 0.28^{a}	3.59 ± 0.32^{b}	5.08 ± 0.63^{b}
5	2.23 ± 0.20^{a}	3.04 ± 0.23^{a}	4.11 ± 0.28^{a}	5.84 ±0.29^{a}
GenotypexParity	*	*	*	*

Means with different superscripts in the same column (within variable groups) are significantly different ($P < 0.05$)
N.B : NZW, New Zealand White; DT, Dutch-Belted; CF, Californian; LAB, Locally-adapted Breed; *= $P<0.05$;

Table 4: Least squares means for trunk length (cm) of various rabbit genotypes at Weeks 1-4

Variables	**Weeks**			
	1	**2**	**3**	**4**
Genotypes				
NZW	7.46 ± 0.16^{gf}	9.26 ± 0.25^{b}	11.40 ± 0.16^{edc}	10.54 ± 0.31^{c}
REX	7.44 ± 0.60^{gf}	13.32 ± 0.91^{a}	12.25 ± 0.42^{bac}	11.56 ± 1.19^{c}
DT	7.00 ± 0.57^{g}	12.43 ± 0.66^{ba}	11.65 ± 0.25^{edc}	11.20 ± 1.12^{c}
CF	7.50 ± 0.93^{gf}	10.36 ± 1.10^{ba}	12.36 ± 0.39^{bac}	11.16 ± 1.39^{c}
LAB	7.64 ± 0.86^{gf}	10.69 ± 0.75^{ba}	12.39 ± 0.46^{bac}	11.08 ± 0.94^{c}
NZW_m x REX_f	7.82 ± 0.29^{edf}	10.85 ± 0.20^{ba}	11.05 ± 0.21^{ed}	10.66 ± 0.48^{c}
DT_m x CF_f	7.98 ± 0.96^{edf}	11.39 ± 0.31^{ba}	11.57 ± 0.15^{edc}	10.75 ± 0.29^{c}
LAB_m x NZW_f	7.74 ± 0.41^{ef}	11.41± 0.15^{ba}	10.93 ± 0.17^{ed}	10.93 ± 0.25^{c}
CF_m x REX_f	10.95 ± 0.16^{a}	12.66 ± 0.27^{ba}	12.28 ± 0.19^{bac}	12.89 ± 0.32^{b}
DT_m x LAB_f	11.00 ± 0.16^{a}	13.01 ± 0.35^{a}	11.32 ± 0.39^{edc}	13.05 ± 0.29^{b}
REX_m x NZW_f	8.39 ± 0.19^{ed}	9.59 ± 0.25^{b}	10.67 ± 0.17^{e}	10.96 ± 0.20^{c}
CF_m x DT_f	9.42 ± 0.09^{cb}	12.23 ± 0.64^{ba}	11.92 ± 0.21^{bdc}	12.79 ± 0.21^{b}
NZW_m x LAB_f	8.52 ± 0.10^{d}	10.34 ± 0.33^{ba}	10.67 ± 0.21^{e}	10.96 ±0.19^{c}
REX_m x CF_f	9.92 ± 0.14^{b}	12.35 ± 0.53^{ba}	13.28 ± 0.20^{a}	14.18 ± 0.19^{a}
LAB_m x DT_f	9.24 ± 0.32^{c}	12.54 ± 0.35^{ba}	12.94 ± 0.23^{ba}	13.87 ± 0.19^{ba}
Parity				
1	8.05 ± 0.22^{b}	11.52 ± 1.44	10.49 ± 1.25^{c}	13.78 ± 0.25^{b}
2	7.74 ± 0.41^{b}	11.17 ± 0.75	10.96 ± 1.64^{cb}	14.50 ± 0.33^{b}
3	9.41 ± 0.44^{a}	11.98 ± 0.72	13.33 ± 0.64^{a}	16.85 ± 0.29^{a}
4	8.12 ± 0.60^{b}	11.36 ± 1.70	11.26 ± 0.68^{b}	14.45 ± 0.32^{b}
5	9.37 ± 0.45^{a}	11.50 ± 0.75	12.85 ± 0.45^{a}	16.78 ± 0.48^{a}
GenotypexParity	*	*	*	*

Means with different superscripts in the same column (within variable groups) are significantly different ($P < 0.05$)
N.B : NZW, New Zealand White; DT, Dutch-Belted; CF, Californian; LAB, Locally-adapted Breed; *= $P<0.05$;

Table 5: Least squares means for chest girth (cm) of various rabbit genotypes at Weeks 1-4

Variables	Weeks			
	1	2	3	4
Genotypes				
NZW	5.18 ± 0.13^{e}	6.61 ± 0.19^{d}	9.88 ± 0.31^{ced}	8.48 ± 0.47^{f}
REX	6.07 ± 1.41^{e}	11.37 ± 0.84^{bac}	11.19 ± 0.27^{b}	10.31 ± 1.01^{dce}
DT	5.21 ± 0.73^{e}	9.89 ± 0.72^{bdac}	10.32 ± 0.16^{cbd}	9.45 ± 1.02^{fe}
CF	6.14 ± 1.33^{e}	8.25 ± 1.33^{dc}	10.99 ± 0.32^{cb}	9.58 ± 1.31^{fe}
LAB	5.95 ± 1.37^{e}	8.13 ± 0.12^{dc}	10.76 ± 0.34^{cb}	9.16 ± 0.25^{fe}
NZW_m x REX_f	6.10 ± 0.14^{e}	9.74 ± 0.16^{bdac}	9.41 ± 0.25^{ed}	9.15 ± 0.47^{fe}
DT_m x CF_f	7.53 ± 1.34^{cd}	11.29 ± 0.22^{bac}	10.94 ± 0.40^{cb}	10.73 ± 0.42^{dc}
LAB_m x NZW_f	5.76 ± 0.72^{e}	10.39 ± 0.11^{bac}	9.07 ± 0.20^{e}	8.99 ± 0.37^{f}
CF_m x REX_f	10.86 ± 0.20^{a}	12.12 ± 0.13^{ba}	10.75 ± 0.14^{cb}	11.85 ± 0.21^{b}
DT_m x LAB_f	11.46 ± 0.18^{a}	12.95 ± 0.33^{a}	9.97 ± 0.37^{cebd}	12.37 ± 0.25^{b}
REX_m x NZW_f	7.09 ± 0.18^{d}	8.24 ± 0.12^{dc}	9.37 ± 0.15^{ed}	9.65 ± 0.23^{dfe}
CF_m x DT_f	8.33 ± 0.12^{cb}	10.65 ± 0.18^{bac}	10.62 ± 0.25^{cb}	11.31 ± 0.28^{bc}
NZW_m x LAB_f	7.30 ± 0.09^{d}	9.06 ± 0.15^{bdc}	9.00 ± 0.33^{e}	9.56 ± 0.22^{fe}
REX_m x CF_f	9.18 ± 0.11^{b}	11.50 ± 0.20^{bac}	12.77 ± 0.16^{a}	13.29 ± 0.20^{a}
LAB_m x DT_f	9.06 ± 0.19^{b}	11.58 ± 0.25^{bac}	12.33 ± 0.22^{a}	12.99 ± 0.23^{a}
Parity				
1	6.57 ± 0.16^{cb}	10.10 ± 1.44	9.00 ± 0.29^{d}	12.24 ± 0.37^{c}
2	6.07 ± 0.55^{c}	9.67 ± 0.82	9.27 ± 1.29^{dc}	13.03 ± 1.50^{b}
3	8.90 ± 0.57^{a}	11.15 ± 0.66	12.53 ± 1.30^{a}	15.41 ± 0.23^{a}
4	6.71 ± 0.85^{b}	9.27 ± 1.72	9.76 ± 0.89^{c}	13.00 ± 1.11^{b}
5	8.85 ± 0.57^{a}	10.42 ± 0.70	11.91 ± 0.46^{b}	15.35 ± 0.60^{a}
GenotypexParity	*	*	*	*

Means with different superscripts in the same column (within variable groups) are significantly different (P < 0.05)
N.B : NZW, New Zealand White; DT, Dutch-Belted; CF, Californian; LAB, Locally-adapted Breed; *= P<0.05;

Table 6: Least squares means for height at withers (cm) of various rabbit genotypes at Weeks 1-4

Variables	Weeks			
	1	2	3	4
Genotypes				
NZW	3.48 ± 0.09^{fe}	4.20 ± 0.09^{b}	5.51 ± 0.11^{gfedc}	4.78 ± 0.13^{d}
REX	4.37 ± 1.97^{cbd}	4.97 ± 0.44^{ba}	6.05 ± 0.19^{bac}	5.30 ± 0.40^{dc}
DT	3.16 ± 0.32^{f}	6.95 ± 0.40^{a}	5.40 ± 0.17^{gfedc}	5.28 ± 0.44^{dc}
CF	3.47 ± 0.11^{fe}	4.64 ± 0.62^{ba}	5.71 ± 0.21^{bedc}	4.88 ± 0.58^{d}
LAB	3.56 ± 0.37^{fe}	4.83 ± 0.46^{ba}	5.81 ± 0.25^{bdc}	4.92 ± 0.43^{d}
NZW_m x REX_f	3.62 ± 0.40^{fe}	5.48 ± 0.09^{ba}	5.14 ± 0.11^{gfed}	4.87 ± 0.17^{d}
DT_m x CF_f	3.91 ± 0.52^{ed}	5.66 ± 0.11^{ba}	5.58 ± 0.11^{fedc}	5.15 ± 0.11^{d}
LAB_m x NZW_f	4.10 ± 0.03^{ced}	5.70 ± 0.02^{ba}	5.06 ± 0.10^{gfe}	5.12 ± 0.05^{d}
CF_m x REX_f	5.49 ± 0.06^{a}	6.19 ± 0.08^{ba}	5.90 ± 0.13^{bac}	6.09 ± 0.09^{ba}
DT_m x LAB_f	5.59 ± 0.06^{a}	6.57 ± 0.10^{ba}	5.38 ± 0.12^{gfedc}	6.21 ± 0.08^{ba}
REX_m x NZW_f	4.08 ± 0.10^{ced}	4.53 ± 0.02^{ba}	4.93 ± 0.10^{gf}	5.05 ± 0.05^{d}
CF_m x DT_f	4.60 ± 0.06^{cb}	5.89 ± 0.07^{ba}	5.58 ± 0.12^{fedc}	5.90 ± 0.08^{bc}
NZW_m x LAB_f	4.08 ± 0.05^{ced}	4.67 ± 0.04^{ba}	4.84 ± 0.14^{g}	5.03 ± 0.11^{d}
REX_m x CF_f	4.86 ± 0.09^{b}	5.85 ± 0.08^{ba}	6.49 ± 0.09^{a}	6.67 ± 0.10^{a}
LAB_m x DT_f	4.65 ± 0.06^{cb}	6.03 ± 0.18^{ba}	6.27 ± 0.13^{ba}	6.53 ± 0.08^{ba}
Parity				
1	3.82 ± 0.11^{b}	5.00 ± 0.32^{a}	4.90 ± 0.71^{c}	5.92 ± 0.20^{b}
2	3.66 ± 0.24^{b}	5.28 ± 0.44^{a}	5.10 ± 0.62^{cb}	6.16 ± 0.10^{b}
3	4.77 ± 0.35^{a}	5.82 ± 0.42^{a}	6.42 ± 0.25^{a}	7.30 ± 0.12^{a}
4	4.01 ± 0.45^{b}	5.75 ± 1.38^{a}	5.30 ± 0.16^{b}	6.14 ± 0.18^{b}
5	4.75 ± 0.35^{a}	5.34 ± 0.43^{a}	6.17 ± 0.76^{a}	7.26 ± 0.34^{a}
GenotypexParity	*	*	*	*

Means with different superscripts in the same column (within variable groups) are significantly different (P < 0.05)
N.B : NZW, New Zealand White; DT, Dutch-Belted; CF, Californian; LAB, Locally-adapted Breed; *= P<0.05;

Table 7: Least squares means for abdominal circumference (cm) of various rabbit genotypes at Weeks 1-4

Variables	Weeks			
	1	**2**	**3**	**4**
Genotypes				
NZW	5.98 ± 0.08^{gf}	6.98 ± 0.11^{g}	10.51 ± 0.21^{cebd}	8.91 ± 0.27^{ef}
REX	6.75 ± 0.16^{dgfe}	9.05 ± 1.02^{ed}	11.69 ± 0.28^{b}	9.98 ± 1.03^{d}
DT	5.65 ± 0.17^{g}	7.18 ± 0.92^{gf}	10.32 ± 0.38^{cebd}	8.74 ± 1.19^{f}
CF	6.55 ± 0.11^{gfe}	8.38 ± 1.62^{ef}	11.39 ± 0.41^{cb}	9.74 ± 1.54^{ed}
LAB	6.63 ± 0.16^{dgfe}	8.70 ± 0.94^{e}	11.31 ± 0.41^{cb}	9.57 ± 0.99^{edf}
NZW_m x REX_f	6.90 ± 0.05^{dfe}	10.14 ± 0.18^{d}	9.68 ± 0.12^{ed}	9.43 ± 0.24^{edf}
DT_m x CF_f	7.60 ± 0.09^{dce}	11.65 ± 0.16^{c}	10.64 ± 0.08^{cebd}	10.20 ± 0.33^{d}
LAB_m x NZW_f	7.02 ± 0.20^{dfe}	12.08 ± 0.21^{c}	9.74 ± 0.07^{ed}	10.14 ± 0.95^{d}
CF_m x REX_f	12.18 ± 0.07^{a}	13.58 ± 0.10^{ba}	11.15 ± 0.08^{cbd}	12.81 ± 0.34^{cb}
DT_m x LAB_f	12.87 ± 0.25^{a}	14.39 ± 0.44^{a}	10.14 ± 0.13^{ced}	13.37 ± 0.53^{b}
REX_m x NZW_f	7.78 ± 0.10^{dc}	8.66 ± 0.10^{e}	9.30 ± 0.07^{e}	10.01 ± 0.39^{d}
CF_m x DT_f	9.34 ± 0.07^{b}	11.80 ± 0.29^{c}	10.68 ± 0.12^{cebd}	12.09 ± 0.40^{c}
NZW_m x LAB_f	8.16 ± 0.05^{c}	9.76 ± 0.24^{ed}	9.43 ± 0.22^{e}	10.25 ± 0.15^{d}
REX_m x CF_f	10.34 ± 0.09^{b}	12.40 ± 0.28^{bc}	13.93 ± 0.33^{a}	14.75 ± 0.35^{a}
LAB_m x DT_f	10.03 ± 0.23^{b}	12.90 ± 0.13^{bc}	13.47 ± 0.18^{a}	14.48 ± 0.27^{a}
Parity				
1	7.29 ± 0.18^{cb}	9.96 ± 0.50^{c}	9.10 ± 1.67^{d}	12.27 ± 0.63^{b}
2	6.75 ± 0.62^{c}	10.35 ± 1.50^{c}	9.24 ± 1.70^{d}	13.10 ± 0.40^{b}
3	9.90 ± 0.65^{a}	12.20 ± 0.92^{a}	13.46 ± 0.41^{a}	16.35 ± 0.35^{a}
4	7.50 ± 0.95^{b}	8.78 ± 0.94^{d}	10.04 ± 0.88^{c}	13.05 ± 0.34^{b}
5	9.83 ± 0.65^{a}	11.25 ± 1.72^{b}	12.65 ± 0.19^{b}	16.26 ± 0.39^{a}
GenotypexParity	*	*	*	*

Means with different superscripts in the same column (within variable groups) are significantly different ($P < 0.05$)
N.B: NZW, New Zealand White; DT, Dutch-Belted; CF, Californian; LAB, Locally-adapted Breed; *= $P<0.05$;

Table 8: Least squares means for body length (cm) of various rabbit genotypes at Weeks 1-4

Variables	Week			
	1	**2**	**3**	**4**
Genotypes				
NZW	7.62 ± 0.08^{ef}	9.59 ± 0.11^{f}	12.39 ± 0.21^{efcd}	11.22 ± 0.28^{d}
REX	8.15 ± 1.22^{def}	11.37 ± 0.86^{edfc}	13.57 ± 0.27^{bc}	12.19 ± 0.97^{d}
DT	7.43 ± 0.67^{f}	12.74 ± 0.80^{ebdac}	12.55 ± 0.24^{efcd}	11.96 ± 1.14^{d}
CF	8.18 ± 0.08^{def}	11.20 ± 1.30^{edf}	13.44 ± 0.35^{bcd}	12.18 ± 1.42^{d}
LAB	8.17 ± 0.11^{def}	11.42 ± 0.83^{edfc}	13.43 ± 0.42^{bcd}	12.02 ± 0.98^{d}
NZW_m x REX_f	8.43 ± 0.06^{de}	12.02 ± 0.22^{ebdfc}	12.14 ± 0.14^{efd}	11.70 ± 0.30^{d}
DT_m x CF_f	8.93 ± 0.07^{dc}	13.00 ± 0.14^{bdac}	12.94 ± 0.14^{ecd}	12.30 ± 0.28^{d}
LAB_m x NZW_f	8.40 ± 0.30^{de}	12.87 ± 0.24^{ebdac}	11.82 ± 0.20^{ef}	12.00 ± 0.20^{d}
CF_m x REX_f	12.62 ± 0.02^{a}	14.06 ± 0.10^{ba}	13.16 ± 0.15^{cd}	14.20 ± 0.23^{c}
DT_m x LAB_f	12.97 ± 0.10^{a}	15.25 ± 0.41^{a}	12.39 ± 0.17^{efcd}	14.68 ± 0.39^{bc}
REX_m x NZW_f	9.03 ± 0.07^{dc}	10.30 ± 0.11^{ef}	11.60 ± 0.15^{f}	11.82 ± 0.20^{d}
CF_m x DT_f	10.42 ± 0.04^{b}	13.42 ± 0.07^{bdac}	13.04 ± 0.14^{ecd}	13.97 ± 0.23^{c}
NZW_m x LAB_f	9.44 ± 0.06^{c}	11.17 ± 0.38^{edf}	11.79 ± 0.29^{ef}	12.09 ± 0.26^{d}
REX_m x CF_f	11.16 ± 0.07^{b}	13.92 ± 0.12^{bac}	14.96 ± 0.22^{a}	15.70 ± 0.40^{a}
LAB_m x DT_f	10.87 ± 0.10^{b}	14.21 ± 0.25^{ba}	14.61 ± 0.18^{ba}	15.47 ± 0.21^{ba}
Parity				
1	8.69 ± 0.18^{cb}	11.63 ± 0.30^{b}	11.40 ± 0.14^{c}	15.18 ± 1.92^{b}
2	8.30 ± 0.49^{c}	12.14 ± 0.40^{ba}	11.78 ± 0.15^{cb}	16.03 ± 0.83^{b}
3	10.72 ± 0.53^{a}	13.46 ± 0.10^{a}	14.86 ± 0.76^{a}	18.41 ± 0.42^{a}
4	8.89 ± 0.76^{b}	12.11 ± 0.82^{ba}	12.29 ± 0.18^{b}	15.98 ± 1.94^{b}
5	10.69 ± 0.54^{a}	12.84 ± 0.78^{ba}	14.29 ± 0.14^{a}	18.35 ± 0.91^{a}
GenotypexParity	*	*	*	*

Means with different superscripts in the same column (within variable groups) are significantly different ($P < 0.05$)
N.B: NZW, New Zealand White; DT, Dutch-Belted; CF, Californian; LAB, Locally-adapted Breed; *= $P<0.05$;

Table 9: Least squares means for nose-to-shoulder length (cm) of various rabbit genotypes at Weeks 1-4

Variables	Week			
	1	2	3	4
Genotypes				
NZW	2.27 ± 0.04^{ij}	2.69 ± 0.07^{h}	4.14 ± 0.09^{bdac}	3.66 ± 0.08^{def}
REX	2.48 ± 0.07^{ihgf}	3.01 ± 0.18^{fg}	4.17 ± 0.07^{bac}	3.81 ± 0.17^{def}
DT	2.22 ± 0.11^{j}	2.77 ± 0.18^{gh}	4.00 ± 0.07^{bdac}	3.57 ± 0.18^{f}
CF	2.39 ± 0.08^{ihj}	2.91 ± 0.25^{fgh}	4.02 ± 0.08^{bdac}	3.66 ± 0.15^{def}
LAB	2.34 ± 0.08^{ihj}	2.91 ± 0.21^{fgh}	3.99 ± 0.06^{bdac}	3.56 ± 0.25^{f}
NZW_m x REX_f	2.52 ± 0.06^{ehgf}	3.37 ± 0.08^{de}	4.03 ± 0.11^{bdac}	3.81 ± 0.09^{def}
DT_m x CF_f	2.63 ± 0.06^{egh}	3.50 ± 0.08^{dc}	3.99 ± 0.08^{bdac}	3.86 ± 0.06^{de}
LAB_m x NZW_f	2.44 ± 0.03^{ihgj}	3.64 ± 0.05^{dc}	3.91 ± 0.04^{bdc}	3.89 ± 0.09^{dc}
CF_m x REX_f	3.49 ± 0.06^{a}	3.96 ± 0.06^{ba}	4.21 ± 0.04^{ba}	4.38 ± 0.10^{ba}
DT_m x LAB_f	3.52 ± 0.06^{a}	4.11 ± 0.08^{a}	3.91 ± 0.06^{dc}	4.30 ± 0.15^{ba}
REX_m x NZW_f	2.75 ± 0.03^{ed}	3.09 ± 0.05^{fe}	3.86 ± 0.04^{d}	3.89 ± 0.08^{dc}
CF_m x DT_f	2.99 ± 0.06^{cb}	3.53 ± 0.09^{dc}	4.03 ± 0.08^{bdac}	4.14 ± 0.17^{bc}
NZW_m x LAB_f	2.68 ± 0.05^{edf}	3.11 ± 0.07^{fe}	3.52 ± 0.04^{e}	3.58 ± 0.05^{ef}
REX_m x CF_f	3.16 ± 0.07^{b}	3.72 ± 0.06^{bc}	4.28 ± 0.08^{a}	4.49 ± 0.12^{a}
LAB_m x DT_f	2.90 ± 0.05^{cd}	3.72 ± 0.07^{bc}	4.20 ± 0.09^{bac}	4.32 ± 0.10^{ba}
Parity				
1	2.57 ± 0.08^{b}	3.27 ± 0.31^{b}	3.78 ± 0.29^{b}	5.37 ± 0.25^{b}
2	2.47 ± 0.15^{b}	3.35 ± 0.28^{b}	3.83 ± 0.14^{b}	5.52 ± 0.28^{b}
3	3.01 ± 0.15^{a}	3.61 ± 0.21^{a}	4.37 ± 0.06^{a}	5.93 ± 0.09^{a}
4	2.56 ± 0.20^{b}	3.01 ± 0.36^{c}	3.85 ± 0.21^{b}	5.51 ± 0.34^{b}
5	3.00 ± 0.15^{a}	3.43 ± 0.37^{b}	4.26 ± 0.24^{a}	5.89 ± 0.09^{a}
GenotypexParity	*	*	*	*

Means with different superscripts in the same column (within variable groups) are significantly different ($P < 0.05$)
N.B : NZW, New Zealand White; DT, Dutch-Belted; CF, Californian; LAB, Locally-adapted Breed; *= $P<0.05$;

Table 10: Least squares means for tail length (cm) of various rabbit genotypes at Weeks 1-4

Variables	Week			
	1	2	3	4
Genotypes				
NZW	1.16 ± 0.03^{h}	1.63 ± 0.04^{f}	2.27 ± 0.07^{dec}	2.04 ± 0.21^{d}
REX	1.32 ± 0.05^{fhge}	1.84 ± 0.15^{de}	2.53 ± 0.09^{ba}	2.25 ± 0.23^{c}
DT	1.19 ± 0.05^{hg}	1.68 ± 0.12^{ef}	2.32 ± 0.07^{bdc}	2.09 ± 0.17^{dc}
CF	1.27 ± 0.03^{fhg}	1.78 ± 0.15^{def}	2.35 ± 0.07^{bdac}	2.11 ± 0.18^{dc}
LAB	1.30 ± 0.06^{fhg}	1.79 ± 0.14^{def}	2.33 ± 0.14^{bdc}	2.06 ± 0.22^{dc}
NZW_m x REX_f	1.33 ± 0.03^{fge}	1.95 ± 0.05^{dc}	2.27 ± 0.06^{dec}	2.15 ± 0.14^{dc}
DT_m x CF_f	1.40 ± 0.05^{fde}	2.11 ± 0.06^{bc}	2.34 ± 0.08^{bdc}	2.23 ± 0.12^{dc}
LAB_m x NZW_f	1.32 ± 0.05^{fhge}	2.14 ± 0.04^{b}	2.11 ± 0.12^{fde}	2.16 ± 0.19^{dc}
CF_m x REX_f	1.99 ± 0.07^{a}	2.29 ± 0.05^{ba}	2.22 ± 0.08^{dec}	2.50 ± 0.12^{b}
DT_m x LAB_f	1.99 ± 0.07^{a}	2.40 ± 0.06^{a}	2.16 ± 0.07^{dec}	2.52 ± 0.11^{b}
REX_m x NZW_f	1.48 ± 0.05^{cde}	1.73 ± 0.02^{ef}	2.07 ± 0.08^{fe}	2.18 ± 0.08^{dc}
CF_m x DT_f	1.62 ± 0.05^{cb}	2.21 ± 0.06^{ba}	2.36 ± 0.05^{bac}	2.47 ± 0.14^{b}
NZW_m x LAB_f	1.51 ± 0.02^{cd}	1.85 ± 0.04^{de}	1.89 ± 0.03^{f}	2.11 ± 0.04^{dc}
REX_m x CF_f	1.77 ± 0.06^{b}	2.21 ± 0.02^{ba}	2.58 ± 0.06^{a}	2.80 ± 0.11^{a}
LAB_m x DT_f	1.74 ± 0.06^{b}	2.34 ± 0.09^{a}	2.53 ± 0.06^{ba}	$2.79 \pm 0{,}07^{a}$
Parity				
1	1.36 ± 0.07^{cb}	1.92 ± 0.06^{cb}	1.97 ± 0.21^{c}	3.11 ± 0.24^{b}
2	1.33 ± 0.11^{c}	1.96 ± 0.05^{b}	2.12 ± 0.38^{b}	3.21 ± 0.17^{b}
3	1.68 ± 0.11^{a}	2.16 ± 0.17^{a}	2.63 ± 0.08^{a}	3.78 ± 0.26^{a}
4	1.42 ± 0.14^{b}	1.85 ± 0.10^{c}	2.14 ± 0.15^{b}	3.20 ± 0.36^{b}
5	1.67 ± 0.11^{a}	2.09 ± 0.10^{a}	2.58 ± 0.23^{a}	3.78 ± 0.39^{a}
GenotypexParity	*	*	*	*

Means with different superscripts in the same column (within variable groups) are significantly different ($P < 0.05$)
N.B : NZW, New Zealand White; DT, Dutch-Belted; CF, Californian; LAB, Locally-adapted Breed; *= $P<0.05$;

DISCUSSION

Analytical results from this study showed differences in litter size at birth, gestation length, individual kit weight, litter weight and average litter weight at birth. These differences were as a result of the genetic make-up of the kits and the environment suitable for the gene expression. However, Ozimba and Lukefahr (1991) attributed differences observed in individual performance to strong maternal effects of litter size and milk production more than genetic effects. In general, the crossbred kits had better performance than the purebred ones. Similar observations were made by Odubote and Somade (1992) and Chineke *et al.* (2002) that preweaning body weights of crossbreds were significantly higher than those of purebreds. This could be attributed to heterosis which made the crossbreds superior to the purebreds. The best performance for reproductive traits was recorded for CF_m x DT_f followed by LAB_m x NZW_f. This fact could be partly attributed to the possession of major genes that improved growth performance in the two rabbit breeds. Also, this could be expected since cross bred does have been reported to produce more milk for their kits than their purebred counterpart (Iyeghe-Erakpotobor *et al*., 2001).

Litter size at birth was higher in New Zealand White than in California White. This agreed with the result of Pascual *et al*. (1996) who explained that it might be due to high uterine capacity or greater conception rate **(**Argente *et al*., 2003**).** However, Khalil and Afifi (2000**)** and Hassanien and Baiomy (2011) reported higher litter size at birth in California White than in New Zealand White. Generally, differences in litter size at birth among breeds may be due to maternal effects determined by the number of mature, fertilized and established ova or differences in conception rate (Nofal *et al*., 2005). The significant effects of parity reported in this study contradicted the report by Hassanien and Baiomy (2011) and Chineke (2006) who reported that parity effects were of no significant effects on litter size at birth but was in line with reports by Das and Yadav (2007), Chineke (2005) and Khalil (1993) who reported significant parity effects. The increase in litter size from parities one to three could be due to related factors such as increased number of ova released as the doe advanced in age and body size. The disparity in results could have been influenced by residual maternal effects of parity. The introduction of Rex and Locally adapted breeds in this study could also have led to significant effects of parity.

Litter weight means in this study were higher than those reported by Ayyat *et al*. (1995). This could be attributed to environmental effects. Among the purebreds, California White had the highest litter weight while Rex had the lowest. This finding opposed that of Hassanien and Baiomy (2011) who reported Rex to be the highest and New Zealand White the lowest. There were consistent increases in body weights from weeks 1 through 4. This was envisaged since breed combinations and nutrition promotes growth, which was in turn associated with increase in weight. Among the purebreds, the mean body weight at week 1 was highest in the locally-adapted breed and lowest in the Dutch. This is in line with reports by Lebas *et al.* (1997) who explained that locally-adapted breeds performed better than exotic breeds. The heavier body weights in the locally-adapted breed could also be due to the smaller litter size at birth since kits born in smaller litters tended to get more milk and maternal care in comparison with those born in large litters.

For the linear traits, the best performance was recorded for Rex_m x CF_m followed by DT_m x LAB_f. The observed increase in each measurement studied as age increased corroborated reports by Oke *et al.* (2004) in pure breeding experiments involving New Zealand White, Dutch and Chinchilla breeds of rabbits, who reported further that associations between body weight and linear body traits were linear. This observation also agreed with that of Sulabo *et al.* (2006) which established that there was a positive correlation between linear measurements and body weights in pigs. It is therefore suggested that rabbit producers could obtain an approximation of rabbit bodyweight without necessarily weighing them.
Significant genotype-parity interaction effect on litter size was similar to results that showed significant interaction effect for litter size and litter weight at birth by Hassanien and Baiomy (2011) using Rex, New Zealand, California White and Baladi Red rabbit breeds. All body weights were significantly affected by interactions among genotype and parity. Similar reports were given by Khalil (1999) on an experiment using Gabali and New Zealand White breeds of rabbit.

CONCLUSION

Since genotype and parity were major sources of variation in this study, improvement in production characteristics through breed manipulation and selection is feasible. Increase in weight with advancement in age implies a better performance in the long run and heavier market weights and sizes. The cross between Locally-adapted breed and New Zealand White (LAB_m x NZW_f**)** had better litter size than other genotypes. California White crossbreds had the best performance for gestation length, individual kit weight at birth and litter weight while the DT_m x LAB_f had the best performance for average litter weight. The superiority of the California White crossbreds would likely enhance faster rate of improvement in productivity of the total population. Crossbreeding programmes involving California White and locally-adapted breeds should be carried out for rabbit improvement in South-Western Nigeria. Breeders need to exploit the preponderance of additive genes in the rabbit population to bring about improvement in the growth traits.

Individual selection of parents in this population should be carried out in order to ensure fast genetic improvement. Proper management of rabbits should be done coupled with provision of suitable environment such as housing and feeding. This will enhance rabbit production in Nigeria since environment enhances gene expression in an animal.

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