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GENOTYPE, GESTATION LENGTH, SEASON, PARITY AND SEX EFFECTS ON GROWTH TRAITS OF TWO RABBIT BREEDS AND THEIR CROSSES

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Abstract: One hundred and thirty rabbits were used to evaluate the effect of genotype, gestation length, season, parity and sex on growth traits of two breeds of rabbit and their crosses. The rabbit used for the experiment were breeds of the New Zealand White (NZW) and Chinchilla (CH) breed. Six breeding bucks (three/breed) and eighteen breeding does (nine/breed) served as the foundation stock. Traits measured include: body weight (BW), nose to shoulder length (NTS), shoulder to tail length (STL), heart girth (HG), trunk length (TL) and length of ear (LE). Results revealed that, BW of the rabbits were influenced ($p<0.05$) by genotype, gestation length and season. CH x (CH x NZW) progenies had better BW at 35-d and 49-d of age while NZW x CH progenies had better BW at 21-d of age. Kittens born late (32-34 days) had better BW at 21-d, 35-d and 49-d while kittens kindled during early dry season had better BW at 21-d, 35-d and 49-d. Genotype affected ($p<0.05$) all the body measurements at 21-d, 35-d and 49-d. Gestation length affected ($p<0.05$) all the body measurements except for NTS at 21-d and HG at 49-d respectively. Season of birth also influenced ($p<0.05$) all the body measurements except for LE 21-d. Parity and sex had no effect ($p>0.05$) on BW, NTS, STL, HG, TL and LE. It was concluded that genotype, gestation length and season influenced BW and body dimensions of the two breeds of rabbit and their crosses while parity and sex had no effect.

Key words: Genotype, gestation, season, parity and sex.

Introduction

There is no doubt that the Nigerian population is fast growing. The recent human population figure of Nigeria was put at over 140 million (*NPC*, 2006). This means that urgent action needs to be taken if the animal protein need of the people is to be met. Livestock have a big role to play in ensuring food security through increased output of their products in the form of meat, egg and milk. Livestock products are generally rich in nutrients and are of high biological value and hence very suitable for man. They are a good source of micronutrients difficult to obtain in adequate quantities from plant sources (*Adama*, 2008). One of the animals likely to play a key role in alleviating protein deficiency in the population is the rabbit. The rabbit is prolific, with excellent meat quality (*Fielding*, 1991). The meat is white, low in fat, rich in protein and in some minerals and vitamins (*Aduku and Olukosi*, 1990). There is no known taboo (cultural or religious) against the consumption of its meat (*Biobaku*, 1992). This makes it a veritable source of easily available protein. It has fast growth, short gestation period, ability to utilize feeds that are not-competed for by man and small body size. The potential for genetic improvement is a characteristic that makes the rabbit suitable as a source of cheap and readily available animal protein.

For the rabbit to meet its full potential as a source of meat and possibly fur, its genetic improvement in Nigeria must be undertaken. One of the prerequisite for genetic improvement is the knowledge of genetic parameters related to important economic traits (*Akanno and Ibe*, 2005). With such knowledge, it becomes easier for breeders to cross different breeds of rabbits with the hope of tapping into hybrid vigour that may arise as a result of such crosses. There are many breeds of rabbit; therefore, this study aims at evaluating the influence of genotype on growth traits of two breeds of rabbit and their crosses. The effect of other factors such as gestation length, season, parity and sex was also investigated.

Materials and Methods

The experiment was conducted at the Rabbitry section of the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Minna, Niger State, Nigeria. Minna is located between latitude 9^0 37’ north and longitude 6^0 32’ east of the equator. The altitude is 853 feet (260 m) above sea level. Annual precipitation averages 1312 mm with a mean temperature of between 19^0C and 37^0C. The mean relative humidity is between 21 – 73 % (*Climatetemp*, 2011). Animals used for this study were NZW and CH rabbits obtained from the National Veterinary Research Institute Vom, Plateau state, Nigeria. This represents the main rabbit types found in the country. Twenty four rabbits made up of 3 bucks per breed, and 9 does per breed served as the foundation animals. The animals were housed in groups (according to breed) in well ventilated and shaded hutches. Feed (16 % CP; 2776 Kcal/Kg ME formulated concentrate, Mango leaves, *Tridax procumbens* as well as legume hay supplement) and water were given *ad libitum* throughout the experimental period. Other routine management practices were observed. Mating began when the rabbits were between 4-5 months of age (120-150 days) and weighing between 1.45-1.50 Kg. Pregnancy was monitored via palpation of the abdominal region between the thighs. Nesting boxes were placed in the doe's hutch five days pre kindling.

Traits measured include BW, NTS, distance from the nose to the point of the shoulder; STL, distance from the point of the shoulder to the pin bone or the end of coccygeal vertebrate; HG, body circumference measured just behind the fore limbs; TL, the longitudinal distance from the point of the shoulder to the tuberosity of the ischium and LE, distance from the point of attachment of the ear to the tip of the ear. The genetic types were form from the mating of the breeds' i.e, purebred, crossbred and its reciprocal, and backcrossing (Table 1). Statistical analysis was performed by means of the PROC GLM procedure of SAS (*SAS*, 1993) with the model

Table 1. Description of genetic group of sires, dams and progenies

Genetic group of sire	Genetic group of dam	Genetic group of progeny
NZW	NZW	NZW x NZW
CH	CH	CH x CH
NZW	CH	NZW x CH
CH	NZW	CH x NZW
NZW	NZW X CH	NZW x (NZW x CH)
CH	CH x NZW	CH x (CH x NZW)
NZW = New Zealand White; CH= Chinchilla.		

$$Y_{ijklmn} = \mu + B_i + C_j + D_k + E_l + F_m + G_n + e_{ijklmn}$$

Where Y_{ijklmn} = record of dependent variable (BW, NTS, STL, HG, TL and LE), μ = overall mean, B_i = effect of the i^{th} genotype (1,…,6), C_j = effect of the j^{th} litter size, D_k = effect of the k^{th} gestation length (1,…,3), E_l = effect of the l^{th} parity (1,2), F_m = effect of the m^{th} sex (Male, Female), G_n = effect of the n^{th} season (1,…,4) and e_{ijklmn} = random error effect.

Results and Discussion

The body weight data for 21, 35 and 49-d of age are presented in Table 2. Mean weights at 21, 35 and 49-d for the various genotypes were significantly ($p<0.05$) different. The NZW x NZW kittens had heavier body weight at 21-d (227.06 g). NZW x NZW and CH x (CH x NZW) kittens had similar body weights at 35-d but CH x (CH x NZW) kittens were superior at 49-d (602.00 g). The mean weights of rabbits by gestation length significantly ($p<0.05$) differed at 21, 35 and 49-d. Kittens born 32-34 days (late gestation) were consistently superior in body weight over those kindled earlier or later (223.97; 386.36; 531.92). Kittens kindled very late (>34 d) were generally poorer than the others in body weight. The mean weights by season were significantly ($p<0.05$) different at 21, 35 and 49-d. Kittens born at the onset of the dry season were better than those born during early rain, late rain and late dry season (270.00; 533.33; 773.33). Kittens born during late dry season were poorer in terms of body weight except at 49-d when kittens born during late rain were poorer. Parity and sex means did not differ significantly ($p<0.05$) for body weight at various ages. Kittens kindled at 1[st] parity were superior in body weight over those kindled at 2[nd] parity. Females were only heavier at 21-d while males predominated at 35 and 49-d respectively. The crossbred recorded lower performances when compared to the NZW x NZW pure breed crosses. The lower values observed for the crossbred may be because; heterosis is generally low for growth traits (about 5 %) and even lower for anatomical traits (e.g. body shape). Even in the presence of substantial heterosis, the better F1 crossbred may not necessarily exceed the better parent; unless both parents have similar performance which clearly was not the case observed in this study. The better performance of the pure breeds over the crossbred contradicts the report of *Chineke et al.* (2003). The mean values obtained for 21, 35 and 49-d were not too far from values earlier reported by some authors (*Adesina*, 2000; *Alokan*, 2000; *Babatunde et al.*, 2000; *Sanni and Dada*, 2001).

Table 2. Effect of genotype, gestation length, season, parity and sex on 21-d, 35-d and 49-d body weight (g) of rabbit

Factor	21-d (**N=125**)	35-d (**N=120**)	49-d (**N=112**)
Genotype			
NZW x NZW	227.06 ± 11.85[a]	420.59 ± 19.07[a]	544.67 ± 35.42[ab]
CH x CH	187.63 ± 11.20[b]	342.11 ± 18.04[b]	429.68 ± 31.47[c]
NZW x CH	192.24 ± 9.07[b]	319.93 ± 14.86[b]	393.70 ± 26.40[c]
CH x NZW	212.32 ± 9.23[ab]	354.07 ± 15.14[b]	492.92 ± 27.99[bc]
NZW X (NZW x CH)	188.68 ± 11.20[b]	340.00 ± 18.04[b]	485.88 ± 33.27[bc]
CH x (CH x NZW)	216.92 ± 13.55[ab]	416.00 ± 24.87[a]	602.00 ± 43.37[a]
Gestation length			
Early (29-31 days)	189.35 ± 6.22[b]	339.70 ± 11.22[b]	446.68 ± 19.46[b]
Late (32-34 days)	223.97 ± 6.01[a]	386.35 ± 10.51[a]	531.92 ± 18.50[a]
Very late (35days +)	164.23 ± 12.69[c]	290.85 ± 21.99[c]	355.39 ± 36.99[c]
Season			
Early rain	205.47 ± 6.13[b]	377.05 ± 9.81[b]	502.18 ± 17.59[b]
Late rain	198.33 ± 6.67[b]	325.35 ± 10.63[b]	425.83 ± 19.17[b]
Early dry	270.00 ± 28.31[a]	533.33 ± 44.23[a]	773.33 ± 76.69[a]
Late dry	170.00 ± 24.52[b]	317.50 ± 38.31[b]	497.50 ± 66.41[b]
Parity			
1[st]	203.90 ± 5.59	363.10 ± 8.52	483.30 ± 14.71
2[nd]	200.60 ± 7.71	355.00 ± 17.58	468.90 ± 28.87
Sex			
Male	202.60 ± 6.09	371.30 ± 12.02	491.80 ± 22.60
Female	203.70 ± 6.72	347.40 ± 10.51	464.40 ± 16.16

Means denoted by different superscripts within the same column differ ($p<0.05$) significantly; ± SEM; NZW = New Zealand White; CH = Chinchilla.

NTS length by genotype differed significantly ($p<0.05$) at 21, 35 and 49-d (Table 3). CH x NZW and NZW x CH kittens were superior over other genotypes in NTS measurements (9.96 and 9.70). The least performance in NTS measurement was observed for NZW x (NZW x CH) kittens at 21-d (8.86), NZW x NZW kittens at 35-d (10.70) and, CH x CH kittens at 49-d (11.55) respectively. There was no difference ($p>0.05$) in NTS measurement by gestation length at 21 and 49-d. However, gestation length significantly ($p<0.05$) affected NTS at 35-d. Late gestated kittens (11.57) were superior in NTS measurement than those born either early or very late. Season significantly ($p<0.05$) affected NTS at 21, 35 and 49-d. Kittens born during early dry season and late rain were statistically superior in NTS measurements at 21 and 35-d. Kittens born during late dry season were poorer at 21-d NTS while those kindled during early rain were poorer at 35 and 49-d. Mean NTS length by parity were not significantly ($p>0.05$) different at 21, 35 and 49-d. However, kittens born during 2nd parity consistently had longer NTS length compared to those born at 1st parity. Mean NTS length by sex were not significantly ($p>0.05$) influenced. Male kittens however had longer NTS length than females.

Table 3. Effect of genotype, gestation length, season, parity and sex on 21-d, 35-d and 49-d NTS (cm) of rabbit

Factor	21-d (**N=125**)	35-d (**N=120**)	49-d (**N=112**)
Genotype			
NZW x NZW	9.20 ± 0.18^{b}	10.70 ± 0.19^{b}	12.12 ± 0.23^{ab}
CH x CH	8.87 ± 0.17^{b}	10.76 ± 0.18^{b}	11.55 ± 0.21^{b}
NZW x CH	9.70 ± 0.14^{a}	11.46 ± 0.15^{a}	12.49 ± 0.17^{a}
CH x NZW	9.96 ± 0.14^{a}	11.51 ± 0.15^{a}	12.60 ± 0.18^{a}
NZW X (NZW x CH)	8.86 ± 0.17^{b}	11.04 ± 0.18^{ab}	12.14 ± 0.22^{ab}
CH x (CH x NZW)	9.19 ± 0.20^{b}	10.84 ± 0.25^{b}	12.26 ± 0.28^{a}
Gestation length			
Early (29-31 days)	9.07 ± 1.11	10.63 ± 0.10^{c}	11.95 ± 0.13
Late (32-34 days)	11.26 ± 1.07	11.57 ± 0.10^{a}	12.49 ± 0.13
Very late (35days +)	9.21 ± 2.26	11.17 ± 0.20^{b}	12.25 ± 0.26
Season			
Early rain	9.01 ± 0.09^{b}	10.82 ± 0.10^{b}	11.90 ± 0.12^{c}
Late rain	9.82 ± 0.10^{ab}	11.46 ± 0.11^{ab}	12.48 ± 0.13^{bc}
Early dry	9.93 ± 0.43^{a}	12.03 ± 0.45^{a}	13.53 ± 0.51^{a}
Late dry	8.98 ± 0.37^{b}	11.18 ± 0.39^{ab}	13.00 ± 0.44^{ab}
Parity			
1st	9.21 ± 0.09	10.91 ± 0.10	12.05 ± 0.11
2nd	9.79 ± 0.12	11.66 ± 0.12	12.63 ± 0.13
Sex			
Male	9.41 ± 0.11	11.21 ± 0.10	12.36 ± 0.12
Female	9.36 ± 0.11	11.07 ± 0.10	12.13 ± 0.14

Means denoted by different superscripts within the same column differ ($p<0.05$) significantly; ± SEM; NZW = New Zealand White; CH = Chinchilla.

The mean of STL by genotype differed significantly ($p<0.05$) at 21, 35 and 49-d respectively (Table 4). NZW x NZW, CH x NZW and CH x (CH x NZW) kittens were similar in STL measurement at 21-d. NZW x NZW and CH x NZW kittens were similar at 35-d, while at 49-d, no statistical difference was observed between NZW x NZW and CH x (CH x NZW) kittens in STL measurement. CH x CH kittens showed poor performance in STL measurements at 21 and 35-d respectively (15.86; 20.01). Gestation length means differed significantly ($p<0.05$) for STL at various ages. Kittens born during late gestation were superior in STL measurement compared to those born at early and very late gestation (16.96; 21.86; 24.88). Season means for STL at all ages also differed significantly ($p<0.05$) with kittens kindled during early dry season having superior STL measurements (18.67; 25.00; 28.67) while those kindled during late dry season were no different statistically in STL measurement at all ages from those kindled at early and late rain. Parity had no significant ($p>0.05$) effect on all STL measurements. Longer STL was however observed for kittens born at 2nd parity compared to those born at 1st parity. Sex equally had no significant ($p>0.05$) influence on STL measurements at all ages. However, males had consistently better STL measurements compared to their female counterparts.

Table 4. Effect of genotype, gestation length, season, parity and sex on 21-d, 35-d and 49-d STL (cm) of rabbit

Factor	21-d (**N=125**)	35-d (**N=120**)	49-d (**N=112**)
Genotype			
NZW x NZW	17.28 ± 0.36^{a}	22.61 ± 0.45^{a}	24.63 ± 0.58^{a}
CH x CH	15.86 ± 0.34^{c}	20.01 ± 0.42^{c}	22.06 ± 0.51^{b}
NZW x CH	16.07 ± 0.27^{bc}	20.98 ± 0.35^{bc}	23.63 ± 0.43^{ab}
CH x NZW	17.00 ± 0.28^{ab}	20.96 ± 0.35^{bc}	24.75 ± 0.45^{a}
NZW X (NZW x CH)	15.99 ± 0.34^{bc}	20.01 ± 0.42^{c}	23.34 ± 0.54^{ab}
CH x (CH x NZW)	16.62 ± 0.41^{abc}	21.62 ± 0.58^{ab}	25.00 ± 0.70^{a}
Gestation length			
Early (29-31 days)	16.10 ± 0.20^{b}	20.23 ± 0.26^{b}	22.87 ± 0.32^{b}
Late (32-34 days)	16.96 ± 0.19^{a}	21.86 ± 0.24^{a}	24.88 ± 0.30^{a}
Very late (35days +)	15.85 ± 0.41^{b}	19.69 ± 0.50^{b}	23.08 ± 0.61^{b}
Season			
Early rain	16.48 ± 0.19^{b}	21.01 ± 0.24^{b}	23.57 ± 0.30^{b}
Late rain	16.41 ± 0.21^{b}	20.74 ± 0.26^{b}	23.88 ± 0.33^{b}
Early dry	18.67 ± 0.87^{a}	25.00 ± 1.09^{a}	28.67 ± 1.31^{a}
Late dry	15.50 ± 0.76^{b}	19.88 ± 0.95^{b}	23.00 ± 1.14^{b}
Parity			
1st	16.38 ± 0.16	20.74 ± 0.21	23.42 ± 0.25
2nd	16.66 ± 0.27	21.57 ± 0.39	24.70 ± 0.42
Sex			
Male	16.61 ± 0.21	21.23 ± 0.28	24.22 ± 0.36
Female	16.36 ± 0.19	20.70 ± 0.23	23.46 ± 0.28

Means denoted by different superscripts within the same column differ ($p<0.05$) significantly; ± SEM; NZW = New Zealand White; CH = Chinchilla.

The means of heart girth by genotype, gestation length and season of birth, parity and sex at 21, 35 and 49-d of age are presented in Table 5. HG values differed significantly (p<0.05) by genotype at all ages. The CH x (CH x NZW), NZW x (NZW x CH) and CH x NZW kittens had similar HG measurements than the others at 21-d (14.00; 13.59; 13.31) while CH x (CH x NZW) kittens were superior at 35-d (17.85) when compared to the other genotypes. At 49-d, HG measurements for CH x (CH x NZW) and NZW x (NZW x CH) kittens were comparable statistically. CH x CH kittens had poorer HG measurement at 21, 35 and 49-d (12.42; 14.20; 15.58) although not statistically different from that of NZW x NZW and NZW x CH (21-days), and NZW x CH (35 and 49-d). The means of HG by gestation length also differed significantly (p<0.05) at 21 and 35-d with kittens born during late gestation having improved HG measurements at all ages (13.82; 16.08). Mean HG measurement was significantly (p<0.05) affected by season of birth with kittens born during early dry season performing better than the others at 21 and 35-d (14.83; 18.67). Mean HG measurements were comparable for kittens kindled at early rain, early dry and late dry season. Parity and sex means did not differ significantly (p>0.05) for HG measurements at various ages. However, better performance was observed for kittens born at 1st parity. Females were better than males only at 21-d post-partum.

Table 5. Effect of genotype, gestation length, season, parity and sex on 21-d, 35-d and 49-d HG (cm) of rabbit

Factor	21-d (**N=125**)	35-d (**N=120**)	49-d (**N=112**)
Genotype			
NZW x NZW	13.14 ± 0.30^{bc}	15.09 ± 0.30^{cd}	16.90 ± 0.43^{b}
CH x CH	12.42 ± 0.28^{c}	14.20 ± 0.29^{e}	15.58 ± 0.38^{c}
NZW x CH	12.80 ± 0.23^{bc}	14.75 ± 0.23^{de}	16.63 ± 0.32^{bc}
CH x NZW	13.31 ± 0.23^{ab}	15.68 ± 0.24^{bc}	17.15 ± 0.34^{b}
NZW X (NZW x CH)	13.59 ± 0.28^{ab}	16.05 ± 0.29^{b}	18.77 ± 0.40^{a}
CH x (CH x NZW)	14.00 ± 0.34^{a}	17.85 ± 0.39^{a}	19.83 ± 0.52^{a}
Gestation length			
Early (29-31 days)	12.69 ± 0.15^{b}	14.86 ± 0.21^{b}	17.00 ± 2.61
Late (32-34 days)	13.82 ± 0.15^{a}	16.08 ± 0.20^{a}	21.30 ± 2.48
Very late (35days +)	12.00 ± 0.31^{c}	14.62 ± 0.42^{b}	15.77 ± 4.96
Season			
Early rain	13.21 ± 0.16^{b}	15.55 ± 0.20^{b}	17.44 ± 0.26^{ab}
Late rain	12.97 ± 0.17^{b}	15.08 ± 0.22^{b}	16.70 ± 0.29^{b}
Early dry	14.83 ± 0.73^{a}	18.67 ± 0.89^{a}	19.67 ± 1.14^{a}
Late dry	13.25 ± 0.63^{b}	15.38 ± 0.77^{b}	18.25 ± 0.99^{ab}
Parity			
1st	13.13 ± 0.15	17.00 ± 1.64	17.26 ± 0.25
2nd	13.16 ± 0.19	15.84 ± 0.28	17.20 ± 0.31
Sex			
Male	13.02 ± 0.17	17.16 ± 1.78	17.34 ± 0.29
Female	13.28 ± 0.16	15.41 ± 0.20	17.13 ± 0.26

Means denoted by different superscripts within the same column differ (p<0.05) significantly; ± SEM; NZW = New Zealand White; CH = Chinchilla.

Trunk lengths by genotype, gestation length, season, parity and sex are presented in Table 6. TL measurement was significantly ($p<0.05$) affected by the genotype of the kittens. NZW x NZW, CH x (CH x NZW), CH x NZW, and NZW x (NZW x CH) had comparable TL measurements at 21-d. CH x (CH x NZW) kittens were superior to other genotypes at 35-d (18.35) while there were similarities in TL measurements of CH x (CH x NZW), NZW x NZW and CH x NZW kittens at 49-d. CH x CH kittens were poorer in TL measurements at 21-d (13.30). Gestation length means differed significantly ($p<0.05$) at all ages with kittens born during late gestation outperforming those born during very late and early gestation at all ages (14.44; 18.19; 20.28). Kittens born during very late and early gestation were comparable in TL measurements. Season significantly ($p<0.05$) affected TL at all ages. Kittens born during early dry, early and late rainy season had similar (longer) TL measurements at 21-d. At 35 and 49-d however, kittens kindled during early dry season were consistently better (20.00; 23.00) than those kindled at other seasons. The means of TL by parity and sex at 21, 35 and 49-d were not significantly ($P>0.05$) different.

Table 6. Effect of genotype, gestation length, season, parity and sex on 21-d, 35-d and 49-d TL (cm) of rabbit

Factor	21-d (**N=125**)	35-d (**N=120**)	49-d (**N=112**)
Genotype			
NZW x NZW	14.55 ± 0.31^{a}	18.19 ± 0.42^{ab}	20.43 ± 0.54^{ab}
CH x CH	13.30 ± 0.29^{c}	17.02 ± 0.40^{bc}	17.87 ± 0.48^{c}
NZW x CH	13.71 ± 0.24^{ab}	17.23 ± 0.33^{abc}	19.28 ± 0.40^{bc}
CH x NZW	14.32 ± 0.24^{a}	17.09 ± 0.34^{bc}	20.17 ± 0.42^{ab}
NZW X (NZW x CH)	13.70 ± 0.29^{ab}	16.68 ± 0.40^{c}	19.53 ± 0.50^{b}
CH x (CH x NZW)	14.40 ± 0.35^{a}	18.35 ± 0.55^{a}	21.25 ± 0.66^{a}
Gestation length			
Early (29-31 days)	13.60 ± 0.17^{b}	16.56 ± 0.22^{b}	19.03 ± 0.32^{b}
Late (32-34 days)	14.44 ± 0.17^{a}	18.19 ± 0.21^{a}	20.28 ± 0.30^{a}
Very late (35days +)	13.39 ± 0.35^{b}	16.23 ± 0.44^{b}	18.85 ± 0.60^{b}
Season			
Early rain	13.98 ± 0.16^{ab}	17.49 ± 0.22^{b}	19.52 ± 0.29^{b}
Late rain	13.94 ± 0.18^{ab}	17.00 ± 0.24^{b}	19.49 ± 0.32^{b}
Early dry	15.33 ± 0.76^{a}	20.00 ± 0.99^{a}	23.00 ± 1.27^{a}
Late dry	13.25 ± 0.66^{b}	16.25 ± 0.86^{b}	19.25 ± 1.10^{b}
Parity			
1st	13.94 ± 0.15	17.21 ± 0.20	19.35 ± 0.26
2nd	14.06 ± 0.20	17.63 ± 0.30	20.19 ± 0.36
Sex			
Male	13.88 ± 0.24	17.49 ± 0.24	20.02 ± 0.32
Female	13.91 ± 0.16	17.14 ± 0.22	19.20 ± 0.27

Means denoted by different superscripts within the same column differ ($p<0.05$) significantly; ± SEM; NZW = New Zealand White; CH = Chinchilla.

The means of length of ear by genotype, gestation length and season of birth, parity and sex are presented in Table 7. Means of LE by genotype differed significantly ($p<0.05$) at all ages with NZW x NZW, CH x NZW and NZW x CH kittens having similar (longer) ears at 21-d. NZW x NZW kittens were superior at 35-d (8.25) while comparable LE measurements were observed for NZW x NZW, CH x (CH x NZW) and NZW x (NZW x CH) kittens at 49-d. Kittens born as a result of CH x CH mating had shorter LE measurement at 21-d (5.19). Gestation length means differed significantly ($p<0.05$) at all ages with kittens born during late and very late gestation outperforming those born during early gestation at 21-d. At 35 and 49-d however, very late (>34 d) gestated kittens were inferior to their peers in LE measurements. Parity and sex had no significant ($P>0.05$) effect on LE measurements of kittens. It was however observed that kittens kindled at 1[st] parity had slightly longer LE at 35 and 49-d. Females equally had longer but no significant LE at 21 and 35-d.

Table 7. Effect of genotype, gestation length, season, parity and sex on 21-d, 35-d and 49-d LE (cm) of rabbit

Factor	21-d (**N=125**)	35-d (**N=120**)	49-d (**N=112**)
Genotype			
NZW x NZW	6.01 ± 0.121^{a}	8.25 ± 0.13^{a}	8.90 ± 0.15^{a}
CH x CH	5.19 ± 0.11^{c}	7.47 ± 0.13^{b}	8.15 ± 0.13^{b}
NZW x CH	5.70 ± 0.09^{ab}	7.48 ± 0.11^{b}	8.32 ± 0.11^{b}
CH x NZW	5.88 ± 0.10^{ab}	7.36 ± 0.11^{b}	8.25 ± 0.12^{b}
NZW X (NZW x CH)	5.60 ± 0.11^{b}	7.51 ± 0.13^{b}	8.52 ± 0.14^{ab}
CH x (CH x NZW)	5.65 ± 0.14^{b}	7.62 ± 0.17^{b}	8.57 ± 0.18^{ab}
Gestation length			
Early (29-31 days)	5.44 ± 0.07^{b}	7.52 ± 0.08^{a}	8.30 ± 0.09^{ab}
Late (32-34 days)	5.88 ± 0.07^{a}	7.72 ± 0.08^{a}	8.58 ± 0.08^{a}
Very late (35days +)	5.85 ± 0.14^{a}	7.18 ± 0.16^{b}	8.15 ± 0.16^{b}
Season			
Early rain	5.60 ± 0.07	7.74 ± 0.09^{ab}	8.51 ± 0.08^{ab}
Late rain	5.77 ± 0.07	7.38 ± 0.08^{b}	8.24 ± 0.08^{b}
Early dry	6.17 ± 0.32	8.07 ± 0.34^{a}	9.03 ± 0.34^{a}
Late dry	5.63 ± 0.27	7.33 ± 0.29^{b}	8.40 ± 0.29^{ab}
Parity			
1[st]	5.61 ± 0.06	7.63 ± 0.07	8.44 ± 0.07
2[nd]	5.84 ± 0.08	7.51 ± 0.11	8.38 ± 0.09
Sex			
Male	5.67 ± 0.07	7.61 ± 0.08	8.44 ± 0.09
Female	5.69 ± 0.07	7.71 ± 0.19	8.39 ± 0.08

Means denoted by different superscripts within the same column differ ($p<0.05$) significantly; ± SEM; NZW = New Zealand White; CH = Chinchilla.

The body measurements were generally observed to show increase with age of the rabbits. This is expected in normal growing and healthy rabbits. The differences observed in body traits, could not be linked solely to breed differences since no particular trend was observed in the superiority of the genotypes as per the traits studied. However, CH x NZW kittens were superior in nose to shoulder measurements at all ages, followed by NZW x CH kittens. This trend repeated itself in almost all the body traits. This difference could be tied to maternal effects since kittens produced from the two mating (CH x NZW and NZW x CH) basically have the same genes (supposing that the gene pool of the NZW males was the same as that of the NZW dams). This seems to indicate the superiority of NZW does over their CH peers. NZW does have been reported to exhibit an outstanding maternal ability related to behaviour, fecundity and lactation (*Lukefahr et al.,* 1983a, 1983b; *Ozimba and Lukefahr*, 1991; *McNitt et al.,* 2000). Nose to shoulder length measurements at all ages were lower than that reported by *Chineke et al.* (2006). Breed differences observed in all body traits agrees with earlier findings (*Chineke et al.,* 2003; *Chineke et al.,* 2006; *Oke et al.,* 2010).

Body weights did not increase with gestation length. However, kittens born within 32-34 d had better body weights at all ages although 32-34 d does not fall within the 30±2 days gestation length reported for rabbits by *Omoikhoje et al.* (2008). Gestation was an important source of variation for body measurements considered in the study. Kittens born within 32-34 d had better body measurements compared to those born earlier or lately. This effect of gestation length on body measurements agrees with the findings of *Chineke et al.* (2003). Season of kindling contributed significantly to the variations in the body weights of the rabbits. The differences observed in body weight cannot be tied to season alone though but also feed availability especially roughage. The variation could possibly be linked to the pattern of seasonality of weather conditions and its effect on roughage quality. According to *Khalil et al.* (1987), seasonality can exert their effects on weaning weights of rabbits in the amount of milk produced by the suckling dams and, on growth performance at later ages (through the quantity and quality of the directly ingested feed, the appetite of the young and food utilization during the post-weaning months). *Orengo et al.* (2004) also reported that season had a great effect on all weaning traits. Season also influenced growth-related traits at different ages except 21-d LE. In all the measurements, kittens born during early dry season were superior. This period likely was the most conducive period for the rabbits leading to enhanced feed intake and hence, better growth. The differences observed in growth-related traits in different season might also be attributed to health and the nutritional status of the does and kittens. According to *Orengo et al.* (2004), hot season has a depressor effect on live weight of rabbits.

Parity effect was found to be not significant for body weight and growth-related traits although kittens born during 1st parity showed the best performance in terms of body weight at all ages. This is in disagreement with earlier reports (*Abdel-Ghany et al.,* 2000; *Garcia*, 2001; *Prayaga and Eady*, 2003; *Chineke et al.,* 2006; *Abou Khadiga et al.,* 2008) as they reported parity to be a significant source of variation of body weight in rabbits. Sex effect was also found not to be significant for body weight and growth-related traits at all ages and this agrees with the reports of *Chineke et al.* (2003) and *Abou Khadiga et al.* (2008).

Conclusion

From the results of this study, it could be concluded that genotype, gestation length and season of birth influenced body weight and growth-related traits of the rabbit breeds and their crosses while parity and sex had no effect. Maternal additive effect appears to be more important than paternal additive effect in influencing body traits in the rabbits.

Uticaj genotipa, trajanja gestacije, sezone, pariteta i pola na osobine porasta dve rase zečeva i njihovih meleza

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Rezime

Sto trideset zečeva je korišćeno za evaluaciju efekata genotipa, dužine gestacije, sezone, pariteta i pola na osobine porasta dve rasa zečeva i njihovih meleza. Zečevi korišćeni u ogledu su rase novozelandski beli zec (NZV) i činčila (CH). Šest priplodnih mužjaka (tri/rasa) i osamnaest priplodnih ženki (devet/rasa) su predstavljali matično stado. Merene su sledeće osobine: telesna masa (BW), dužina od nosa da ramena (NTS), dužina od ramena do repa (STL), obim srca (HG), dužina tela (TL) i dužine uha (LE). Rezultati su pokazali da je BW zečeva pod uticajem ($p<0,05$) genotipa, dužine gestacije i sezone. CH x (CH x NZV) potomci imali su bolju BW u uzrastu od 35 i 49 dana starosti, dok su potomci NZV x CH imali bolju BW u uzrastu od 21dana. Zečevi rođeni kasno (32-34 dana) imali su bolju BW 21., 35. i 49. dana, dok su zečevi rođeni tokom ranog perioda sušne sezone imali bolju BW 21., 35. i 49. dana. Genotip je uticao ($p<0,05$) na sve telsne mere 21., 35. i 49. dana. Dužina gestacije je uticala ($p<0,05$) na sve telesne mere osim NTS 21., i HG 49. dana, respektivno. Sezona rođenja je takođe uticala ($p <0.05$) na sve telesne mere osim LE 21. dana. Paritet i pol nisu imali uticaj ($p>0,05$) na BW, NTS, STL, HG, TL i LE. Zaključeno je da su genotip, dužina gestacije i sezona uticali na BW i dimenzije tela dveju rasa zečeva i njihovih meleza, dok paritet i pol nisu imali efekta.

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