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Influence of Genotypes, Season of Birth, Parity Order and the Interactions between Them on Litter Traits and Body Weight Measurements of Rabbits

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Abstract

The aim of current study was to investigate the effects of the effect of genotype, season of birth and parity order on litter traits and body weight measurements of V-line and Moshtohor line (M-line) of rabbits. A total number of six thousand and three hundreds (6300 kits) offspring obtanid from these strains (100 sires and 300 dams) were used in this study. The body weight traits were recorded at 4, 8 and 12 weeks of age. Litter size at birth (LSB), Litter size at weaning at 28 days postnatal (LSW), Litter weight at birth (LWB), Litter weight at weaning at 28 days postnatal (LWW), Mortality rate and killing intervals. The effect of genotype showed that M-line revealed significant superiority ($P<0.05$) value of the body weight at all periods of estimation compared to V-line breeds. Also, the effect of season showed a significant ($P < 0.05$) change in the body weight at all periods of estimation due to season's effect. The heaviest live body weight was recorded for rabbits in springe, while the lowest live body weight was recorded in summer. Influence of parity indicated highly significant ($P <0.05$) differences in body weight in different intervals of age. The heaviest body weight was recorded in the third parity, while the lowest body weight was recorded in first parity. Likewise, the present study revealed a Highly significant ($P < 0.05$) difference were deleted in the litter size and at birth and weaning, litter weight at birth and at weaning between the different genotype, season and parity order. It can be concluded that M-line had the highest values of live body weight and litter traits compared to V-line rabbits. Current study finding suggest that M-line rabbits will be more productive and reproductive efficiency than V-line rabbit under Egyptian environmental conditions. So, the authors suggest that measuring of body weight and litter traits early ages could be a good and accurate indicator of growth performance in M-line.

Key words: Genotype, season, Litter size, litter weight, body weight, Rabbits.

Introduction

Rabbits, as opposed to other farm animals, have a high capacity for producing a significant amount of meat. As a result, rabbits can be a good source of inexpensive animal protein in developing countries. Rabbit meat is a low-cost source of meat that is high in protein, low in calories, and low in fat and cholesterol. (Dalle Zotte, 2002 and Ajayi *et al.,* 2018). Litter weight at weaning is controlled by the number of survived kits at weaning (Risam *et al.,* 2005 and Ahmed *et al.,* 2005). The individual birth weight is observed to decrease with an increase in the size of the litter. Rabbit Kits of larger litters usually have a lower weight at weaning than the corresponding weight for smaller litter kits (Poigner *et al.,* 2000). This is due to the fact that their body weight gain depends on milk intake. Does milk production is also positively related to litter size (Ayyat *et al.,* 1995 and El-Attrouny and Habashy, 2020).

The influence of the season on the reproductive performance of rabbits could differ in does and in growing rabbits. Choudhary *et al*. (2001) showed that the seasons had strong influence on kindling interval and litter weight at weaning. Bhatt *et al.* (2002) found that litter size and weight at birth, litter size at weaning as well as litter weight at weaning were all higher during winter as compared to those during the summer season. Litter size at birth was found to be lowest during summer and highest during winter (Ayyat and Marai, 1998 and Habeeb *et al.,* 1999).

Body weight is known to be highly heritable and hence the selection of heavier animals in a population should be as a result of genetic improvement of the traits (Garcia *et al.,* 2000; El-Attrouny *et al*., 2017 and El-Attrouny *et al*., 2020). According to Castellini *et al.,* 2003, the post birth bodyweight of rabbit kits is significantly influenced by litter size at birth due to the fact that the relative share of milk per kit decreased as the litter size increased. The objective of the following study was to evaluate the effect of genotype, season, and parity order on litter size and body weight measurements of rabbits at pre-weaning and post-weaning stages.

Materials and Methods

Location and experimental period

The experimental work of this study was carried out within a project of "Development of livestock in the village" - Intensification and production of genetically enhanced rabbit in MEET KENANA village Qalyoubia (application form) - in cooperation with the Bank of Misr for development and community service through four successive seasons from 2012 to 2013.

Experimental Animals

The used animals in this experiment were M-line and V-line. M- Line was synthesized in the Department of Animal Production, Faculty of Agricultures, Moshtohor, Benha University, Egypt (Iraqi *et al.,* 2008). The breeding program of M- line was conducted by crossing Sinai Gabali rabbits bucks (S) with V-line does (V) followed by selection for LWW in three subsequent generations and after F3. Consequently, this line is formed from 50% Sinai Gabali and 50 % V line (½S½V) where selection was practiced for LWW and individual weight at 56 d and the animals were kept in the rabbitry of Benha University. The V-line is a maternal line selected for LSW by Animal Science Department, Universidad Politécnica de Valencia, (UPV), Valencia, and Spain. A total number of six thousand and three hundreds progenies generated from two breeds were used for this experiment. Total number of three hundreds does (i.e. 150 V-line and 150 M-line) and one hundred bucks (50 V-line and 50 M-line) were used in the experiment.

Housing and Feeding

Breeding bucks and does were housed separately individual in wired cages with standard dimensions (60 x 40 x 35cm, length x width x height) in a flat dick batteries. In rabbitry, temperature ranged from 15 to 35^0C, the relative humidity ranged from 30 to 70 % and photoperiod was at 16 L: 8 D. Each maternity cage was supplied with a galvanized steel nest boxes. Cages and nest boxes were cleaned and disinfected regularly after each kindling. Urine and feces dropped from cages on the building floor were cleaned every day morning.

The experimental buck: doe ratio was 1:5 by using natural mating. Each doe was transferred to the assigned buck to be mated and returned back again to her own cage. On the day 10 post mating, each doe was palpated to detect pregnancy. Doe that was not pregnant would returned to the same mating buck to be remated and returned every other day thereafter until a service was observed. Likewise, does were remating after kindling by the same assigned buck.

On the 25^{th} day of pregnancy, the nest boxes were supplied with thick layer of rice straw, which was placed in the bottom of the nest box to help the doe in preparing a worm comfortable nest for her bunnies. Litters born were examined and recorded for, LSB within 12 hours after kindling; litters were checked and examined each morning during the suckling period to remove the dead young. Bunnies were weaned at 28 days post kindling, sexed and transferred to standard progeny wire cages.

The breeding animals were fed ad libitum all over the experimental period on a pelleted commercial ration; pellets were cylindrical in form (1-2 cm in length and 0.4 cm in diameter). The ration was composed of 23 % barley, 19 % wheat bran, 24 % soybean meal , 21 % berseem hay, 13 % yellow corn, 1 % limestone, 0.5 % table salt, 14 kg di-calcium phosphate/ton, 1 kg minerals mixture/ton, 1 kg anti-coccidian/ton, 1 kg anti-toxicity/ton, provided 18.01% crude protein, 13.7% crude fiber and 2.5% fat (digestible energy = 2600 kc/kg feed according to NRC (1977). All growing and breeding rabbits were kept under the same managerial, hygienic and environmential contions. Fresh drinking water was available all the time.

Data Collection

Data were recorded for individual rabbits body weights (BW) in two genetic groups (M-line and V-line) at 4, 8 and 12 weeks of age, daily weight gains (DG) were calculated during the age intervals from 4-8, 8-12 and 4-12 weeks of age, Litter traits studied include: Litter size at birth (LSB), litter size at weaning at 28 days postnatal (LSW),litter weight at birth (LWB) and litter weight at weaning at 28 days postnatal (LWW).

Statistical analysis

Analysis of variance of Two-way ANOVA was carried out using SAS procedure guide (SAS, 2004). According to the following liner model:

$Y_{ijk} = \mu + B_i + S_j + P_k + (BS)_{ij} + e_{ijkl}$

Where: Y_{ijk} = the observation of traits for ijkth buck and doe rabbit; μ = general mean, common element to all observations; Bi = the fixed effect of the ith breed group. S_j = the fixed effect of the jth season. P_k = the fixed effect of the kth parity $(BS)_{ij}$ = the fixed effect of the interaction between the ith breed Group and the jth season; e_{ijkl}= random error associated with the individual observation.

Results and discussion

Live body weight

Effect of breed

Results in Table 1 showed that M-line had the highest significant estimates of (P<0.05) body weight at all periods of estimation compared with V-line breeds. This may be due to differences in genetic make-up of the two lines. These results are in agreement with the same trend obtained by Afifi *et al.* (2000); Iraqi (2003) and Badr *et al*. (2019).

Seasonal effect

The present study (Table, 1) showed a significant (P < 0.05) change in the body weight at all periods of estimation due to seasons effect. The heaviest live body weight (653, 1682, and 2381g at 4, 8 and 12 wks of age, respectively) were recorded for rabbits in springe, while the lowest live body weights were recorded in summer (442, 1443 and 2092 g for 4, 8 and 12 wks of age, respectively). Such difference in body weight might be related to changes in nutrition during winter (green food), climate of summer as well as to differences in losses during month of suckling period (Afifi and Khalil, 1990 and Youssef, 1992). The majority of investigators indicated that the lowest performance was observed during the summer season, while the highest values of body weight at different ages were recorded in springs and winter seasons (Enab *et al.*, 2000; Abd El-Aziz *et al.*, 2002 and Saleh *et al.*, 2005). Afifi and Emara (1990) attributed the differences caused by year of birth effects on post-weaning daily gain to the annual changes in climate, management, feeding and disease conditions which might vary from one year to another. Generally, the dissimilarity among seasons in body weight traits could be attributed to the decreased feed intake, depression of thyroid activity and hence in the metabolic rate of pregnant does during hot summer months affected body weight weight negatively (Abdel-Azeem *et al*., 2007).

Table 1. Least–square means and standard error (X±S.E) for body weight of rabbits of different experimental groups as affected by studied factors.

Item	Life body weight (g) at		
	BW4	BW8	BW12
Breed (B)			
V-line	578±4.1[b]	1566±10.6[b]	2256±14.7[b]
M-line	631±4.3[a]	1682±11.1[a]	2378±15.4[a]
Season (S)			
Autum	551±9.6[c]	1549±24.7[c]	2250±34.4c
Winter	638±5.4[b]	1660±14.0[b]	2356±19.6b
Springe	653±6.2[a]	1682±16.1[a]	2381±22.4a
Summer	442±11[d]	1443±28.4[d]	2092±39.5d
Parity (P)			
First	566±9.3[c]	1568±23.9[b]	2249±33.4[b]
Second	633±7.5[b]	1653±19.3[a]	2344±26.9[a]
Third	652±6.6[a]	1684±17.3[a]	2387±23.8[a]
Fourth	561±7.0[c]	1573±18.1[b]	2251±25.2[b]
Interaction (B x S)			
V X Autum	529±8.2d	1521±20.9cd	2227±29.3bc
V X Winter	613±5.7b	1604±14.5b	2294±20.4b
V X Springe	625±6.7b	1600±17.1b	2305±24.0b
V X summer	411±11.2f	1409±28.4e	2029 ± 39.9d
M X Autum	570±7.8c	1575±19.8bc	2270±27.8b
M X Winter	671±6.5a	1733±16.7a	2437±23.4a
M X Springe	684±7.1a	1774±18.1a	2465±25.5a
M X Summer	480±12e	1485±31.8d	2170±44.6c

[a,b, c] Means with different superscript in the same column are significantly different at ($P<0.05$).
BW4, body weight at 4 weeks; BW8, body weight at 8 weeks; BW12, body weight at 12 weeks of age.

Parity effect

Data presented in Table (1) indicated highly significant ($P <0.05$) differences in body weight in different intervals of age. The heaviest body weight (652, 1684, and 2387g) was recorded in the third parity at 4, 6 and 12 wks, respectively. While the lowest body weight was recorded in first parity (566, 1568 and 2249g at 4, 8 and 12 wks, respectively). The results obtained agree with the same trend reported by Youssef (1992); Abd El-Raouf (1993) and Afifi *et al.* (1994) who revealed a general trend indicating that body weight at different ages increased with advance of parity till reaching its maximum at a certain parity and decreased thereafter. Also, other studies revealed an inconsistent trend for the effect of parity on body weight (Hanna, 1992; Tag El-Din *et al.*, 1992 and Afifi *et al*., 2000).

The interaction between breed and season

Data presented in table, 1, revealed a highly significant ($P < 0.05$) effect due to the interaction between the breed and season on body weight of rabbits. The heaviest body weight recorded by M-line in springe (684, 1774 and 2465 g at 4, 8 and 6 wks, respectively) and the lowest average of body weight was observed in the V-line breed in summer (411, 1409 and 2029g at 4, 8 and 6 wks of age, respectively). This finding support that observed in some previous investigations by Afifi *et al.*, 2000 and Abd El-Halim, 2003, with New Zealand White (NZW), Gabali and Californian (CAL) rabbits and their crosses, indicating the presence of a significant ($p<0.05$)) seasonal effect on kindling interval. However, a non-significant effect for season of kindling on day's open, kindling interval and insemination period was noticed with NZW, Baladi Red rabbits and their crosses (Khalil, 1993; Khalil *et al.*, 1995 and Ahmed, 1997) with NZW rabbits

Daily weight gain

Effect of breed

As shown in table, 2, the present study revealed significant (P < 0.05) difference in the body weight gain among breeds at the period from 4-8wks only. The highest means of daily gain during periods from 4-8, 8-12 and 4-12weeks of age were in M-line found recording (35.0, 23.2 and 29.1, respectively). Also, it was recorded 32.9, 23.0 and 27.95 g /day for V-line during the periods from 4-8, 8-12 and 4-12 wks, respectively. These results are in agreement with the same trend obtained by Afifi *et al.,* 2000 and Iraqi, 2003.

Seasonal effect

Results in Table 2 showed non-significant (P < 0.05) change, in body weight gain, different intervals between the different seasons. The best weight gains (34.3, 23.3, and 28.80 g day) were recorded during the periods from 4 - 8, 8 - 12 and 4 - 12,wks of rabbits age in springe respectively, However the lowest weight gains, (33.3, 21.6 and 27.5g / day) during the periods from 4-8, 8-12 and 4-12 wks, respectively in summer. Afifi and Emara (1988 and 1990) attributed the differences caused by year of birth effects on post-weaning daily gain to the annual changes in climate, management, feeding and disease conditions which might vary from one year to another.

Table2. Least–square means and standard error (X±S.E) for daily weight gain of rabbits of different experimental groups as affected by studied factors.

Item	daily weight gain (g) during		
	DG4-8	DG8-12	DG4-12
Breed (B)			
V-line	32.9 ± 0.23^{b}	23.0 ± 0.18^{a}	27.95±0.23a
M-line	35.0 ± 0.24^{a}	23.2 ± 0.19^{a}	29.10±0.23a
Season (S)			
Autum	33.2±0.55a	23.3 ± 0.43^{a}	28.31±0.43a
Winter	34.0±0.31a	23.2±0.24a	28.62±0.43a
Springe	34.3±0.36a	23.3±0.28a	28.80±0.43a
Summer	33.3±0.63a	21.6±0.50b	27.50±0.43b
Parity (P)			
First	33.4 ± 0.53^{b}	23.3 ± 0.42^{a}	28.38±0.43ab
Second	34.0 ± 0.43^{ab}	23.0 ± 0.34^{ab}	28.50±0.43ab
Third	34.3 ± 0.38^{a}	23.4 ± 0.30^{a}	28.91±0.43a
Fourth	33.7 ± 0.40^{ab}	22.5 ± 0.32^{b}	28.16±0.43b
Interaction (B*S)			
V X Autum	33.0 ± 0.45b	23.5 ± 0.37a	28.30 ± 0.37b
V X Winter	33.0 ± 0.32b	23.0 ±0.25a	28.01 ± 0.37bc
V X Springe	32.4 ± 0.37b	23.5 ±0.30a	28.01 ± 0.37bc
V X summer	33.0 ± 0.62a	20.6 ± 0.50b	26.96 ± 0.37c
M X Autum	33.4 ± 0.43a	23.1 ±0.35a	28.31 ± 0.37b
M X Winter	35.3 ± 0.36a	23.4 ± 0.29a	29.43 ± 0.37a
M X Springe	36.3 ± 0.39a	23.7 ± 0.32a	29.69 ± 0.37a
M X Summer	33.5 ± 0.69b	22.8 ± 0.56b	28.17 ± 0.37b

^{a,b,c} Means with different superscript in the same column are significantly different at (P<0.05).

DG4-8, daily weight gain from 4 to 8 weeks; DG8-12, daily weight gain from 8-12 weeks; DG4-12, daily weight gain from 4 to 12 weeks of age.

Parity effect

Data presented in Table (2) showed a significant (P <0.05) difference in the body weight gains at different intervals of age. The highest body weight gain (34.3, 23.40, and 28.90 g/ day) were recorded in third parity at 4-8, 8-12 and 4-12 wks, respectively, while the lowest weight gains (33.4, 23.3 and 28.38 g/day) were recorded in first parity during the periods from 4-8, 8-12 and 4-12 wks, respectively. These results are in agreement with the same trend obtained by Abd El-Raouf (1993) and Afifi *et al.,* (1994) who revealed a general indicating that body weight at different ages increased with advance of parity till reaching its maximum at certain parity and decreased thereafter. Also, other studies revealed an inconsistent trend for the effect of parity on body weight (Khalil and Afifi1987 and Afifi *et al.,* 2000).

The Interaction between breed and season

Table, 2 results revealed a significant (P < 0.05) effect of the interaction between the breed and season on the body weight gains. The best body weight gains recorded by M-line in springe (table 2) at the periods from 4-8, 8-12 and 4-12 wks, respectively) and the lowest weight gains were observed in the V-line breed in summer (table 2) during the periods from 4-8, 8-12 and 4-12 wks, respectively. These findings are consistent with that observed in some previous investigations (Afifi *et al.,* 2000 and Abd El-Halim, 2003.).

Litter traits
Litter size
Effect of breed

Table, 3 showed no significant (P < 0.05) effect in the litter size at birth due to the breed genotype. The highest LSB (6.6) was found in M-line, while the lowest (6.3) was observed in V-line. However breed effect has highly significant effect on LSW. M-line had the higher LSW (6.03) compared with V- line which showed the lowest litter size.

Significant (P<0.05) difference was indicated in the number of mortality at weaning between the different breeds. The highest value was 1.04 in M-line and the lowest (0.96) was observed in V-line. The litter size varied from 5.26 to 5.62. Previous studies emphasized the breed effect on the litter size (Enab *et al.,* 2000 and Iraqi *et al.*, 2010). This effect might be attributed to the higher ovulation rate, better milk secretion and lower pre-weaning mortality rates as well as the suitability of environmental conditions for some breeds more than others (El-Badawy, 2004). the experiments on or the investigation on NZW, Gabali rabbits and their crosses (Abd El-Aziz, 1998), NZW and CAL rabbits (Afifi *et al.,* 2000) and with NZW and Baladi Red rabbits (Abd El-Halim, 2003), revealed that there were a significant (p < 0.01) effect, for season of kindling on the kindling interval and the insemination period.

Seasonal effect

Table 3 in the showed a significant (P<0.05) difference in the LSB and LSW due to season. The highest value appeared in summer (6.8 and 6.1) and the lowest in summer and autum (6.3 and 5.5). Insignificant (P<0.01) difference in the LSW was observed between the different seasons. This finding came in agreement with that reported by Abdel-Azeem, 2007 where in Baladi Red the highest LSW was recorded in January.

This may be due to the favorable climatic and nutritional conditions as well as to the high milk yield produced during winter months (Khalil, 1993; Pascual *et al.*, 1996 and Abou Khadiga, 2004). The number of mortality at weaning, significantly difference between the different by seasons. The values varied from 0.78 to 1.17. May-June may be attributed to effects of the high ambient temperature that results in a reduction in the quantity of feed consumption of does (Sallam *et al.,* 1999 and Garcia *et al.,* 2000). From the previously mentioned results it could be stated that the season of kindling is considered one of the most important non-genetic factors affecting productive rabbit does (El-Maghawry, 1999). Many studies suggested that the effect of season of kindling on litter size is a reflection to the climatic seasonality as well as to the availability and quality of diets (Youssef, 1992; Abd EL-Aziz, 1998 and Garcia *et al.,* 2000).

Table 3. Effect of breed, season and parity on litter size at birth (LSB), litter size at weaning (LSW), and mortality at weaning (MORT.), in rabbits.

Item	LSB	LSW	MORT
Breed (B)			
V-line	6.3±0.17[a]	5.31±0.16[b]	0.96±0.14[ab]
M-line	6.6±0.18[a]	6.03±0.17[a]	1.04±0.12[a]
Season (S)			
Autum	6.4±0.40[b]	5.5±0.39[b]	0.88±0.14[a]
Winter	6.8±0.23[a]	6.1±0.22[a]	0.78±0.11[a]
Springe	6.6±0.26[a]	5.6±0.25[b]	0.97±0.12[a]
Summer	6.3±0.46[b]	5.5±0.45[b]	1.17±0.12[b]
Parity (P)			
First	6.4±0.39[a]	5.6±0.38[a]	0.87±0.21[b]
Second	6.6±0.31[a]	5.5±0.30[a]	1.11±0.21[a]
Third	6.6±0.28[a]	5.7±0.27[a]	0.83±0.23[b]
Fourth	6.3±0.29[a]	5.7±0.28[a]	0.85±0.18[b]
Breed* Season(B*S)			
V X Autum	6.0 ± 0.34[b]	5.2 ± 0.33[b]	0.9±0.28[b]
V X Winter	6.7 ±0.24[ab]	5.9 ± 0.23[b]	0.07±0.18[c]
V X Springe	6.4 ±0.28[ab]	5.2 ± 0.27[b]	0.65±0.20[b]
V X summer	6.2 ± 0.47[b]	5.6 ± 0.45[b]	1.12±0.23[a]
M X Autum	6.6 ±0.33[ab]	5.9 ± 0.31[ab]	1.1±0.18[ab]
M X Winter	7.5 ± 0.27[a]	6.9 ±0.26[a]	1.82±0.19[b]
M X Springe	6.4 ± 0.30[ab]	5.8 ±0.29[ab]	1.6±0.20[a]
M X Summer	6.5 ± 0.53[b]	5.2 ± 0.51[b]	1.75±0.17[a]

a ,b, …c Means with different superscript with the main factor B, S , P and their interaction are significantly different (P≤ 0.05) Values are expressed in means ± SEM. LSB, litter size at birth , LSW, litter size at waning, Mort, Mortality rate.

Parity effect

Data presented in Table (3) indicated that non-significant (P <0.05) differences in the LSB and LSW were observed between the different parity. The highest values showed in the second and third parity for LSB and the third and fourth parity of LSW. This finding came in agreement with that reported by Youssef (1992); Abd El-Raouf (1993) and Afifi *et al.* (1994) who revealed a general trend indicating that body weight at different ages increased with advance of parity till reaching its maximum at a certain parity and decreased thereafter. Also, other studies revealed an inconsistent trend for the effect of parity on body weight (Khalil *et al.*, 1987; Tag El-Din *et al.*, 1992 and Afifi *et al.*, 2000). Khalil *et al.* (1993) reported that changes with parity are mostly a reflection of the efficiency of the dam as a mother especially those associated with sustained ability of the lactating dam to suckle her young until weaning.

The effect Interaction between breed and season

The Interaction between breed and season are presented in (table, 3) revealed a significant (P < 0.05) effect on the LSB and LSW and the number of mortality at weaning. The highest value of LSB and at weaning appeared with the M-line in winter (7.5 & 6.9, resp.) and the lowest values were observed with the V-line in autumn (6.0 & 5.2, resp.). Interaction effect between breed x season showed significant effect on mortality rate at weaning, the lowest averages of mortality rate was observed in V- line x winter (0.70 %), While the highest value was observed in M-line X winter (1.82%), when compared with different interaction applied. These findings came in agreement with some previous studies indicating the presence of a curvilinear relationship with season of kindling where the litter size seems to decrease during the autumn and increase during the winter and spring and then decrease again during the summer in relation to the breed difference (Ahmed, 1997 and Enab *et al.*, 2000). On the other hand, the present study came in disagreement with some previous investigations reported that the season of kindling does not significantly affect litter size expressed by LSB, LSW and LWW for the different breeds (Abou-Khadiga, 2004 and Badr et al., 2016).

Litter weight

Effect of breed

As shown in (table, 4), the present study revealed a highly significant (P < 0.05) difference in the LWB and LWW between the different breeds. The heaviest weight at birth came with the M-line (629 g) and the lowest weight with the V-line breed (443 g), whereas, the highest LWW appeared with M-line (3793 g) and the lowest with the V-line (3107 g). Breed effect has significant effect on kindling interval. The higher value was observed in V-line (46.0 days).while the lower value was obtained by M-line (42.7d).These findings came in agreement with some previous investigations of (Enab *et al.,* 2000;) they indicating that the performance of doe was better in some breeds like NZW rabbits than those of local breed. Blasco *et al.* (1992) and Khalil, (1993) attributed the superiority of NZW rabbits over Cal ones for litter weights to the difference in the ovulation rate, uterine capacity, milk production, and maternal behavior...etc. It can be attribute the improvements of LWB and LWW in V-line rabbit does to the high thyroid activity of this breed. However, the present study came in disagreement with few previous investigators found that the LWB and LWW was not significantly affected by breed (EL-Attrouny and habashy 2020).

Table 4. Effect of breed, season and parity on litter weight at birth (LWB), at weaning in rabbits (LWW) and Kindling interval (KI).

Items	LWB (g)	LWW (g)	KI (days)
Breed (B)			
V-line	443±16.8[b]	3107±103[b]	46.0±1.1[a]
M-line	629±17.6[a]	3793±108[a]	42.7±1.1[b]
Season (S)			
Autum	550.1±39.4[a]	3119±242[b]	44.6±2.6[a]
Winter	558.4±22.4[a]	3588±137[a]	43.8±1.5[a]
Springe	504.8±25.7[a]	3680±157[a]	44.6±1.7[a]
summer	529.5±25.2[a]	2758±277[b]	46.0±3.0[a]
Parity (P)			
First	524±38.1[a]	3085±38.1[a]	43.9±2.5[a]
Second	540±30.7[a]	3495±30.7[a]	43.7±2.0[a]
Third	535±27.2[a]	3365±27.2[a]	45.1±1.8[a]
Fourth	521±28.8[a]	2987±28.8[a]	45.1±1.9[a]
Breed* Season(B*S)			
V X Autum	417± 33[c]	2795±207[cd]	44.6 ± 2.2[a]
V X Winter	477± 23[c]	3286±144[c]	46.3 ± 1.6[a]
V X Springe	417± 27[c]	3361±170[c]	46.0 ± 1.8[a]
V X summer	432± 45[c]	2300 ±282[d]	47.2 ± 3.0[a]
M X Autum	669±31[ab]	3410 ±197[abc]	44.7 ± 2.1[a]
M X Winter	717± 26[a]	3983±165[ab]	40.5 ± 1.8[b]
M X Springe	603± 29[b]	4038± 180[a]	43.0 ± 1.9[a]
M X Summer	598±51[b]	3330±315[c]	44.8 ± 3.4[a]

[a ,b, …c] Means with different superscript with the main factor (breed and season)and their interaction are significantly different (P>0.05) Values are expressed in means ± SEM.

Effect of season

The present study (Table, 4) show a significant (P < 0.05) change in the LWB and at weaning was observed between the different seasons. At birth, the litter weight varied from 504.5g in spring to 558.4 g in winter, while at weaning, it varied from 2758 g in summer to 3680g in winter. Such difference in the litter weight between birth and weaning might be related to changes in nutrition during winter (green food), climate of summer as well as to differences in losses during month of suckling period (Afifi and Khalil, 1990 and Youssef, 1992).The majority of investigators indicated that the lowest performance was observed during the summer season, while the highest values of litter weight and mean bunny weight at different ages were recorded in autumn and winter seasons (Enab *et al.,* 2000, Abd El-Aziz *et al.,* 2002 and Saleh *et al.,* 2005). Generally, the dissimilarity among seasons in litter weight traits could be attributed to the decreased feed intake, depression of thyroid activity and hence in the metabolic rate of pregnant does during hot summer months affected litter weight and mean kit weight at birth negatively (Abdel-Azeem *et al.,* 2007).

Parity effect

Data presented in Table (3) showed that insignificant (P <0.05) differences in the LWB, LWW and KI were found due to parity. The heaviest values appeared in the second parity (540.0 and 3495g) and the lowest in the fourth parity (521and 2987g, respectively). This findings came in agreement with that reported by Youssef (1992); Abd El-Raouf (1993) and Afifi *et al*. (1994) who revealed a general trend indicating that body weight at different ages increased with advance of parity till reaching its maximum at a certain parity and decreased thereafter. Also, other studies revealed an inconsistent trend for the effect of parity on body weight (Afifi *et al.,* 1990; Hanna, 1992; Tag El-Din *et al.,* 1992 and Afifi *et al.,* 2000). Khalil *et al.* (1993) reported that changes with parity are mostly a reflection of the efficiency of the dam as a mother (especially those associated with sustained ability of the lactating dam to suckle her young until weaning).

The interaction between breed and season

Data presented in (table, 4) revealed a highly significant (P < 0.05) effect of the interaction between breed and season on the LWB, at weaning and kindling intervals (Table, 4). The highest LWB appeared with the M-line in winter (717 g) and the lowest appeared with the V -line breed in springe (417g), whereas the highest LWW was shown in the M-line breed in springe (4038g) and the lowest in the V-line in summer (2300 g).This finding came in accordance with some previous investigations (Enab *et al.,* 2000; Afifi *et al.,* 2000; Abou Khadiga, 2004). It has been reported that, in cross breeding group (BB x VL), the best performance was obtained in autumn with insignificant differences from winter on LWB, while, seasonal effects had no significance on the rest of litter weight traits (Saleh *et al.,* 2005).

Conclusion

The findings of this study clearly show that genotype, parity, and season have a major effect on rabbit live body weight and litter traits. Based on present research, it can be concluded that M- line had the highest values of live body weight and litter traits compare to V-line rabbits. Variation in growth rate of rabbit within the same breed or among different breeds could be attributed to environmental factors such as nutrition, season, parity order and management. Similarly, individual birth weight decreases with increase in litter size and rabbit kits of larger litters also showed a lower weight at weaning than the corresponding weight for kits of smaller litters.

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الملخص العربي

هدفت الدراسة الحالية علي دراسة تأثير التركيب الوراثي وموسم الميلاد وترتيب البطن على صفات الخلفة ووزن الجسم في خطين من الارانب خط ارانب الفي لاين (V–line) وخط ارانب مشتهر (M–line) . تم استخدام عدد ستة آلاف وثلاثة مائه (6300 ارنب) في هذة الدراسة إنتجت من 300 أم و 100 ذكر لدراسة صفات وزن الجسم عند عمر 4 و 8 و 12 أسبوع من العمر. حجم الخلفة عند الميلاد (LSB) وحجم الخلفة عند الفطام في 28 يومًا بعد الولادة (LSW) ، وزن الخلفة عند الميلاد (LWB) ، وزن الخلفة عند الفطام 28في يومًا بعد الولادة (LWW) ، معدل الوفيات وفترات الولادة. أظهر تأثير التركيب الوراثي تفوقاً معنوياً (0.05 >P) لسلالة مشتهر لصفات وزن الجسم في جميع الفترات مقارنة بسلالة الفي لاين . كما أظهر تأثير الموسم اختلافا معنوياً (0.05 >P) في صفات وزن الجسم في الاعمار المختلفة. تم تسجيل أثقل وزن للجسم للأرانب في موسم الربيع ، بينما سجل أقل وزن جسم في الصيف. أشار تأثير ترتيب البطن إلى وجود فروق معنوية (0.05 >P) في وزن الجسم في الفترات المختلفة من العمر. تم تسجيل أثقل وزن للجسم في البطن الثالثة ، بينما سجل أقل وزن للجسم في البطن الأولي. وبالمثل ، إظهرت الدراسة الحالية عن فروق معنويه (0.05 >P) في حجم الخلفة عند الميلاد والفطام ، ووزن الخلفة عند الميلاد والفطام بين التركيب الوراثي وموسم الميلاد وترتيب البطن . يمكن الاستنتاج أن خط ارانب مشهر M–line كان لها أعلى قيم لوزن الجسم وصفات الخلفة مقارنة بأرانب الفي لاين V–line. تشير نتائج الدراسة الحالية إلى أن أرانب خط مشتهرM–line ستكون أكثر إنتاجية وكفاءة إنجابية من خط أرنب الفي لاين V–line في ظل الظروف البيئية المصرية. لذلك ، يقترح الباحثون أن قياس وزن الجسم وصفات الخلفة في الأعمار المبكرة يمكن أن يكون مؤشرًا جيدًا ودقيقًا لأداء النمو في M–line.