Evaluation of productive performance in synthetic maternal line (APRI rabbits) under Egyptian conditions.

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Research Article

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Evaluation of productive performance in synthetic maternal line (APRI rabbits) under Egyptian conditions.

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ABSTRACT

Synthetic lines have been developed in hot climate countries over the last few decades through selection for specific goals such as APRI rabbits, and depending on their specialisation, these lines perform better than the standard of the original breeds, and contemporary production tends to rely on them. The aim of the study was to identify and explain genetic parameters in synthetic maternal line (APRI rabbits) under Egyptian conditions. (**DFREML**) was used to assess data on body weights (BW) at 4, 8, and 12 weeks, also daily gains (DG) at 4-8, 8-12 and 4-12 weeks. Highest heritability (h^2) estimate for BW was at 4 weeks (0.10), while the lowest estimate was at 12 weeks (0.03). The highest estimate (0.08) was for h^2 of DG at 4-8 weeks, while the lowest estimate was for DG at 8-12 weeks (0.02). All genetic correlations (r_g) between BW at different ages were moderate to high and positive; estimates of r_g for DG ranged from low to high and were positive, with the exception of -0.84 between 4-8 and 8-12 weeks. BW and DG at different intervals had significance and the highest value in the first parity. BW and DG were significantly different in different seasons (P <0.05), with the highest value in the autumn. Significant differences in BW owing to litter size at birth (LSB) (P<0.05). Moreover, LSB had a significant impact on DG at 8-12 and 4-12 weeks, but not at 4-8 weeks.

Key Words: APRI line rabbits; heritability; genetic and phenotypic correlations; parity; season; litter size at birth.

INTRODUCTION

The APRI line was established by mating Baladi Red (BR) bucks to V line does, resulting in F1, F2, and F3 generations, with selection beginning at this generation (**Youssef et al., 2008**). Synthetic lines have been developed in hot climate countries during the last few decades through selection for specific goals (**Youssef et al., 2008 and Khalil, 2010**). These lines perform better than the standard of the original breeds, depending on their specialisation, and contemporary production tends to rely on them. The degree of selection, heritability, and standard deviation of the traits are all directly linked to the response to selection (**Falconer and Mackay 1996**). One of the key factors determining the profit function is post-weaning average body weights and average daily increase. Understanding post-weaning body weights and growth is critical. Although the rabbit's pre-weaning environment and genotype have an impact on post-weaning growth performance. It also has a significant impact on performance. Various genetic and non-genetic variables such as parity, season and litter size at birth influence a rabbit's post-weaning growth. To estimate genetic parameters for examined traits without bias in predictions, environmental effects must be considered in the model analysis (**Amira El-Deghadi, 2005**). Changes in heritabilities estimations between researches can be related to differences in study design, rabbit breeds maintained under certain environmental conditions for a set amount of time and the length of time, the size of the data, and the statistical methodologies utilized all play a role (**El-Zanfaly, 1996**). The implementation of a typical litter animal model is effective for partitioning phenotypic variations due to direct additive genetics.and environmental consequences inside litter (residual) (**Yossef et al., 2009**). Quantitative techniques are used in animal genetic improvement programmes to aid the selection of the finest animals based on their breeding values in order to genetically improve their production and reproductive efficiency **Amira El-Deghadi, (2019).** The goal of this study was to evaluate and explain genetic parameters such as heritability, common litter effect, genetic and phenotypic correlations, and breeding value in synthetic maternal line (APRI rabbits) under Egyptian conditions, as well as to determine fixed effects such as parity, season, and litter size at birth.

Materials and Methods

APRI line a maternal line rabbits are an improved line rabbit breed bred at the Animal Production Research Institute's Gemmayzeha experimental rabbitery (APRI). APRI line data on body weight at 4, 8, and 12 weeks, as well as daily gains at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks, was collected during three seasons (autumn, winter, and spring). Breeding does and bucks were housed separately in single-tier batteries with feeding and mechanical nipple drinkers in individual welded wire cages. At 25 days after fruitful mating, rabbit doe houses were equipped with nest boxes. The rabbits were all fed the same commercial pelleted diet, which contained 18% protein, 2.39 percent crude fat, and 12.8 percent crude fiber. Water and food were available throughout the day. Four weeks after kindling, the litter was weaned. Before each kindling, the cages of the entire group of animals were cleaned and disinfected on a regular basis. Throughout the study, animals were given the same medications and were kept under the same management and environmental circumstances.

Statistical and analysis

APRI line data was collected on 666 bunnies from 130 does and 17 sires. Starting with the mixed model procedure (Co) variance matrix, the REML method of the VARCOMP procedure of SAS, 2003 was used to create the REML variance matrix for each of the analyzed traits. The more accurate and trustworthy estimates of multi trait animal model variance and covariance components were estimated using these beginning values. The Derivative Free Restricted Maximum Likelihood Animal Model (**DFREML**) of **Boldman, (1995)** was used to assess data on body weight at 4, 8, and 12 weeks, as well as daily gains at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks. The model used to analyse the data included fixed effects like as parity, season, and litter size at birth, as well as additive genetic and common litter effects (as random effects).

The animal model employed was as follows:

$$y = X_b + Z_a u_a + Z_c u_c + e.$$

Where:

where y = vector of observations on animal for body weight at 4, 8, and 12 weeks, as well as daily gains at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks, b = vector of fixed effects including parity (3 levels), season (3 levels) and litter size at birth and (7 levels); u_a = vector of random additive genetic effects of the animal for the i^{th} trait; u_c = vector of random common litter effect (doe-parity combination); e = vector of random error; X, Z_a and Z_c are incidence matrices relating records of i^{th} trait to the fixed, random animal and random common litter effects; respectively. **MTDFREML** evaluates also the proportions of additive genetic effects (heritability; h^2_a, common litter effects (c^2), and error (e^2). The heritability in the narrow sense (h^2_a) is computed as: $h^2_a = (\sigma^2_a / \sigma^2_a + \sigma^2_c + \sigma^2_e.)$ Where: σ^2_a = additive genetic variance, σ^2_c = common litter variance, and σ^2_e = error variance.

Breeding values (BV), standard error (SE), and accuracy ranges (RI)

The same software uses the (co)variances matrix derived via **MTDFREML** analysis to forecast breeding values, their accuracies (r_{Ai}), and standard errors SE_{Ai}. The BLUP accuracies for each subject were calculated using Henderson's equation (**Henderson, 1973**).

Results

Heritability

Estimates of heritability for body weights and daily gains at dfferet ages ranged from 0.03 to 0.10, with the highest estimate for body weight at 4 weeks (0.10) and the lowest estimate for body weight at 12 weeks (0.03). As well as the highest estimate was for daily gains at 4 to 8 weeks (0.08) and the lowest estimate was for daily gains at 8 to 12 weeks (0.02) in Table 1.

Table 1 shows heritability (h^2), common litter effect (c^2), and error (e^2) estimates for body weight (BW) at 4, 8, and 12 weeks, as well as daily gains (DG) at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks of APRI rabbit, with standard errors.

Traits	h^2 ± SE	c^2 ± SE	e^2 ± SE
BW4	0.10 ± 0.09	0.47 ± 0.06	0.42 ± 0.07
BW8	0.04 ± 0.08	0.31 ± 0.06	0.66 ± 0.06
BW12	0.03 ± 0.09	0.36 ± 0.07	0.61 ± 0.06
DG4-8 weeks	0.08 ± 0.10	0.34 ± 0.06	0.58 ±0.07
DG8-12 weeks	0.02 ± 0.06	0.25 ± 0.05	0.73 ± 0.05
DG4-12 weeks	0.07 ± 0.10	0.34 ± 0.06	0.59 ± 0.07

Common-litter effect (c^2)

The common litter impact of weaning body weight was higher (0.47) than that of an elderly. As the rabbits grew older, it gradually decreased to 0.31 and 0.36. c^2 of daily gains at 4 -8, 8-12 and 4-12 weeks were moderate, with ranging from 0.25, to 0.34 in Table 1.

Genetic correlations (r_g)

All genetic correlations between body weights at different ages were moderate to high and positive, with 0.27 between body weights at 4 weeks and 8 weeks, 0.84 between body weights at 8 weeks and 12 weeks, and 0.44 between body weights at 4 weeks and 12 weeks. Estimates of r_g for daily gain ranged from low to high and were positive, with the exception of -0.84 between DG4-8 and DG 8-12 weeks in Table 2.

Table 2 shows genetic (r_g), common-litter (r_C), environmental (r_e) and phenotypic (r_p) correlations estimates for body weight (BW) at 4, 8, and 12 weeks, as well as daily gains (DG) at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks of APRI rabbit, with standard errors.

Traits	**r_g ± SE**	**r_c ± SE**	**r_e± SE**	**r_p**
BW4 & BW8	0.27 ± 0.99	0.59 ± 0.99	0.74 ± 0.05	0.62
BW8 & BW12	0.84 ± 0.57	0.81± 0.06	0.56 ± 0.04	0.67
BW4 & BW12	0.44 ± 0.90	0.40 ± 0.12	0.21 ± 0.09	0.31
DG4-8 & DG8-12	-0.84 ± 0.10	-0.18 ± 0.16	-0.37 ± 0.05	-0.33
DG4-8 & DG4-12	0.64 ± 0.92	0.57 ± 0.11	0.40 ± 0.04	0.46
DG8-12 & DG4-12	0.13 ±0.11	0.64 ± 0.10	0.69 ± 0.03	0.64

Common-litter correlations (r_C)

The common litter correlation (**r_C**) estimations were moderate to high and positive, with 0.59, 0.81 and 0.40 between body weights at 4 weeks and 8 weeks, between body weights at 8 weeks and 12 weeks, and between body weights at 4 weeks and 12 weeks respectively. **r_C** estimations were high and positive, with 0.57 and 0.64 between DG4-8 and DG 4-12 weeks and between DG8-12 and DG 4-12 weeks but were negative with, -0.18 between DG4-8 and DG 8-12 weeks in Table 2.

Phenotypic correlations (r_p)

Table 2 shows that all feasible phenotypic correlations estimated among different body weights were positive and moderate to high, with 0.62, 0.67, and 0.31 between body weights at 4 weeks and 8 weeks, 8 weeks and 12 weeks, and 4 weeks and 12 weeks, respectively. r_p estimations were also moderate to high and positive, with 0.46 and 0.64 between DG4-8 and DG 4-12 weeks and between DG8-12 and DG 4-12 weeks, respectively, but negative with -0.33 between DG4-8 and DG 8-12 weeks.

Environmental correlations (r_e)

Table 2 reveals that the estimations of environmental correlations were moderate to high and positive, with 0.74, 0.56, and 0.21 between body weights at 4 weeks and 8 weeks, 8 weeks and 12 weeks, and 4 weeks and 12 weeks, respectively. The re estimates were moderate to high and favorable, with 0.0.40 and 0.69 between DG4-8 and DG 4-12 weeks and DG8-12 and DG 4-12 weeks, respectively, but negative with -0.37 between DG4-8 and DG 8-12 weeks.

Breeding value

The breeding values and accuracy ranges for body weight at 4, 8, and 12 weeks, as well as daily gains at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks, are shown in Table 3.

Table 3 shows the breeding values (BV), standard error (SE), and accuracy ranges (RI) for body weight (BW) at 4, 8, and 12 weeks, as well as daily gains (DG) at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks in the APRI rabbit.

Traits	**Min**			**Max**			**Range**		
	BV	**SE**	**RI**	**BV**	**SE**	**RI**	**BV**	**SE**	**RI**
BW4	-105.39	54.82	0.33	115.33	72.40	0.70	220.72	17.58	0.37
BW8	-33.42	33.60	0.17	35.66	37.45	0.47	69.08	3.85	0.30
BW12	-23.44	30.69	0.13	20.55	32.69	0.37	43.99	2.00	0.24
DG4-8 weeks	-1.56	1.27	0.24	2.12	1.50	0.57	3.68	0.23	0.33
DG8-12 weeks	-0.94	0.90	0.18	0.98	1.06	0.45	1.92	0.09	0.27
DG4-12 weeks	-0.72	0.88	0.14	0.14	0.94	0.38	1.43	0.06	0.24

Parity effect

Table 4 shows that the variations in body weight in different intervals were highly significant ($P < 0.05$), with the largest value of body weight in the first parity (455.56, 1064.57, and 1871.03 g at 4, 8, and 12 weeks, respectively). The first parity's distinction may be related to the small number of litters in it, which causes weight increase. As well as, in the first parity, the largest averages and significant daily gains were between 4 and 8 weeks and 4 to 12 weeks (21.75 and 25.28), respectively, but the effect of parity was not significant between 8 and 12 weeks.

Season effect

In different seasons, body weights at 4, 8, and 12 weeks of age were significantly different ($P < 0.05$), having the highest body weight value in the autumn (460.60, 1091.31, and 1879.70 g at 4, 8, and 12 weeks, respectively). The biggest averages and significant daily gains in the autumn were between 4 and 8 weeks and 4 to 12 weeks (22.5 and 25.34, respectively), but the largest averages in the winter were between 8 and 12 weeks (29.96) in Table 4.

Table 4 shows the actual means and standard errors (SE) for body weight (BW) at 4, 8, and 12 weeks, as well as daily gains (DG) at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks, as influenced by parity, season, and litter size at birth of APRI rabbit.

The effects	BW4	BW8	BW12	DG4-8	DG8-12	DG4-12
	Means ± SE	**Means ± SE**	**Means ± SE**	**Means ± SE**	**Means ± SE**	**Means ± SE**
Parity						
1	455.56 ± 4.65^{a}	1064.57 ±10.80^{a}	1871.03 ± 12.34^{a}	21.75±0.32^{a}	28.80±0.36	25.28±0.19^{a}
2	448.58 ± 4.83^{a}	992.58 ± 11.2^{b}	1817.62 ± 12.82^{b}	19.43±0.33^{b}	29.47±0.37	24.45±0.20^{b}
3	413.06 ± 5.14^{b}	931.11 ± 11.97	1745.76 ± 13.66^{c}	18.50±0.35^{b}	29.09±0.39	23.80±0.2^{c}
Season						
Autumn	460.60 ± 5.09^{a}	10.91.31 ±11.68^{a}	1879.70 ± 13.39^{a}	22.52±0.34^{a}	28.15±0.38^{a}	25.34±0.21^{a}
Winter	445.31 ± 4.05^{b}	983.20 ± 9.30^{b}	1821.94 ± 10.74^{b}	19.21±0.27^{b}	29.96±0.31^{b}	24.58±0.16^{b}
Spring	404.77 ± 5.80^{c}	918.20 ± 13.32	1719.90 ± 15.38^{c}	18.33±0.39^{b}	28.63±0.44^{b}	23.49±0.24^{c}
Litter size at birth						
≥ 4	482.81 ±12.76^{a}	1056.41 ±31.04^{ab}	1835.63 ± 34.42^{a}	20.49±0.91	27.83±0.97^{c}	24.16±0.53^{b}
5	475.6 ± 9.56^{a}	1025.96 ±23.26^{ab}	1866.66 ± 25.79^{a}	19.64±0.68	30.22±0.72^{ab}	24.84±0.39^{ab}
6	448.46 ± 7.08^{b}	1014.38 ±17.22^{ab}	1860.53 ± 19.09^{a}	20.20±0.50	30.21±0.54^{a}	25.21±0.29^{ab}
7	450.44 ± 6.21^{b}	1013.19 ±15.11^{ab}	1815.23 ± 16.76^{a}	20.10±0.44	28.64±0.47^{ab}	24.37±0.25^{ab}
8	433.08 ± 6.36^{bc}	1004.30 ±15.46^{ab}	1847.05 ± 17.14^{a}	20.38±0.45	30.09±0.48^{ab}	25.24±0.23^{a}
≤ 9	418.33 ± 4.99^{c}	967.77 ± 12.14^{b}	1757.56 ± 13.46^{b}	19.63±0.36	28.21±0.38^{c}	23.92±0.21^{b}

Litter size at birth effect

The differences in body weight due to litter size at birth were significant (P < 0.05), with the maximum body weight values for 4 to 6 litter (482.81, 1056.41, and 1866.66) at 4, 8, and 12 weeks, respectively, and decreasing with large litters. In addition, the influence of litter size at birth was significant for daily gains between 8 and 12 weeks and 4 to 12 weeks, but not for daily gains between 4 and 8 weeks in Table 4.

Discussion

Heritability

Low heritability values for body weights at 4, 8, and 12 weeks, also daily gains at 4-8, 8-12 and 4-12 weeks. Crossbreeding across breeds or lines, rather than selection, might be a superior strategy to improve growth traits, according to this view. This result in present study close to **Amira El-Deighadi, (2005)** who found the heritability estimate of body weight was higher at younger ages of 4 and 8 weeks (0.23 and 0.15, respectively) than at later ages of 12 weeks (0.00). Heritability estimates between 4 and 8 weeks of age are moderate. These moderate heritability estimates suggest that at 4 and 8 weeks, the response to body weight selection is promising. Individual weight does not appear to be a good selection trait due to weak heritability estimates. Heritabilities for post-weaning daily gain throughout various intervals were estimated to be quite low, ranging from 0.02 to 0.09. **Elmin et al., (2011),** who found that in the first generation of Sudanese rabbits, estimates of heritability based on paternal half sib analysis ranged from 0.211 to 0.372 for body weight at different ages (6 to 15 weeks). The heritability estimates for the second generation ranged from 0.085 to 0.295 for body weight at different ages (6 to 15 weeks), indicating that they were low to moderate. **Minguez et al., (2015),** reported heritability estimates for weaning weight, slaughter weight, and average daily gain were 0.07 ± 0.00, 0.19 ± 0.00, and 0.21 ± 0.00, respectively. The small marginal posterior standard deviations were notable; this was due to the large number of records. **Amira El-Deighadi and Ibrahim (2017)** they reported at 4, 6, 8, 10, and 12 weeks of age, heritability estimates for body weights were low to moderate, ranging from 0.13 to 0.20. Heritability estimates for growth rate during the study periods were low and inconsistent, ranging from 0.06 to 0.13. **Amira El-Deighadi and Ibrahim (2018)** they reported, individual body weight at 4, 6, 8, 10, and 12 weeks of age was estimated to be 0.06, 0.18, 0.26, 0.11, and 0.10. **Abdel-Kafy et al., (2021)** reported heritabilities estimates for body weights and relative growth rate were generally moderate and ranged from 0.10 to 0.24. **Rym Ezzeroug et al., (2020)** revealed that heritability estimates for growth traits were low, with 0.033 for weaning weight and 0.059 for fattening period weight. As well as my results are lower than those of **Intear Ali (2021)** found that the heritability values for body weight at weaning, weight at slaughter and daily growth from weaning to slaughter weight in V line rabbits were 0.46, 0.32, and 0.43. On other hand **Ajayi et al., (2014)**, reported the estimated heritability for individual body weight at weaning and at 12 weeks was 0.02 ± 0.05 and 0.46 ± 0.26, respectively. He suggests that variances from other results could be due to differences in genotypes, geography, environmental factors, and sample sizes. **Garcia and Argente (2020)** reported on a wide variety of heritability estimations

(0.03 to 0.48 for weaning weight and 0.06 to 0.67 for slaughter weight). The heritability estimates for growth rate, on the other hand, show a narrow range (0.12 to 0.34) and a moderate average value (0.22).

Common-litter effect (c^2)

Weaning body weight had a greater impact on the common litter than that of an elder. It gradually decreased as the bunnies grew older, indicating that rabbits began to demonstrate their genetic capabilities; also, its variations are increasing, while maternal influences are decreasing. As well as the common litter effect for daily gains at 4 to 8 weeks, 8 to 12 weeks, and 4 to 12 weeks were moderate. This result correspond with those of **Amira El-Deighadi and Ibrahim (2017)** they reported, in comparison to later age, c^2 of body weight at weaning was higher (0.69). It slowly decreased as individuals grew older 0.54, 0.44, 0.37 and 0.32 at 6, 8, 10 and 12 weeks of age. Between weaning weight and 6 weeks, the c^2 of growth rate were larger than all other times. **Amira El-Deighadi and Ibrahim (2018)** they reported the estimate of c^2 when compared to the phenotypic variance for body weight at weaning was larger than at other ages, indicating that common-litter effects at weaning are highly variable. The greater estimate was attributed to litters being nursed by the same dam and reared in the same cage, as well as a rapid decrease in the maternal or common-litter effect as the animals got older. At 4, 6, 8, 10, and 12 weeks of age, the percentages were 74 percent, 46 percent, 34 percent, 41 percent, and 35 percent, respectively. Also the common little influence of body weight and relative growth rate were big as weaning then progressively dropped as the rabbit grew older at 20 weeks of age, according to **Abdel-Kafy et al., (2021)**. On other hand the common litter effect, according to **Minguez et al., (2015),** includes factors related to each female's pregnancy and birth, such as uterine environment, milk production, and maternal behavior, but not the litter size in which each rabbit was born, as this effect was included as a covariate in the model. In rabbits, a significant portion of phenotypic variation in growth and feed efficiency is a result of environmental factors connected to the dam or the litter; hence the estimates for $\mathbf{c^2}$were larger than the heritability estimate. Also **Rym Ezzeroug et al., (2020)** showed that the common environmental effect of litter (c^2), which was 0.636 for weaning weight and 0.381 for fattening phase weight, explained the majority of phenotypic variance.

Genetic correlations (r_g)

Generally all genetic correlations between body weights and daily gains at different ages were moderate to high. The genetic correlations among growth traits suggest that selection can be utilised at any stage of the post-weaning phase because improving body weight at any stage leads to improvements in growth traits at later stages. This conclusion is consistent with the range of reviewed estimates obtained by **Amira El-Deighadi, (2005)** showed all the probable genetic associations between body weight at different ages were determined to be low or high and positive, r_g estimates for post-weaning daily gain were generally low, moderate, or high, and all were positive. **Elmin et al., (2011)** found the genetic correlations among the growth traits in the first generation were all positive, however were low to moderate between weights at younger ages, but rather high between weights at older ages. These correlations, on the other hand, were often high in the second generation. According to **Ajayi et al., (2014),** genetic correlations with weekly body weight from birth to week 12 ranged from low (0.09) to very high (1.00). **Amira El-Deighadi and Ibrahim (2018)** they found r_g estimates ranged from 0.37 to 0.91 for all conceivable genetic correlations between body weights at different ages. **Rym Ezzeroug et al. (2020)** showed that the genetic correlations for weight at weaning were positive and highly correlated with weight at slaughter (0.611). Also the genetic connections between growth parameters, according to **Garcia and Argente (2020),** are positive and highly correlated with weight at slaughter, ranging from 0.61 to 0.74. The genetic association between growth rate and weight at slaughter is stronger than the genetic correlation between growth rate and weight at weaning (0.56 vs. 0.31).

Common-litter correlations (r_C)

Between body weights at different ages, the common litter correlation (r_C) values were generally moderate to high and positive. Between daily gains at different ages, r_C estimations were high and positive.These conclusions are in agreement with **Amira El-Deighadi (2005)** revealed that correlations between body weight and daily body increase were usually positive and moderate to high in magnitude. These estimations ranged from 0.85 to 0.94 for body weight records and 0.41 to 0.94 for daily growth records. **Amira El-Deighadi and Ibrahim (2018)** they reported all of the possible genetic correlations between body weights at different ages were positive, with r_C estimates ranging from 0.53 to 0.94 for the majority of them. They suggested obtaining unbiased estimates of genetic, phenotypic, and environmental correlations, common environmental influences must be incorporated in the model of estimation of variance and covariance components.

Phenotypic correlations (r_p)

All phenotypic correlations that could be assessed between different body weights and daily gains at different ages were found to be positive and moderate to high. In reality, in the current studies, moderate or high and positive estimations of phenotypic correlation between body weights and daily gains at different ages give rabbit breeders a significant benefit in their culling decisions and management. This conclusions are in agreement with **Amira El-Deighadi (2005)** found that the r_P between records of different post-weaning body weights and daily rise at various age stages was mainly positive and of moderate to high amplitude. Estimates r_P varied from 0.63 to 0.82 between records of post-weaning body weights, and from 0.42 to 0.89 between records of post-weaning daily growth. **Elmin et al.,**

(2011) reported in both generations, the phenotypic correlations between growth traits were high (> 0.5). According to **Amira El-Deighadi and Ibrahim (2018**), r_p between bodies weights at different ages were positive, moderate to high magnitude, and ranging from 0.48 to 0.82. **Rym Ezzeroug et al. (2020)** showed that the phenotypic correlations for weight at weaning were positive and highly correlated with weight at slaughter (0.631).

Environmental correlations (r_e)

Environmental correlations between body weights and daily gains at various ages were estimated to be moderate to strong and positive. Some estimates of r_G and r_E are different in magnitude, or even in sign, from others. Genetic and environmental sources of variation affect the characters through different physiological mechanism (**Falconer, 1989**). A large difference, and particularly a difference in signs, showed that there is a genetic and environmental source of variation in these characters. This conclusion is consistent with the range of reviewed estimates obtained by **Amira El-Deighadi (2005)** observed that the estimates of re between various body weights were high and positive. Estimates of re ranged from 0.55 to 0.93 for body weight records and 0.46 to 0.87 for post-weaning daily gain records. **Elmin et al., (2011)** showed the environmental influences on both generations' growth features positive and extremely high (approaching one). **Amira El-Deighadi and Ibrahim (2018)** found that re estimations were moderate to high, positive, and ranged from 0.21 to 0.82 between body weight records.

Breeding value

The breeding values for body weights and daily gains at various ages were lower than those reported by **Hanaa et al., (2014)**, for weaning weight, slaughter weight, and daily weight gain, the ranges of transmitting ability for all animals measured for growth traits were 512, 878, and 22.4, respectively. At 4, 6, 8, 10, and 12 weeks of age, **Amira El-Deighadi and Ibrahim (2017)** found that estimations of all progeny breeding values for body weight varied from -0.244 to 0.389, -0.245 to 0.362, -0.259 to 0.346, -0.195 to 0.235, and -0.233 to 0.265 g, respectively. At 4, 6, 8, 10, and 12 weeks of age, the ranges of breeding values declined (0.633, 0.607, 0.605, 0.403, and 0.498 g, respectively). Furthermore, their accuracy was great. Variations in breeding values can lead to the correct culling decision and the selection of the best rabbits from those with high estimations of breeding values for growth traits.

Parity effect

The differences in body weight between intervals were very significant (P < 0.05), with the first parity having the highest value of body weight. The first parity's distinction may be related to the small number of litters in it, which causes weight increase. In addition, the greatest averages and significant daily improvements were found between 4 and 8 weeks and 4 to 12 weeks in the first parity, while the effect of parity was not significant between 8 and 12 weeks.

Unlike **Desouky et al., (2021)**, who found extremely significant (P < 0.05) changes in body weight across age intervals; this is the finding i obtained. The third parity had the heaviest body weight at 4, 8, and 12 weeks, and body weight gain at 4-8, 8-12 and 4-12 weeks respectively. In the first parity, the lowest body weight and body weight gain at 4-6, 6-12 and 4-12 weeks were recorded. **Intear Ali, (2021)** found that the parity order was shown to be significantly (P≤0.05) affecting weaning weight, slaughter weight, and daily gain from weaning to slaughter weight in V line rabbits, the parity effect revealed a propensity for weaning weight to increase until the sixth parity. On the other hand, **Hanaa (2014)** noted that the parity order, had no significant effect on most rabbit post-weaning growth traits.

Season effect

Body weights at 4, 8, and 12 weeks of age were significantly varied (P < 0.05) in different seasons, with the maximum body weight value in the autumn. In the autumn, the largest averages and significant daily improvements were between 4 and 8 weeks and 4 to 12 weeks, whereas in the winter, the largest averages were between 8 and 12 weeks. This could allude to the quantity and nutritional worth of the available greens at the time of use, as well as the moderate weather experienced throughout these months. Through the quantity and quality of directly ingested food usage throughout the post-weaning period, these variables may have an effect on rabbit weaning weight, amount of milk provided by suckling dams, and growth performance at later ages. These results in agreement with **(El-Maghawry *et al.,* 1999; Soliman *et al.,* 1999; Enab *et al.,* 2000 and Amira El-Deghadi, 2005)**. On other hand **Desouky et al., (2021)** found a substantial change in body weight due to the seasons impact at all measurement periods. Rabbits had the heaviest live body weights in the spring, while the lightest live body weights were observed in the summer. While there was no statistically significant difference in body weight gain between seasons, there was a non-significant difference in body weight gain across seasons. In the spring, the best weight growth were reported at 4 8, 8-12, and 4-12 weeks of age, respectively. In the summer, the lowest weight gains were recorded during 4-8, 8-12, and 4-12 weeks of age, respectively. **Intear Ali, (2021)** reported weaning weight, slaughter weight and daily growth from weaning to slaughter weight in V line rabbits were significantly varied (P≤0.001) in different months, For weaning weight, slaughter weight, and daily gain, the lowest averages denote rabbits born in July and August, while the highest averages denote rabbits born in November, March, and March.

Litter size at birth effect

There were significant differences in body weight owing to litter size at birth (P < 0.05), with the maximum body weight values for 4 to 6 litters and decreasing with bigger litters. Furthermore, litter size at birth had a significant impact on daily increases between 8 and 12 weeks and 4 to 12 weeks, but not between 4 and 8 weeks. These findings correspond with those of **Amira El-Deghadi (1996)**, who found that litter size had a highly significant effect on body weight at 8 and 12 weeks in New Zealand White and Californian rabbits, and that less weight was connected to larger litter size. As a result, the effect of litter size on kindling must be addressed while making selection decisions. In every age group, **Szendroe et al. (1996)** found a negative connection between litter size and body weight (3, 6, 10 and 12 weeks). They also found that the size of the litter at birth had a minor impact on male body weight at 16 weeks of age. From 12 to 16 weeks of age, the litter size had no effect on daily gain, according to the same author. Body weight and daily increase of rabbit's breastfed in tiny litters were maximum until a particular litter size was reached (≤ 4 or 5 for N-line; ≤ 7 for Z-line and ≤ 6 for G-line) and thereafter reduced. With V Line rabbits, **Ghada, (2018)** observed that those born in large litters have lower body weight at weaning than those born in small litters. According to **Intear Ali, (2021)**, there were highly significant differences ($P \le 0.001$) in body weight at weaning between litter sizes born a live (BW4). There was a clear trend that BW4 decreased as the number of kits born alive increased. There were also significant differences in body weight at slaughter (BW9) between the various litter sizes born alive, with rabbits raised in litters of 8 kids having the best BW9 and those raised in litters of ≥10 bunnies having the lowest.

Conclusion

Because body weights and daily growth have low heritability values, crossbreeding between the same lines or different breeds, rather than selection, may be a better strategy to improve body weights and daily gains. Since the APRI line rabbit contains 50% Egyptian strain (Baldi Red) genes that are more acclimated to Egyptian climatic conditions and 50% V Line, a maternal line that was selected for litter size at weaning. It may cross with Baldi Red or V Line again in order to benefit from their features. Moderate or high and positive estimations of phenotypic correlation between body weights and daily gains at different ages give rabbit breeders a significant benefit in their culling decisions and management.

The most important non-genetic parameters impacting body weights and daily gains were parity, season, and litter size at birth. As a result, these effects must be taken into account in the model analysis in order to estimate genetic parameters for the traits being researched without biassing predictions.

Declarations

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Data availability The writing author declares database availability and sends a request to the related writers for any query. We ask that you contact the author for access to and consultation of supplemental information (databases).

Author contribution Nabila Elsiad Mahmod Elkassas; Mervat Mahmoud Mahmoud Arafa and Mohammed Ibrahim abd El-Naby Seif El-Naser collated the data and Amira Soliman El-Deghadi performed statistical analysis of the data, also prepared and reviewed the research. The final manuscript was read and approved by all contributors.

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