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PERFORMANCE OF 3 RABBITS STRAINS AND THEIR RECIPROCAL CROSSES IN EGYPT DURING SUMMER.

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ABSTRACT : The present work was conducted to study the performance of 3 rabbits strains: New Zealand White (NZW), Baladi Black (BB) and Baladi Red (BR) and 4 of the reciprocal crosses between NZW and Baladi rabbits, during hot summer of Egypt. Values of litter size at birth, weaning (28 days) and marketing ages (84 days) did not differ significantly as affected by genotype, sex or the interaction between them. Mortality values of offspring from birth to weaning age differed significantly (P<0.01) among the 7 genetic types and NZWxNZW showed the lower value (5.4%), while BRxBR showed the highest value (41.1%). They were no significant differences for mortality from weaning to marketing age due to the effect of genotype, sex or interaction between them. Kit weight at birth was significantly higher (P<0.05) for crossbreds (72 to 78g) than purebreds (48 to 54g), the same trend was realized at marketing age, except for BBxBB group. Significant (P<0.05) interaction between genotype and sex was shown for kit weight at birth, females of BBxNZW cross showed the highest kit weight at birth (80 g). Male kits significantly (P<0.05) surpassed the female kits in marketing live weight at 12 weeks of age (1420 *vs* 1357 g). The difference between purebred and crossbred groups in the average daily gain was statistically significant (P<0.05) from birth to weaning age (0-28 days). Reciprocal crosses between NZW and BB were of heavier daily gain than that of the reciprocal crosses between NZW and BR. From weaning to marketing age (28-84 days), daily gain of the crossbred groups was superior (17.5 to19.4g/day) and the liveweight heavier than that of the purebred ones (14.1 to 16.4g/day). Positive superiority for the studied crosses was observed for the litter size at weaning, mortality rate from birth to weaning, live weight at birth and weight gain from weaning to marketing age.

RESUME : Performances de croissance de 3 souches de lapins et de leurs croisements réciproques pendant l'été en Egypte.
Ce travail a pour objet d'étudier les performances de 3 souches de lapins : Néo-zélandais blancs (NZW), Baladi Noir (BB) et Baladi Rouge (BR) ainsi que 4 des croisements réciproques impliquant les NZW dans des conditions estivales en Egypte. Le génotype, le sexe ou l'interaction entre les souches n'influencent pas de manière significative la taille de la portée à la naissance, au sevrage (28 jours) ou à l'âge commercial (84 jours). Le taux de mortalité de la naissance au sevrage varie entre les 7 génotypes (P<0,01) et les lapereaux NZWxNZW ont le taux le plus bas (5,4%) tandis que les sujets BRxBR ont le taux le plus élevé (41,1%). Pour la mortalité entre le sevrage et l'âge commercial, il n'y a pas de différences significatives dues à l'effet du génotype, du sexe ou de leur interaction. Le poids des lapereaux à la naissance est significativement plus élevé (P<0,05) pour les croisements (72 à 78g) que pour les races pures (48 à 54g) ; on note la même tendance à l'âge commercial sauf pour le groupe BBxBB. Il existe une interaction significative (P<0,05) génotype-sexe sur le poids à la naissance des lapereaux, les femelles issues du croisement BBxNZW ayant le poids à la naissance le plus élevé (80g). Le poids des lapins mâles dépassent significativement (P<0,05) celui des femelles à l'âge de 12 semaines (1420 vs 1357g). La différence entre les lapins de race pure et les croisements est significative (P<0,05) en terme de gain de poids moyen de la naissance au sevrage (0-28 jours). Les croisements réciproques entre NZW et BB donnent des vitesses de croissance avant sevrage plus fortes que les croisements réciproques entre NZW et BR. Du sevrage à l'âge commercial (28-84 jours) le gain de poids et le poids vif des lapins issus de croisement sont supérieurs à ceux des lapins de races pures. La supériorité des performances des lapins croisés est démontrée pour la taille de la portée au sevrage, le taux de mortalité entre la naissance et le sevrage, le poids vif à la naissance et le gain de poids du sevrage à l'âge commercial.

INTRODUCTION

In Egypt as in other developing countries, to import buildings and/ or cages is very expensive and to control the environment is more difficult than in temperate climates. As a consequence it is frequent that productivity is not such to permit successful economical results (FINZI, 1987 and 1988). In tropical countries hot climate impairs reproduction (MORERA *et al* 1990 and KUSMINSKY *et al.*, 1990). Mating is even not performed during a period of about three months (AFIFI *et al.*, 1992) with the result to reduce the productivity per doe. Cyclic variation in the physiological reactions of rabbits is induced by diurnal variation of climatic temperature (FINZI, *et al.*, 1994). Exposure of rabbits to a high temperature increases the heat load on animals. Above 35°C rabbits can no longer regulate their internal temperature and heat postration sets in (LEBAS *et al.*,1986). Growth traits in growing rabbits are important because heavier marketable body weight constitutes the economics of rabbit farms. Breed crossing generally provides offspring with heavier weight at marketable age. The percent superiority depends on the magnitude of non-additive genetic variation in a trait (NAGPURE *et al.*, 1991).

The present work was undertaken to study the performance of 3 rabbits strains: one exotic NZW and two coloured local BB and BR and their reciprocal crosses: NZWxBB, BBxNZW, NZWxBR and BRxNZW as single crosses, under the thermal waves and thermal fluctuations of the hot Summer season in Egypt.

MATERIALS AND METHODS

This work was carried out at Sakha Experimental Rabbitry, Kafr El-Sheikh, Middle Delta, belonging to the Animal Production Institute, Egypt.
Data of 261 kits (132 males and 129 females) which survived from birth up to marketing age (84 days), and

Table 1.: Averages (x ± S.E.) of pre- and post-weaning traits of 3 rabbit strains and their reciprocal crosses.

		Purebreds			Crossbreds			
Male x Female		**NZWxNZW**	**BBxBB**	**BRxBR**	**NZWxBB**	**BBxNZW**	**NZWxBR**	**BRxNZW**
Traits²								
Number of litters		17	10	10	14	10	14	13
Litter size (alive) at :								
Birth:	*total*	*4.41±0.38*	*6.10±0.80*	*5.60±0.67*	*6.14±0.38*	*5.10±0.55*	*4.93±0.27*	*5.08±0.29*
Weaning:	males	2.06±0.18	2.50±0.27	1.60±0.27	2.64±0.32	2.10±0.48	2.07±0.34	2.15±0.32
	females	2.12±0.28	1.60±0.34	1.70±0.33	3.00±0.28	2.30±0.42	2.00±0.38	2.00±0.32
	total	*4.18±0.41*	*4.10±0.43*	*3.30±0.49*	*5.64±0.51*	*4.40±0.75*	*4.07±0.46*	*4.15±0.53*
Marketing	males	1.88±0.15	1.70±0.21	1.20±0.25	1.71±0.40	1.50±0.40	1.64±0.37	1.62±0.33
	females	1.53±0.21	1.30±0.26	1.20±0.33	1.93±0.32	1.70±0.42	1.00±0.30	1.15±0.42
	total	*3.41±0.29*	*3.00±0.26*	*2.40±0.40*	*3.64±0.50*	*3.20±0.70*	*2.64±0.48*	*2.77±0.63*
Mortality rate % from:								
Birth-weaning:	*total*	*5.4^{C} ±3.6*	*32.8^{AB}±10.9*	*41.1^{A} ±8.4*	*8.1^{C} ±3.7*	*13.7^{C} ±7.3*	*17.4^{BC} ±6.7*	*18.1^{BC}±6.9*
Weaning-marketing:								
	males	11.7±6.8	28.0±8.4	25.0±10.0	37.9±10.6	28.6±12.9	34.3±15.5	25.1±12.6
	females	25.2±8.1	25.0±13.8	29.4±12.9	33.3±8.7	43.5±15.9	35.5±11.0	42.5±11.0
	total	*23.2±6.0*	*26.8±10.0*	*27.3±8.5*	*35.5±6.4*	*27.3±10.7*	*35.1±10.4*	*33.5±10.1*
Total number of kits:		58	30	24	44	32	37	36
Live weight (g) at:								
Birth	males	54^{ef} ±1	47^{f} ±2	57^{de} ±1	73^{abc} ±1	75^{abc} ±1	69^{c} ±2	76^{abc} ±1
	females	53^{ef} ±1	49^{ef} ±2	52^{ef} ±1	72^{abc} ±3	80^{a} ±1	74^{abc} ±2	76^{abc} ±1
	total	*54^{C}±1*	*48^{D}±2*	*54^{C}±1*	*73^{B}±2*	*78^{A}±3*	*72^{B}±1*	*76^{AB}±1*
Weaning	males	505±16	542±11	349±14	433±19	470±22	323±20	324±16
	females	511±18	526±10	328±14	425±21	466±24	348±15	342±34
	total	508^{A}±12	535^{A}±7	339^{D}±10	429^{C}±14	468^{B}±16	335^{D}±12	332^{D}±17
Marketing	males	1392±27	1501±21	1223±44	1429±76	1455±66	1455±66	1480±90
	females	1244±34	1400±31	1030±39	1561±70	1447±90	1447±90	1337±110
	total	*1321^{B}±24*	*1454^{A}±20*	*1126^{C}±35*	*1504^{A}±52*	*1451^{AB}±56*	*1393^{AB}±56*	*1421^{AB}±71*
Daily weight gain(g)								
Birth-weaning:	males	16.1±1.6	17.6±2.0	10.4±2.0	12.9±2.0	14.1±2.5	9.1±2.6	8.9±1.6
	females	16.4±1.0	17.0±2.2	9.9±1.9	12.6±1.8	13.8±2.4	9.8±1.6	9.5±2.3
	total	*16.3^{AB}±1.1*	*17.4^{A}±1.5*	*10.2^{CD}±14*	*12.7^{BCD}±1.3*	*14.0^{ABC}±1.7*	*9.4^{D} ±1.3*	*9.1^{D}±1.3*
Weaning-marketing:								
	males	15.8±3.2	17.1±4.7	15.6±4.3	17.8±4.1	17.6±4.7	19.6±3.8	20.6±3.8
	females	13.1±1.2	15.6±4.8	12.5±3.7	20.3±3.8	17.5±4.5	18.1±3.8	17.8±4.4
	total	*14.5±2.2*	*16.4±3.3*	*14.1±2.8*	*19.2±2.8*	*17.5±3.2*	*18.9±2.5*	*19.4±2.8*

d A, B, C, D and F : means in the same row differ significantly (P<0.01 and 0.05) between genotypes.
a,b,c,d,e and f : means in the same columns and rows (interaction) differ significantly (P<0.05).

were produced from 88 litters in the summer season (June, July and August) of the year 1995 were used. The average minimum and maximum daily temperature ranged from 23-30 °C in June, 25-30.6 °C in July and 26-31.7 °C in August *vs* 50.8-82.5%, 61.9-94.2% and 64.4-99.4% relative humidity, respectively. However, some thermal waves from time to time (30-40 °C for 7-10 days, each) and the thermal fluctuations during day and night (40-20 °C) take place always during Summer season.

The breeding rabbits in the present work represent 7 genetic groups including New Zealand White (NZW) as an exotic standard breed, and Baladi Black (BB) and Baladi Red (BR) as two native colored purebreds and reciprocal crosses between the NZW and the Baladi Black and between the NZW and the Baladi Red to produce 4 colored single crosses.

All animals were subjected to the same experimental conditions. The feed was a commercial pelleted diet with 17.6% crude protein, 11.8% crude fibre, 2630 kcal digestible energy and 2.2 ether extract/ kg diet (for the lactating does) and with 16.0% crude protein, 10.5% crude fibre, 2700 kcal digestible energy and 2.7 ether extract/ kg diet (for the bucks, non lactating does and weaned rabbits up to marketing age). Rabbits were fed *ad libitum* as nursers or growers and water was provided fresh and clean through an automatic system. Animals were housed in metallic battery cages of a commercial type and a nest box was provided for each doe. The rabbits were housed in a closed housing system with windows representing 40% of the house area under natural ventilation system. Does which failed in pregnancy were remated 12 days after the last mating. Young rabbits were weaned at 4 weeks of age.

Litter size at birth, then sexwised at weaning (28 days) and at marketing age (84 days) were recorded. Mortality as percentages were recorded from birth to weaning and from weaning to marketing. The growth characters were measured as birth weight, individual weight at weaning and at marketing for males and females, live and daily weight gain from 0-28 days, 28-84 days were also recorded and calculated.

The method of analysis of variance according to SNEDECOR and COCHRAN (1982) was used only for the surviving rabbits at marketing age. The following model was used:

$$Y_{ijk} = \mu + B_i + S_j + BS_{ij} + e_{ijk}$$

where:

- Y_{ijk} = an observation,
- μ = the overall mean,
- B_i = effect of breeds or their crosses (i=1-7),
- S_j = effect of sex (j= 1-2),
- BS_{ij} = effect of interaction between genetic type and sex
- e_{ijk} = random error

Differences among means within the same trait were tested by using DUNCAN's New multiple range test (1955).

Superiority percentages were estimated for single crossbred over the average of the two involved purebreds according to the following equation:

$$\text{Percent superiority} = 100 \times \frac{\text{crossbred value} - \text{purebreds average}}{\text{purebreds average}}$$

RESULTS AND DISCUSSSION

Litter size:

Values of litter size at birth, weaning and marketing ages did not differ significantly as affected by genotype, sex or the interaction between them (Table 1). Although the feed intake was *ad libitum* for either breeding does or growing rabbits, the loss of appetite and more drinking water accompained by the absence of the proper ventilation as a result of heat stress may be suspected causes for the lower litter size at the different ages for the native and exotic purebreds and their reciprocal crosses. Available results on litter size reviewed from the literature for Egyptian rabbits were ranged from 6.5 to 5.4 at birth and from 5.5 to 4.3 at 5 weeks for Baladi Red, Baladi White, Baladi and Giza White (YAMANI, 1990), while for NZW exotic breed averaged 7.05 at birth and 5.59 at weaning (EL-MAGYAWRY *et al.*, 1988 and YAMANI, 1990). The litter size of the NZW was lower than the finding of EL-KELAWY (1993) at birth and at weaning at the summer season of Sharkiyah Governorate. Average litter size for male and female kits were nearly similar at weaning and marketing age (Table 2).

Table 2 : Average (x ± S.E.) of pre- and post-weaning traits of male and female rabbit kits.

Traits	Male Kits	Female kits
Litter size (alive) at:		
weaning age	2.17 ± 0.09	2.14 ± 0.13
marketing age	1.64 ± 0.12	1.41 ± 0.12
Mortality rate (%) from:		
weaning - marketing	27.2 ± 4.2	31.3 ± 3.7
Live weight (g) at:		
birth age	64 ± 1	65 ± 1
weaning age	413 ± 13	431 ± 10
marketing age	1.420^a ± 24	1.357^b ± 28
Daily weight gain (g):		
birth - weaning	12.9 ± 0.8	13.1 ± 0.8
weaning - marketing	17.8 ± 1.5	16.5 ± 1.5

* This means regardless of breeds and crossbreds.
a,b means in the same row differ significantly (P<0.05).

Mortality rate:

Table 1 shows that means of mortality differed significantly (P<0.01) among purebred and crossbred genetic groups from birth to weaning age (0-28 days). and the highest percentage (41.1%) was recorded for BRxBR. NZWxNZW purebred group showed lower mortality rate from birth to weaning and from weaning to marketing age than the other genetic groups. In this respect, mortality rate from birth to weaning age showed lower, but not significant values for the males than the females (Table 2).

Live weight:

Concerning the interaction between genotype and sex, male and female kits at birth were significantly (P<0.05) of the lightest live weights for the purebred groups if compared to that of the crossbred ones (Table 1). At weaning age (28 days), male and female kits of the purebred groups showed heavier (but not significant) live weight than the corresponding of the crossbreds except the PRxPR purebred group which was of light live weight. At marketing age (84 days) the crossbred males performed better than the purebred ones except BB group and the females of the crossbreds were heavier too than the purebred groups as well. Purebred BBxBB male kits and crossbred NZWxBB

Table 3.: Superiority (%) of crossbred over purebred rabbits.

Traits		Crossbreds			
		NZWxBB	BBxNZW	NZWxBR	BRxNZW
Litter size (alive) at :					
Birth	total	+ 16.8	- 2.95	- 1.5	+ 1.5
Weaning	males	+ 15.8	- 7.8	+ 13.1	+17.5
	females	+ 61.3	+ 23.7	+ 4.7	+ 4.7
	total	+ 36.2	+ 6.3	+ 8.8	+ 11.0
Marketing age	males	- 4.5	- 16.2	+ 6.5	+ 5.2
	females	+ 36.4	+ 20.1	- 26.7	- 15.8
	total	+ 13.6	- 0.2	- 9.1	- 4.6
Mortality rate % from :					
Birth-weaning	total	- 57.4	- 28.4	- 25.0	-22.1
Weaning-marketing	males	+ 91.1	+ 44.1	+ 87.2	+ 37.1
	females	+32.8	+ 3.59	+30.0	+ 53.8
	total	+ 56.7	+ 20.5	+ 53.8	+ 46.6
Live weight (g) at :					
Birth age	males	+ 43.1	+ 47.1	+ 23.2	+ 35.7
	females	+ 41.2	+ 56.9	+ 39.6	+ 43.4
	total	+ 43.1	+ 52.9	+ 33.3	+ 40.7
Weaning age	males	- 16.4	- 10.3	- 24.4	- 24.1
	females	- 18.1	- 10.2	- 16.5	- 18.0
	total	- 17.8	- 10.3	- 21.0	- 21.7
Marketing age	males	- 12.4	+ 0.5	+ 8.6	+ 13.1
	females	+18.1	+ 9.5	+ 20.0	+ 17.6
	total	+ 8.4	+ 4.5	+ 13.8	+ 16.1
Daily weight gain (g) :					
Birth-weaning	males	- 23.9	- 16.9	- 31.7	- 33.3
	females	- 24.6	- 17.5	- 25.3	- 27.7
	total	- 24.4	- 17.0	- 28.6	- 30.7
Weaning-marketing	males	+ 7.9	+ 6.6	+ 24.7	+ 31.2
	females	+ 41.3	+ 22.0	+ 42.0	+ 38.6
	total	+ 24.2	+ 13.4	+ 32.1	+ 36.0

female ones were heavier in marketing weight (12 weeks), and the purebred BRxBR male and female kits were of the lightest live weight at the same age. Results of Table 2 shows that males significantly ($P<0.05$) surpassed females in marketing live weight. As early as of the fifties, the literature cited revealed that mean birth weight for rabbits raised in Egypt, were similar to that of the present study (EL-KHESHIN *et al.*, 1951 ; RAGAB and WANIS, 1960) and in close agreement with those reported by CARREGAL (1983), WELLEKE *et al.* (1983) and NAGPURE *et al.* (1991), but were lighter than the findings of AFIFI *et al.* (1987). At weaning age (84 days), the live weight was similar in the present study to the findings reported by NAGPURE *et al.*, (1991), but lighter than that of CARREGAL (1983), LUKEFAHR *et al* (1984) and MACH (1987).

Generally, crossbred kits showed significant ($P<0.05$) more rapid growth during post-weaning period than purebred ones (Table 1). These results agree fairly with the results of WELLEKE *et al.* (1983), NAGPURE *et al.* (1991) and RASHWAN *et al.* (1995). However, contrary to the present findings, NIEDZWIADEK and KAWINSKA (1984) reported in Poland heavier marketing live weight for purebreds *vs* crossbreds.

Weight gain:

Daily weight gain from birth to weaning age (0-28 days) differed significantly ($P<0.05$) due to the effect of genotypes (Table 1). Purebred males and females exceeded that of the crossbred ones except that of the BRxBR groups which was of light weight gain.

The reciprocal crosses between NZW and BB exhibited significantly ($P<0.05$) heavier weight gain than the reciprocal crosses between NZW and BR. From weaning to marketing (28-84 days), the weight gain of the crossbred groups was superior than purebred ones. Concerning the post weaning weight gain, it seems that the tolerance of the crossbreds under the hot climate is higher than that of the purebreds. In general, the male kits exceeded the female ones from weaning to marketing age in the average weight gain (Table 2).

Superiority:

Superiority percentage for litter size, mortality rate and growth traits at birth, weaning and marketing ages were calculated (Table 3). Positive superiority was observed for the litter size at weaning, mortality rate from birth to weaning, live weight at birth and marketing and weight gain from weaning to marketing age for studied crosses. These results agree with those of TAG EL-DIN *et al.* (1992). Negative effects were observed for litter size at birth when NZW female were sired with BB or when NZW males sired the BR females. At marketing age the NZW and BB males showed negative superiority when sired the BB or the NZW females while BR and NZW females showed negative values when sired with the NZW or the BR females. Table 3 shows that superiority percentages were varied between the various crossbreds. The highest superiority percentages for litter size was at weaning for both males and females of NZW and BB reciprocal crosses reflecting the existence of non-additive genetic effects to maintain more youngs than purebreds in the hot climate of summer season at this age. Also, weight gain from weaning to marketing age may assure that the positive superiority values reflecting non additive genetic effects improve the weight gain of crossbreds at later ages than the purebreds in the summer season of Egypt in spite of the thermal waves and the thermal fluctuations.

CONCLUSION

It could be concluded that the traits studied in the present study were pronouncely affected by the thermal waves and thermal fluctuations in summer season of Egypt. The litter size were lower, the mortality rate were higher and the growth traits were poor at birth, weaning and marketing ages. Both the purebred and the crossbred groups were adversely affected. Meanwhile, crossbred were relatively better than purebred groups in their performance.

It was recommended to pay attention to the housing system which may be industrialized in tropical and subtropical countries and be efficient in environmental thermoregulations and proper ventilation and insulation, otherwise, the economics of the rabbitry will be deteriorated. It is worth to note that under an unsuitable housing system, it is better to stop mating during the Summer season (June, July and August). Exploitting non-additive genetic effect, the NZW may be reciprocally crossed with Baladi Black.

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