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ADAPTIVE AND REPRODUCTIVE PERFORMANCE OF RABBITS. 1- RESPONSE TO SEASONAL CONDITIONS

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SUMMARY

Twenty two adult female rabbits (11 New Zealand White, NZW and 11 Egyptian Baladi Red, BR) were used to study the performance of does under summer and winter conditions in Egypt, South Delta region. The does average age and body weight were 9 months and 3.0 Kg resp.. The animals were maintained under the usual normal nutritional status. The responsiveness of the two breeds to seasonal variation were greatly different, NZW had higher respiration rate, body temperature and mortality rate in summer either barren, pregnant or lactating. Winter was the favorite season for both breeds, however NZW adaptive response and reproductive performance exceeding BR. NZW showed greater changes under winter conditions in hematological parameters (Hb, PCV and RBCs), T_3, T_4 and P_4 levels, with more drop in summer than BR. Litter size, survival rate and daily milk production in both breeds had higher values in winter than in summer in the first and second parities. Body weight gain of BR bunnies showed less seasonal difference than NZW bunnies. The reproductive merits of the NZW was particularly apparent in litter size.

Keywords: Rabbits, seasonality, adaptation, reproduction

INTRODUCTION

Breeding domestic rabbits in Egypt is traditionally confined to the period from September to April while

stopped in summer months to avoid the low reproductive performance and high mortality rate of kindlings in this season. The environmental factors responsible of the drastic decline of the reproductive potentialities of the does during summer are attributed, by several authors, to a complex of factors, particularly high ambient temperature and low plane of nutrition especially lack of green fodder.

Many investigators found positive correlation between ambient temperature and thermo-respiratory responses, respiration rate being the most sensitive physiological response to heat stress (Kamer et al., 1970 ; Shafie et al., 1970 and 1982 and Wolfenson and Orlyblum 1988). Weisbroth et al. (1974) found that the highest Hb values and RBCs count were in spring. They also reported that the highest levels of Hb and RBCs were found at eight in the morning and the lowest in late afternoon and evening. The levels of T_3 and T_4 were declined in hot weather (Oloufa et al., 1951 and Mahmoud, 1993).

Seasonal fluctuations affect rabbit's productivity and reproductivity, through successive physiological activities of ovulation, implantation, gestation, litter size, bunny weights and mortality rate, as well as milk production (Hafez and Rajakoski, 1964; Sittmann et al., 1964; El-Fouly et al., 1977; Boyd and Myhill, 1987; Khalil and Mansour, 1987 and Yamani et al., 1991). Sittmann et al. (1964) found that all reproductive traits of rabbits were at the lowest levels in 4 months of the year (June, July, August and September). They concluded that conception rate exhibited a highly significant seasonal trend being more in spring and low in autumn, total litter size at birth, and number born alive per litter, decreased consistently from spring to a low level in September. They found also,that the monthly proportion of stillbirths closely paralled the changes in maximum temperature. Hafez and Rajakoski (1964) found that the highest values of ovulation rate were recorded in winter (13.4°C) and spring (20.3°C) and the lowest were those in summer and autumn (27.1°C). El-Fouly et al. (1977) found that the number of ova recovered per doe in winter (6.4) and spring (7.9) was higher than that for summer (5.4) and autumn (3.6). They also found that mean number of implantation sites per doe was higher in spring (9.5) and winter (7.6) and low in autumn (6.2) and summer (5.2). In Egypt, many

investigators found that the lowest values of viable embryos, litter size at birth, litter weight at birth and at weaning and milk yield were recorded in summer (El-Fouly et al., 1977; EL-Maghawry et al., 1988; Sallam et al., 1989 and Yamani et al., 1991). On the other hand the highest percentages of stillbirth and preweaning mortality were found in spring and summer (Yamani et al., 1991).

This work was carried out to determine the extent of decline in adaptive and reproductive performance in summer, in Egypt, in comparison between the native Egyptian rabbits and the exotic breed the New Zealand White.

MATERIALS AND METHODS

Twenty two adult female rabbits (11 New Zealand White, NZW and 11 Egyptian Baladi Red, BR) were used to study the performance of does under summer and winter conditions. These does were divided into two groups, (5 NZW and 5 BR) in summer and (6 NZW and 6 BR) in winter. The does average age and body weight were 9 months and 3.0 Kg resp.. The animals were maintained under normal nutritional status, ad. lib. green Berseem (Trifolium alexandrinum) in winter but berseem hay in summer alongside pelleted concentrate.

This study was continued for 8 months, 4 months for each season from June till March including the post-pubertal 1st and 2nd parities. Rabbits were raised in semiclosed rabbitry and housed separately in individual wiredcages in two rows along the rabbitry. Body temperature and respiration rate were recorded once daily for each doe at morning (8-9 a.m.). Air temperature (AT) and relative humidity (RH) were recorded simultaneously with measuring physiological responses. The average body weight of the offsprings was recorded by weighing the animals collectively for the litter after suckling three times a week, until 4 weeks of age. The daily milk yield of each doe was determined till 30 day post-partum by the difference in weight of the litter before and after suckling. Blood samples were collected from the marginal ear vein at morning (8-9 a.m.) to avoid diurnal variation in the blood picture as stated by Thompson and Proctor (1984). Blood samples were taken from each doe at three times, one week before

mating, at the 15th day post-coitum and one week after parturition. RBCs ($10^6/mm^3$), Hb (g/100ml) and PCV (%) were determind. Progesterone (P_4), Triiodothyronine (T_3) and Thyroxine (T_4) were determined by using RIA technique (Pantex, santa Monica, U.S.A.).

Data were statistically analyzed using SAS (1990).

RESULTS AND DISCUSSION

There was great seasonal difference in air temperature (AT),while there was no appreciable difference in relative humidity (RH). The average maximum and minimum temperature in both seasons were 32.0 and 24.5°C in summer versus 15.0 and 6.0°C in winter.

A. Adaptive Response

1. Body temperature

Body temperature of New Zealand White (NZW) rabbits was higher by 0.3°C in summer than in winter during gestation and lactation stages (Table 1). The Baladi Red (BR) rabbits showed less elevation in summer than in winter in comparison with (NZW). The seasonal differences during most of gestation and lactation stages were significant in the 1st and 2nd parities.

2. Respiration rate

Respiration rate was elevated under summer conditions by highly significant rate in the first and second parities during gestation and lactation in NZW and BR rabbits (Table 1). Animals showed greater increase in respiration rate due to summer conditions during gestation than during lactation with greater extent in NZW rabbits. The overall mean of respiration rate of BR was increased by 103.6 and 97.5 breath/min. during gestation in the first and second parities resp. This increment was 93.9 and 60.8 breath/min during lactation in the first and second parities, resp., due to hot summer conditions (Table 1). Wolfenson and Orlyblum, (1988) outlined that respiration rate in pregnant rabbits was increased from 149 to 215 breath/ min. due to raising ambient temperature from 21°C to 33.6°C. In non sweating animals like rabbit the respiration rate goes up enormously by 5-6 % for each 4°C increase in air temperature in order to increase heat dissipation by water vaporization (Brody, 1945). Shafie et al. (1970)

found that when air temperature increased two folds from winter to summer, respiration rate increased by 70% of its winter average. The local breed (BR) had lower respiration rate than (NZW) in winter at any case of physiological status, thus it has better chance of exersizing more increase in RR in summer than NZW with still lower rate (Table 1). This breed difference was particularly clear during pregnancy and lactation. It was observed that the BR depilated more of the hair coat for nesting thus diminishing the barrier of heat dissipation from body surface consequently less need of dissipation through respiratory water vaporization.

Table 1. Seasonal changes in body temperature (BT) and respiration rate (RR) of NZW and BR for two consecutive parities during one week before gestation (B.G), gestation (G.) and lactation (L.) as affected by season

	Season	NZW			BR		
		B.G	G.	L.	B.G	G.	L.
BT	Winter	39.05	39.05	39.25	39.10	38.95	39.10
	Summer	39.30	39.35	39.55	39.15	39.20	39.25
	W/S	00.99	00.99	00.99	00.99	00.99	00.99
RR	Winter	81.90	93.70	108.50	78.00	82.60	91.20
	Summer	166.20	188.50	193.30	181.10	183.40	168.60
	W/S	0.50	0.50	0.56	0.43	0.45	0.54

3. Hematological response

Hematological parameters were significantly decreased due to summer condition at any physiological status in NZW (Table 2). These findings were in agreement with Mahmoud (1993). In both breeds the Hb concentration (g/dl) was almost the same at all reprodctive stages, with slight drop in summer (around 10 %) in BR versus greeter drop (25 %) in NZW. PCV % and RBCs count were decreased significantly ($P<0.05$) only in NZW (Table 2). It can be concluded that the hematological parameters (Hb, PCV and RBCs) were greater in NZW than BR particularly in winter.

Table 2. Seasonal changes in hematological parameters (PCV, RBCs & Hb) in barren (B), lactating (L) and at midterm of gestation (G) in NZW and BR rabbits (Means±SE)

Status season	PCV % NZW	PCV % BR	RBCs $10^6/mm^3$ NZW	RBCs $10^6/mm^3$ BR	Hb g/dL NZW	Hb g/dL BR
	**					
Winter	38.9^{b}±0.6	31.5 ±0.6	4.29^{b}±0.01	3.50 ±0.08	12.3^{b}±0.1	10.9 ±0.4
B Summer	29.4^{a}±0.7	30.7 ±1.0	3.48^{a}±0.03	3.40 ±0.10	9.7^{a}±0.1	10.3 ±0.6
W/S	1.3	1.0	1.23	1.03	1.3	1.06
	**		**			
Winter	37.8^{b}±0.5	31.2 ±0.9	4.18^{b}±0.00	3.17 ±0.01	12.8^{b}±0.2	10.1 ±0.7
1st G Summer	28.9^{a}±0.7	28.0 ±1.3	3.17^{a}±0.02	3.10 ±0.02	9.6^{a}±0.6	9.3 ±0.8
Winter	34.8^{b}±0.9	35.0 ±1.2	3.89^{b}±0.01	4.00^{b}±0.00	12.1^{b}±0.3	11.0 ±0.1
2nd G Summer	28.5^{a}±0.9	28.7 ±1.1	3.14^{a}±0.02	3.15^{a}±0.20	9.5^{a}±0.7	9.6 ±0.9
	**		**			
Winter	36.9^{b}±0.1	34.4 ±1.1	4.14^{b}±0.01	3.97 ±0.09	12.4^{b}±0.0	11.1 ±0.4
L Summer	28.7^{a}±0.3	31.1 ±1.9	3.30^{a}±0.03	3.43 ±0.09	9.5^{a}±0.1	10.4 ±0.9
W/S	1.3	1.1	1.25	1.16	1.3	1.07

a,b $P<0.05$, ** $P<0.01$.

4. Thyroid activity

The concentration of thyroid hormones T_3 and T_4 showed clear drop in summer in both NZW and BR breeds. About one quarter to one half more in winter in case of T_3 but less in case of T_4. This seasonal difference was more conspicuous in case of pregnant BR (Table 3). The ratio T_4/T_3 was greater in barren BR than in NZW, around a double value, this is most probably in accordance with the more active irritable behavior of BR (Table 3). Gestation caused doublier in this ratio in the 1st post-puberty gestation in both breeds. Anyhow the ratio was equal in the 1st and 2nd gestations in NZW, while, it droped in the 2nd gestation in BR to be equal to that of barren case. This increase in ratio denotes faster transformation from T_4 to the most penetrate hormone T_3 to meet the active metabolic process of embryonic development. The lactating NZW showed higher ratio than in barren case, while, BR did not show this difference. This may be due to more milk production of NZW.

Table 3. Seasonal changes in T_3, T_4, T_4/T_3 and P_4 levels ng/ml in serum of NZW and BR rabbits at one week before gestaion (B.G), midterm of 1st and 2nd gestation (G) and one week after parturition (A.P) (Means ± SE)

Item	season	B.G		1st G.		2nd G.		A.P	
		NZW	BR	NZW	BR	NZW	BR	NZW	BR
T_3	Winter	0.86 ±0.01	1.08 ±0.07	1.91 ±0.11	2.52 ±0.09	1.81 ±0.07	2.36^{b} ±0.05	1.81 ±0.04	1.75 ±0.03
	Summer	0.72 ±0.02	0.84 ±0.08	1.67 ±0.15	2.04 ±0.10	1.54 ±0.10	1.70^{a} ±0.06	1.78 ±0.03	1.57 ±0.01
	W/S	1.20	1.29	1.14	1.23	1.17	1.38	1.01	1.11
T_4		**		**			**		
	Winter	3.65^{b} ±0.07	2.26 ±0.08	4.20^{b} ±0.25	4.65^{b} ±0.10	4.24^{b} ±0.31	4.90^{b} ±0.35	3.80^{b} ±0.01	4.01 ±0.01
	Summer	2.62^{a} ±0.10	2.06 ±0.09	3.16^{a} ±0.35	3.59^{a} ±0.12	2.77^{a} ±0.45	3.08^{a} ±0.40	2.78^{a} ±0.05	3.56 ±0.10
	W/S	1.39	1.10	1.24	1.30	1.53	1.59	1.37	1.13
T_4/T_3	Winter	4.2	2.5	2.1	1.9	2.3	2.1	2.1	2.3
	Summer	3.7	2.1	1.9	1.8	1.8	1.8	1.6	1.8
	W/S	1.2	1.2	1.1	1.1	1.3	1.2	1.4	1.3
P_4	Winter	0.41 ±0.01	0.39 ±0.03	11.04^{b} ±0.30	9.69^{b} ±0.26	13.45^{b} ±0.58	12.93^{b} ±0.50	0.61 ±0.01	0.30 ±0.00
	Summer	0.36 ±0.02	0.34 ±0.01	7.54^{a} ±0.53	12.13^{a} ±0.28	10.07^{a} ±0.67	10.52^{a} ±0.40	0.53 ±0.02	0.25 ±0.01
	W/S	1.15	1.14	1.46	0.80	1.34	1.23	1.15	1.20

a,b $P<0.05$, ** $P<0.01$.

B. Reproductive Performance

1. Progesterone level (P_4)

Progesterone concentration in both breeds was always higher in winter than in summer (Table 3), but to a less extent in BR than in NZW. These findings are in agreement with Challis et al. (1973) and Habeeb and El-Masry (1991).

2. Litter Size and Mortality Rate

Litter size (L.S) of NZW during winter had higher values than summer by 20 % and 7.7 % in the first and second parities, resp.. In BR (L.S) had higher values in winter than summer by 24.1 % ($P<0.05$), in first parity but there was no seaaonal difference in the second parity (Table 4). Mortality rate (M.R) showed the highest level in summer than winter by 45.6 % ($P<0.01$) and 31.2 % ($P<0.05$) in NZW and by 8.7% and 15.1% in BR than in winter in the first and the second parities, resp. (Table 4). It is clear that summer induced more incidence of mortality in the exotic breed NZW than the local breed BR. As shown from data, BR rabbits differed from NZW in their response to seasonal effects on M.R and S.R. Winter conditions in the present study (15.0 max.°C, 6.0 min.°C and 64.0 % RH) seems to expose BR to certain level (not severe) of cold stress while it seems to be within the thermonuteral conditions to NZW. El-Fouly et al.(1977) found that in Bouscat and Giza white rabbits (local breed) the average number of viable embryos/doe for the two breeds in winter, spring, summer and autumn were 6.8, 8.9, 3.0 and 5.9 resp.. Yamani et al. (1991) found that the highest percentages of stillbirths and pre-weaning mortality of NZW rabbits were found in spring (10.2 and 36.2% resp.) followed by that in summer (4.1 and 22.4 %) while the lowest percentages occurred during autumn (1.3 and 11.3 %) and winter (1.0 and 12.9%) under Egyptian conditions. The differences among seasons were significant.

3. Daily Milk Production (DMP)

Milk production was greater in winter than in summer at all weeks of lactation in both breeds. The seasonal differences were significant ($P<0.05$) only in the 3rd week in the first parity and the 3rd and 4th weeks in the second parity (Table 5). The differences in DMP between winter and summer increased in the second parity

than in the first parity, which can be due to further growth, physiological development and better mothering ability. Many investigations are in agreement with these suggestions (Khalil and Mansour, 1987 and Maerteus and De Groote, 1990).

Table 4. Seasonal changes in litter size (L.S), average bunny birth weight (B.W), weaning wight (W.W), mortality rate (M.R) in NZW and BR rabbits during first parity (means)

Breed	Season	Bunny weight (g)			
		L.S	B.W	W.W	M.R%
NZW	Winter	7.1	68.6	447.0	23.6
	Summer	6.3	56.9	367.1	32.9
	W/S	1.1	1.2	1.2	0.7
BR	Winter	7.6	54.4	381.7	33.6
	Summer	5.9	47.4	341.1	37.5
	W/S	1.3	1.1	1.1	0.9

Table 5. Seasonal changes in average daily milk production (DMP, g/d) and bunny body weight gain (BWG) in NZW and BR during four weeks of suckling in two consecutive parities (means)

Items	Breed	Season	Weeks of lactation				
			1st	2nd	3rd	4th	average
DMP	NZW	Winter	96.2	130.9	157.2	109.6	123.5
		Summer	84.3	111.7	122.8	92.0	102.3
		W/S	1.1	1.2	1.3	1.2	1.2
	BR	Winter	85.2	122.0	145.9	97.4	112.6
		Summer	83.3	102.0	121.4	87.0	98.4
		W/S	1.0	1.2	1.2	1.1	1.1
BWG	NZW	Winter	78.3	97.2	105.2	97.5	92.1
		Summer	61.9	79.0	91.4	77.9	77.6
		W/S	1.3	1.2	1.2	1.3	1.2
	BR	Winter	60.8	81.4	98.5	86.7	81.8
		Summer	58.9	71.3	85.9	77.7	72.2
		W/S	1.0	1.1	1.2	1.1	1.1

4. Growth of Offspring

Body weight gain of bunnies of NZW rabbits showed higher values in winter than in summer through 4 weeks

of suckling in the first and second parities, the seasonal differences were significant (Table 5). The BR bunnies in the first parity, contrary to NZW, showed less weight gain in winter than in summer in the first week of age. This denotes less endurance of cold in BR native breed than the exotic breed at this early age and low milk production (Table 5) and maybe less developed mothering ability. In the following ages 2-4 weeks the winter born bunnies showed faster growth than the summer born ones, however, with less seasonal difference in BR than in NZW (Table 5). These findings are in agreement with Sallam et al.(1989) who found in New Zealand White, Californian and Baladi Red rabbits, litters kindled in November and December had heavier body weight gain from birth to weaning (2895 g, total litter weight) than those kindled in January -February (2705 g) or in March-May (2682 g). Yamani et al. (1991) found that growth of rabbits offspring was nearly similar in spring and summer, however lower than that of autumn and winter being significantly greater in the cold season.

It could be concluded that the responsiveness of the breeds (BR and NZW) to seasonal variation were greatly different. Winter has been the favorite season for both NZW and BR rabbits. However NZW adaptive response and reproductive performance exceeded that of BR. The NZW showed higher value in the hematological parameter (Hb con., PCV % and RBCs count), T_3 and T_4 levels and progesterone (P_4) during winter. On other hand the reproductive merits of NZW was particularly apparent in litter size (L.S). The stressful hot conditions had greater effect on NZW than BR. Both adaptive response and reproductive performance deteriorated with great value in NZW than in BR.

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كفاءة التأقلم والتناسل فى الأرانب ١-الإستجابة للظروف الموسمية

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أستخدم فى هذه التجربة إثنا وعشرون من إناث الأرانب (١١ من النيوزيلندى الأبيض و ١١ من البلدى الأحمر) لدراسة أداء إناث الأرانب تحت الظروف الطبيعية لموسمى الصيف والشتاء فى منطقة جنوب الدلتا بمصر بمزرعة جزيرة الشعير - القناطر الخيرية. كان متوسط عمر الإناث ٩ شهور بينما متوسط أوزانهم ٣ كجم وتمت رعاية الحيوانات وتغذيتها طبقا للنظام المعتاد بالمزرعة. وكانت أهم النتائج التى توصلت اليها هذه الدراسة هى:-

الإستجابة للتغيرات الجوية الموسمية فى كلا النوعين مختلفة بدرجة كبيرة فكانت معدلات التنفس ودرجة حرارة الجسم ونسبة النفوق مرتفعة فى كلا السلالتين فى فصل الصيف سواء فى الاناث الغير حامل أو الحامل أو المرضعات. إرتفعت مقاييس الدم (نسبة الهيموجلوبين ، الهيماتوكريت،عدد كرات الدم الحمراء) فى الأمهات النيوزيلندى عن الأمهات البلدى خاصة فى موسم الشتاء بينما إنخفضت هذه المقاييس بوضوح فى موسم الصيف فى الأمهات النيوزيلندى فى كل الحالات الفسيولوجية. وإنخفضت مستويات هرمونات الدرقية(T_3, T_4) و هرمون البروجيستيرون بوضوح خلال موسم الصيف عن الشتاء فى كلا السلالتين. كان عدد الخلفة ونسبة الاحياء (من الميلاد الى الفطام) وكذلك إنتاج اللبن اليومى خلال فترة الرضاعة (٤أسابيع) أعلى فى فصل الشتاء عن فصل الصيف بينما أظهر معدل الزيادة فى وزن الصغار (من الميلاد الى الفطام) فى الأمهات البلدى أقل إختلافات موسمية مقارنة بصغار الأمهات النيوزيلندى.و كان موسم الشتاء هو الموسم الأفضل لكلا السلالتين مع تفوق الأمهات النيوزيلندى على الأمهات البلدى. وكانت وفرة عدد الخلفة فى البطن من أهم المميزات التناسلية الواضحة للنيوزيلندى الأبيض. وكانت للظروف الحارة الشديدة تأثير سيء على كفاءة التأقلم والتناسل فى كلا السلالتين ولكن بدرجة كبيرة على الأمهات النيوزيلندى عن البلدى.