Effects Of Cage Density And Climatic Conditions On The Performance Of Growing Rabbits

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ABSTRACT

One hundred and two weaned males of New Zealand white (NZW) rabbits at 35 days of age and nearly equal average initial live body weight were randomly assigned to 8 treatment groups to study the period of the year and cage density effect on the performance of growing rabbits. A 2x4 factorial design experiment was performed including two periods of the year (the mild period; from October, 2007 to April, 2008, and the hot one; from May to September, 2008) and four cage densities (2, 3, 4, and 5 animals/cage). Growth performance, carcass characteristics and some blood constituents were studied.

Results indicated absence of heat stress during the Mild and exposure to severe heat stress during the hot period.

Results obtained also showed that the hot period of the year affected negatively ($P \leq 0.05$ or 0.001) on live body weight at 11 weeks of age and body gain during the periods from 8 – 11 and 5 – 11 weeks of the age. Mild period of the year caused an improvement in feed intake and feed conversion. Crowding had a bad effect ($P \leq 0.05$ or 0.01) on live body weight and body gain in all ages studied. Feed intake and feed conversion were improved ($P \leq 0.05$ and 0.01) in rabbit groups of low cage density. Rabbits reared in 5 animals / cage during hot period of the year showed the lowest ($P \leq 0.05$ or 0.01) body weight at 11 weeks of age and gain during 8 – 11 and 5 – 11 weeks of age, while those reared in the cages during mild period recorded the highest body weight and gain. Most of carcass traits studied (carcass weight for lamb trunk and hind lamb) were improved during mild period of the year as comparing with those during hot one ($P \leq 0.05$ or 0.01). Growing rabbit groups reared in 2 animals / cage showed nearly the best carcass traits while the worst ones were observed for those reared in 4 or 5 animals per cage. Plasma total protein, albumin, globulin, creatinine and urea didn't show any significant differences due to the effect of period of the year, cage density and their interaction. It could be seen from the results of the present study that cage density must be adjusted at the hot period of the year. The best results could be obtained when 800 – 1200 square centimeters are provided to each growing rabbit.

INTRODUCTION

There are many factors affecting the intensive rabbits production such as environmental and nutritional conditions. The environmental conditions play an important element in the production cycle. The domestic rabbit has a high metabolic rate, undeveloped sweat glands and slow heat loss. The high temperature in hot climate conditions affects negatively growth, reproductive performance, feed intake and blood constituents *(1-8)*. Growing rabbits are so sensitive to heat stress. Since, they have few functional sweat glands and difficulty in eliminating excess body heat *(9)*. The comfort zone for rabbits under Egyptian conditions is between 18 and 21 C° for adult rabbits *(10,11)* and 15 – 18 C° for growing rabbits of 6 – 12 weeks of age *(12)*. Poor weight gains, impaired feed conversion, increase disease incidence and mortality are the most signs of heat stress *(13)*. It's unclear to what extent the biological performance of growing rabbits is influenced by the environmental conditions especially under different stocking densities. The susceptibility of growing rabbits will be increases during hot seasons with high stocking density. This may be due to the high production of heat from animal bodies through radiation, contacting and evaporation during breathing in unit area. Moreover, overcrowding reduces the available space of feeding and drinking, which in turn leads to reduction in feed utilization. Using a favorable stoking density for the different environmental conditions to maximizing the growing rabbits performance is questionable. Beside well-being, stocking density and group size affect the production traits. In overcrowding cages the alimentary and locomotory behaviour of growing rabbit changes, which influences their meat quality and carcass traits *(14 ,15)*.

The increase of animals per cage reduces investment costs in cages and equipments, but it worsens animal performance *(16-18)*. Minimum space allowances and stocking densities for rabbits should always refer to the final weight that rabbits would reach (of a certain strain, sex, feeding regime) while housed in a particular compartment *(19)*. In cage housing, each rabbit should be allowed to stretch full length along one side of the cage. The height should allow the rabbits to sit up straight. Young rabbits need more space since they are more active and perform more rapid locomotion than elders *(20)*. Recommended cage area for rabbits is different in the US and European guidelines. In cage floor area is based on weight, such that one rabbit of less than 2 kg should be housed in a cage with a minimum floor area of 1350 cm^2 *(21)*. In the Council of Europe Appendix A ETS 123 *(22)*, cage floor area is based on weight and age, such that rabbits less than 10 weeks of age should be housed in a cage with a minimum floor area of 1200 cm^2. However, there is a lake in published reports about the effects of stress due to different cage density on growth and some blood constituents of young male rabbits. Therefore, the present study was designed to study the period of the year (mild and hot periods) and cage density effects on the performance of growing rabbits.

MATERIALS AND METHODS

This study was carried out at a Private Farm in Zagazig city during the period from October, 2007 to September, 2008. One hundred and two of weaned males New Zealand White (NZW) rabbits at 35 days of age and nearly equal average initial live body weight were randomly assigned to 8 treatment groups. A 2x4 factorial design experiment was performed including two periods of the year (the mild period; from October, 2007 to April, 2008, and the hot one; from May to September, 2008) and four cage densities (2, 3, 4, and 5 animals/cage) as shown in Table 1. Since weaning, rabbits were housed in galvanized wire cages (Dimensions of 60 × 40 × 35 cm) until marketing at 6 weeks after weaning.

Averages of ambient temperature and relative humidity at mid-day inside the Rabbitry building during the experimental period were 17.84 C^o and 68.9% in the mild period and 30.12 C^o and 77.6 % in the hot period, respectively.

All rabbits were fed pelletized feed *ad libitum*. The basal diet consisted of 28% alfalfa hay, 18% barley, 18% soybean meal (44% crude protein), 25% wheat bran, 6% yellow corn, 3 % molasses, 1.1% limestone, 0.3% sodium chloride, 0.6 % vitamin and mineral premix. The basal diet contained of 18.18 % crude protein, 13.43% crude fiber, 2.29% ether extract, 2656 digestible energy (Kcal/kg). The diet was formulated *(23)*.

All rabbits were kept under the same managerial, hygienic and environmental conditions. The rabbits were reared in a well ventilated building, fresh water was automatically available all the time by stainless steel nipples fixed in each cages. All rabbit cages were equipped with feeders and nipples. During the experimental periods, light / dark rate was 16 / 8 hours.

Live body weight was recorded individually for each rabbit at 5, 8 and 11 weeks of the age, then weight gain was calculated. Feed intake was determined precisely and calculated as gram per rabbit per day. Unused feed from each cage was collected daily, weighed and taken into consideration for calculation of feed intake. Feed conversion was also estimated (g feed / g gain).

At the end of the experimental period (11 weeks of the age), three male rabbits from each group were randomly taken and fasted for 12 hrs then slaughtered. After complete bleeding, pelt, viscera's and tail were removed then the carcass and some it's components were weighed (head, fore limb, trunk, hind limb, liver, kidney and abdominal fat). The blood samples were collected from rabbits during the slaughtering in dry heparinized tubes and the plasma was separated by centrifugation at 3000 rpm for 20 minutes and kept in plastic vials in a deep freezer at -20 C° until the time of analysis. Total protein, albumin, creatinine and urea concentration in plasma were estimated using commercial kits (Bio Merieux, France) according to the procedure outlined by the manufacturer. The globulin values were obtained by subtracting the values of albumin from the corresponding values of total protein.

In order to study the combined effects of temperature and humidity, temperature humidity index (THI) was calculated according to the formula *(24)*.

THI= db C°-{(0.31-0.31RH)(db C°-14)}, where db C°= dry bulb temperature in Celsius and RH = Relative humidity % the estimated values of THI were classified as follows; <22,2 = absence of heat stress, 22,2 - <23.2= moderate heat stress, 23.3 – <25.5 = severe heat stress and 25.5 or more = very severe heat stress.

The obtained data were statistically analyzed in 2x4 factorial design *(25)* using SAS® Software Statistical Analysis *(26)* by the following model:

$$Y_{ijk} = \mu + P_i + F_j + PF_{ij} + E_{ijk}$$

Where, μ = general mean, P_i = fixed effect of i^{th} period (Mild and hot periods), F_j = fixed effect of j^{th} rabbit densities (2, 3, 4 and 5 animals / cage), PF_{ij} = interaction between period and growing rabbits density and E_{ijk} = random error. Differences among mean were tested by Duncan's multiple range test *(27)*.

Table 1. Experimental design.

Mild period (51 growing rabbits)				Hot period (51 growing rabbits)			
2	3	4	5	2	3	4	5
1200 sq cm/head 12 rabbits	800 sq cm/head 12 rabbits	600 sq cm/head 12 rabbits	400 sq cm/head 15 rabbits	1200 sq cm/head 12 rabbits	800 sq cm/head 12 rabbits	600 sq cm/head 12 rabbits	400 sq cm/head 15 rabbits

Sq = square and cm = centimeter.

RESULTS AND DISCUSSION

Temperature –humidity index

Temperature – humidity index values (THI) were 17.5 and 27.13 at comfort and hot periods.

Growth performance

Live body weight and weight gain

Period of the year effect

Results in Table 2 indicated that hot period of the year affected negatively ($P \leq 0.05$ or 0.01) live body weight at 11 weeks of age and body gain of growing rabbits during the periods from 8 – 11 and 5 – 11 weeks of age. Such difference may be a reflection of differences in seasonal conditions; also the depression in body weight gain due to heat stress may be attributed to the impairment of feed intake and a consequent shortage of energy substrates *(28)*. The adverse effects of exposing growing animals to heat stress were similar to that reported by several investigators *(1, 3, 5, 9, 24, 29 ,30)* and indicated that the absence of heat stress during the Mild (less than 22.2) and exposure to severe heat stress during the hot period (23.3 - 25.5).

Table 2. Live body weight and body weight gain ($\bar{X}$ ± S.E.) of growing rabbits as affected by climatic conditions, cage density and their interaction.

Items	Live body weight (gm)			Body weight gain (gm /day)		
	5 weeks	8 weeks	11 weeks	5-8 weeks	8-11 weeks	5-11 weeks
Period of the year effect:						
Hot period	812.83±0.7	1280.12±4.5	1727.96^{b}±8.90	22.25±0.31	21.33^{b}±0.49	21.79^{b}±0.36
Mild period	813.13±1.3	1287.45±4.1	1837.53^{a}±10.1	22.59±0.25	26.19^{a}±0.52	24.39^{a}±0.42
Significance	N.S	N.S	***	NS	*	*
Cage Density effect:						
5 / cage	820.34±1.1	1254.00^{b}±5.2	1602.50^{b}±9.10	20.65±0.29	16.60^{b}±0.41	18.62^{b}±0.53
4 / cage	809.75±1.0	1257.84^{b}±6.8	1766.81^{ab}±13.2	21.34±0.19	24.24^{a}±0.61	22.79^{a}±0.59
3 / cage	814.95±0.9	1336.29^{a}±7.1	1800.10^{a}±11.7	24.82±0.21	22.09^{ab}±0.36	23.45^{a}±0.41
2 / cage	811.17±0.9	1259.96^{b}±5.4	1817.04^{a}±11.8	21.37±0.33	26.53^{a}±0.45	23.95^{a}±0.38
Significance	NS	**	**	NS	***	**
Interaction effect:						
Hot period:						
5 / cage	810.67±1.9	1179.67±6.7	1488.00^{b}±13.8	17.57±0.14	14.68^{c}±0.36	16.13^{b}±0.42
4 / cage	815.83±2.0	1269.00±8.1	1731.95^{ab}±14.0	21.56±0.19	22.02^{b}±0.29	21.79^{a}±0.85
3 / cage	813.60±1.3	1358.67±9.3	1763.11^{ab}±11.1	26.03±0.16	19.27^{bc}±0.41	22.65^{a}±0.50
2 / cage	818.67±2.1	1237.59±5.6	1781.74^{ab}±9.80	19.94±0.20	25.90^{ab}±0.38	22.92^{a}±0.48
Mild period:						
5 / cage	830.00±2.5	1328.33±4.9	1717.00^{ab}±12.5	23.73±0.28	18.51^{c}±0.49	21.12^{a}±0.60
4 / cage	803.67±2.4	1246.67±6.0	1801.67^{a}±16.1	21.10±0.21	26.43^{a}±0.45	23.76^{a}±0.67
3 / cage	816.33±1.5	1313.91±7.3	1837.08^{a}±14.3	23.69±0.18	24.91^{ab}±0.38	24.30^{a}±0.72
2 / cage	803.67±1.7	1282.33±7.5	1852.33^{a}±15.0	22.79±0.17	27.14^{a}±0.41	24.96^{a}±0.80
Significance	NS	NS	**	NS	**	**

NS = Not significant, * = $P<0.05$, ** = $P<0.01$ and *** = $P<0.001$

Means bearing different letters in the same column within each factor differ significantly ($P\leq0.05$).

Cage density effect

The present results phoned that crowding had a bad effect ($P\leq0.05$ or 0.01) on live body weight and body gain in all ages studied, since rabbits reared in 5 rabbits / cage had the lowest live body weight at 8 and 11 weeks of age and body gain during 8 – 11 and 5 – 11 weeks of age. In general, nearly similar results were observed for rabbits reared in 2 to 4 animals / cage either for body weight or body gain (Table 2). The unfavorable effect of high cage density may be attributed to modification of the resting behavior due to the disturbances by the other animals *(31)*. Accordingly, the reduction of body weight and growth rate when cage density increased is directly related to the reduction of feed intake *(16-18)*. Contradicting results were obtained *(32 33)* which showed that cage density had no effect on body weight of growing rabbit. The European Food and Safety Authority *(33)* recommended a minimum surface of 625 cm^2/rabbit at the end of fattening, in order to avoid disturbances in rabbit performance and behaviour. On the other hand, in tropical and sub-tropical conditions, whether control is very difficult which increases heat stress during fattening period. In these conditions the increase of cage density on performance might be more important than in European conditions. The present results are in consistent with those obtained previously *(35)*.

Interaction effect

The interaction between period of the year and cage density were significant (P≤ 0.01) on live body weight at 11 weeks of age and body weight gain during 8 – 11 and 5 – 11 weeks of age (Table 2). Rabbits reared in 5 animals / cage during hot period of the year showed the lowest (P≤0.05 or 0.01) body weight and gain, while those reared in 2 animals / cage during mild period recorded the highest body weight at 11 weeks of age and body weight gain during 8 – 11 and 5 - 11 weeks of age.

Feed intake and feed conversion

1.Period of the year effect

Mild period of the year caused an improvement in feed intake and feed conversion, however this improvement was significant (P≤0.01) only for feed intake. Feed intake was increased by 12% during mild period than that during the hot one (Table 3). This means that the period was responsible for any increase in feed intake. This may be explained on the basis that growing rabbits require more heat during cold conditions, covered by increasing feed intake. Similarly it has been recorded that feed intake was increased significantly (P≤0.01) in NZW rabbits under winter conditions comparing with that under summer conditions *(7)*. Conversely, rabbits exposed to sever heat stress increases heat production while decreasing voluntary feed intake. Several previous studies indicated that feed intake decreased significantly (P≤0.05) in NZW rabbits under heat stress condition *(4-6,9,30)*.

2.Cage density effect

Results in Table 3 showed that feed intake and feed conversion were significantly (P≤0.05 and 0.01) affected by cage density. There was a decrease in feed intake and increase in feed conversion with increasing cage density. It could be noticed that feed intake and feed conversion were improved in groups of low cage density (2 or 3 animals / cage). Similar results were reported *(19,35)*. On the other hand cage density didn't affect feed intake and conversion in growing rabbits *(32, 33,36)*. The reason of decreasing feed intake and consequently weight gain with the increase of cage density may be due to limiting of feed place and lacking of comfort due to overcrowding. Also, Feed consumption reduction may be due to the reduction in floor space, which increases the competition for positions at the feeder, while in lower density there is a more area allowed for movement, which may have resulted in less more movement that lead to loss stressful environment *(37)*.

Interaction effect

The interaction effect between period of the year and cage density didn't show any significant differences in feed intake and feed conversion (Table 3).

Carcass traits

Period of the year effect

Most of carcass traits studied (weight of carcass, fore limb, trunk, hind limb and liver) were improved during mild period of the year as comparing with those during the hot one (P≤0.05 or 0.01). The other carcass traits (weight of head, kidney and abdominal fat) didn't affect significantly by the period of the year (Table 4). In Egyptian similar findings were recorded *(6 , 30)*.

Cage density effect

Cage density effect was significant (P≤0.05 or 0.01) for all carcass traits except liver and head weights, which were not significantly affected (Table 4). It could be seen that growing rabbit groups reared in 2 animals / cage showed the best carcass traits while the worst ones were observed for rabbits reared in 4 or 5 animals / cage. Cage density had minor influence on carcass compared to growth traits *(35)*.

Interaction effect

There is no any significant effects for interaction between period of the year and cage density on all carcass traits studied (Table 4).

Table 3. Feed intake and feed conversion ($\bar{X}$ ± S.E.) of growing rabbits as affected by climatic conditions, cage density and their interaction during 5 – 11 weeks of age.

Items	Feed intake (g/day)	Feed conversion (g feed / g gain)
Period of the year effect:		
Hot period	92.43^{b}±0.43	4.24±0.3
Mild period	100.91^{a}±0.38	4.14±0.4
Significance	**	NS
Cage Density effect:		
5 / cage	89.60^{b}±0.50	4.80^{a}±0.3
4 / cage	94.76^{ab}±0.41	4.51^{ab}±0.6
3 / cage	101.00^{a}±0.58	4.44^{ab}±0.5
2 / cage	101.10^{a}±0.52	4.29^{b}±0.4
Significance	**	*
Interaction effect:		
Hot period:		
5 / cage	75.65^{c}±0.46	4.69^{b}±0.6
4 / cage	85.50^{b}±0.63	4.63^{b}±0.5
3 / cage	98.00^{a}±0.59	4.59^{b}±0.5
2 / cage	100.00^{a}±0.81	4.49^{c}±0.4
Mild period:		
5 / cage	103.54^{a}±0.61	4.90^{a}±0.6
4 / cage	104.02^{a}±0.67	4.38^{c}±0.7
3 / cage	104.00^{a}±0.50	4.28^{c}±0.4
2 / cage	102.20^{a}±0.44	4.09^{c}±0.5
Significance	**	*

NS = Not significant, * = P<0.05 and ** = P<0.01

Means bearing different letters in the same column within each factor differ significantly (P≤0.05).

Blood constituents

Period of the year effect

Plasma total protein albumin, globulin, creatinine and urea didn't show any significant differences due to the period of the year effect (Table 5). The present results are agree with those obtained under Egyptian conditions ***(6,29)***.

Cage density effect

Cage effect didn't reach to the significant level for all blood plasma traits studied (Table 5).

Interaction effect

There is no any significant effect for interaction between period of the year and cage density on all blood plasma traits studied (Table 5).

In conclusion: it could be seen from the results of the present study that cage density must be adjusted at the hot period of the year. The best results could be obtained when 800 – 1200 square centimeters are provided to each growing rabbit.

Table 4. Some carcass traits ($\overline{X}$ ± S.E.) of growing rabbits as affected by climatic conditions, cage density and their interaction.

Items	Carcass weight (gm)	Fore limb (gm)	Trunk (gm)	Hind limb (gm)	Liver (gm)	Head (gm)	Kidney and Abdominal fat (gm)
Period of the year effect:							
Hot period	1083.82^{b}±69.2	225.19^{b}±36.5	286.43^{b}±28.1	346.96^{b}±42.1	64.78^{b}±5.9	125.00^{a}±10.3	17.39^{a}±3.8
Mild period	1189.70^{a}±75.3	262.05^{a}±41.8	308.60^{a}±32.6	409.58^{a}±40.1	68.52^{a}±6.8	124.77^{b}±11.7	16.19^{b}±3.2
Significance	**	**	**	**	**	**	**
Cage Density effect:							
5 / cage	1005.68^{c}±83.9	209.30^{d}±46.3	278.38^{b}±34.7	319.43^{c}±31.5	61.99±7.1	123.53±12.0	13.98^{b}±3.4
4 / cage	1097.70^{b}±81.0	224.04^{c}±49.0	295.65^{a}±22.9	378.51^{b}±41.1	63.91±8.2	126.44±11.5	14.50^{b}±2.7
3 / cage	1130.04^{a}±65.6	245.82^{b}±37.9	294.22^{a}±26.1	382.62^{b}±41.1	66.89±7.5	125.53±10.7	19.48^{a}±4.5
2 / cage	1145.52^{a}±54.1	262.58^{a}±24.1	309.42^{a}±28.5	420.82^{a}±52.1	68.58±6.4	124.63±10.0	17.00^{a}±5.0
Significance	***	**	**	**	NS	NS	*
Interaction effect:							
Hot period:							
5 / cage	990.79^{d}±67.1	208.52^{c}±40.1	270.10^{ab}±19.5	318.85^{b}±48.9	60.65±7.0	128.67±9.5	13.00^{b}±1.8
4 / cage	1063.23^{c}±69.5	211.39^{c}±27.5	300.35^{a}±25.9	350.34^{b}±45.7	62.82±7.4	125.00±11.3	14.00^{b}±2.0
3 / cage	1085.24^{c}±78.6	230.33^{c}±33.0	278.01^{b}±23.6	355.04^{b}±39.2	64.90±6.5	130.00±11.7	24.96^{a}±2.7
2 / cage	1105.77^{b}±93.1	230.08^{c}±39.1	278.06^{b}±28.6	390.77^{ab}±39.9	65.52±8.3	123.34±13.2	17.00^{b}±2.1
Mild period:							
5 / cage	1020.56^{c}±70.6	210.08^{c}±29.3	286.66^{ab}±41.0	320.01^{b}±31.8	63.33±6.5	125.53±15.3	14.95^{b}±1.7
4 / cage	1132.17^{b}±84.3	226.69^{b}±37.2	290.44^{a}±36.9	406.67^{a}±37.3	65.00±7.5	127.87±14.7	15.00^{b}±2.0
3 / cage	1184.84^{a}±65.0	261.30^{b}±21.4	310.43^{a}±25.4	410.14^{a}±46.5	68.87±6.7	120.05±13.1	14.00^{b}±2.3
2 / cage	1285.27^{a}±54.3	295.08^{a}±28.0	324.77^{a}±39.0	450.87^{a}±35.2	71.63±5.8	125.92±11.9	17.00^{ab}±1.9
Significance	**	**	***	**	NS	NS	**

NS = Not significant, * = P<0.05, ** = P<0.01 and *** = P<0.001
Means bearing different letters in the same column within each factor differ significantly (P≤0.05).

Table 5. Some blood constituents ($\overline{X}$ ± S.E.) of growing rabbits as affected by climatic conditions, cage density and their interaction.

Items	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	Creatinine (mg/dl)	Urea-N (mg/dl)
Period of the year effect:					
Hot period	6.17±0.53	3.52±0.17	2.65±0.19	1.05±0.05	15.67±1.8
Mild period	6.14±0.49	3.13±0.19	3.01±0.23	0.09±0.09	16.62±1.9
Significance	NS	NS	NS	NS	NS
Cage Density effect:					
5 / cage	5.90±0.39	3.34±0.13	2.56±0.17	1.04±0.03	17.39±2.0
4 / cage	5.83±0.46	3.23±0.11	2.60±0.19	1.06±0.04	15.64±2.3
3 / cage	6.32±0.54	3.29±0.16	3.03±0.19	1.04±0.03	16.52±1.7
2 / cage	6.83±0.49	3.50±0.17	3.33±0.15	1.05±0.03	16.18±1.5
Significance	NS	NS	NS	NS	NS
Interaction effect:					
Hot period:					
5 / cage	6.10±0.53	3.68±0.16	2.42±0.21	1.01±0.04	17.58±1.9
4 / cage	5.56±0.51	3.62±0.16	2.54±0.23	1.09±0.05	14.36±2.0
3 / cage	6.03±0.67	3.27±0.17	2.76±0.25	1.06±0.02	15.98±2.3
2 / cage	6.94±0.71	3.90±0.14	3.64±0.19	1.05±0.03	16.47±2.5
Mild period:					
5 / cage	5.70±0.80	3.00±0.15	2.70±0.17	1.07±0.02	17.19±1.9
4 / cage	6.10±0.75	3.43±0.13	2.67±0.20	1.02±0.02	16.92±2.7
3 / cage	6.60±0.68	3.31±0.10	3.29±0.23	1.02±0.03	17.05±1.9
2 / cage	6.71±0.66	3.10±0.16	3.61±0.11	1.04±0.04	15.88±1.6
Significance	NS	NS	NS	NS	NS

NS = Not significant

REFERENCES

1. ***Ayyat MS,Gabr HA,Marai IFM and Abdel – Monem UM (1997).*** Alleviation of Heat – stressed growing rabbits by using some chemical growth enhances under subtropical Egyptian condition. *Proceeding of the international Conference on Animal, Poultry and Rabbit Production and Health*, Cairo, Egypt, pp. 637 – 651.

2. ***Marai IFM, El-Masry KA and Nasr AS (1994).*** Heat stress and its amelioration with nutritional, buffering, hormonal and physical techniques for New Zealand White rabbits maintained under hot summer condition of Egypt. *Cahiers Option Mediterranean's*, 8 (Supplement): 475-487.

3. ***Marai IFM, Ayyat MS, Gabr HA and Abdel–Monem UM (1999).*** Growth performance, some blood metabolites and carcass traits of New Zealand White broiler male rabbits as affected by heat stress and its alleviation, under Egyptian conditions. *Cahiers Option Mediterranean's*, 8: 35-42.

4. ***Marai IFM Ayyat MS and Abdel – Monem UM (2000).*** Young doe rabbit performance traits as affected by dietary, Zinc, Copper, Calcium or Magnesium, under winter and summer condition of Egypt. *Proceedings of the 7th World Rabbit Conference*, Spain, 8: 313 – 320.

5. ***Marai IFM, Askar AA and Bahgat LB (2006).*** Tolerance of New Zealand and Californian doe rabbits at first parity to the sub–tropical environment of Egypt. *Livestock Production Science*, 104:165-172.

6. ***Abd El-Monem U M (2000).*** Dietary

supplementation with ascorbic acid and its effects on productive and reproductive performance of New Zealand white rabbits, under the summer condition of Egypt. *Second Inter. Conf. On Animal Pord. & Health in Semi-Arid Areas.*

7. ***Mahrose Kh M A (2000).*** Environmental studies on growth and reproduction traits in rabbits. M.Sc. Thesis, Faculty of Agriculture, Zagazig University, Zagazig, Egypt.

8. ***Daader AH, Askar AA and Abd El-Monem, UM (2003).*** Influence of temperature-humidity index values on the performance of New Zealand White rabbits. *Egyptian Journal of Rabbit Science*, 13 (2): 157 – 170.

9. ***Marai IFM, Habeeb AAM and Gad AE*** *(2002).* Rabbits productive, reproductive and physiological performance traits as affected by heat stress: a review. *Livestock Production Science*, 78: 71-90.

10. ***Ahmed Nagwa A (2000).*** Diurnal and seasonal variations in thermoregulation and physiological reactions of pregnant and non-pregnant rabbits. *Journal of Agricultural Sciences, Mansoura Univ.*, 25 (6): 3221 – 3233.

11. ***Ahmed Nagwa A, Elfar AA and Sakr OG (2005).*** Evaluation of sexual and maternal behaviour, hormonal pattern and reproductive performance of doe rabbits as affected by seasonal variation. *The 4th Inter. Cong. On Rabbit Prod. In Hot Clim.*, Sharm El-Sheikh, Egypt, 225 – 231.

12. ***Rafai P, Papp Z and Szechy K (1972).*** Tenyesz es ujszulott hybrid nyulak oxygen fogyasztasanak vizsgalata. Baromfiipar, 19(9): 392-399.

13. ***Pla M, Fernandez Carmona J, Blas E and Cervera C (1994).*** Growth of rabbits under a high ambient temperature. *Cahiers Option Mediterranean's, "Rabbit Production in Hot Climates"*, 8: 495 – 497.

14. ***Morisse JP and Maurice R (1996).*** Influence of stocking density on the behaviour of fattening rabbits kept in intensive conditions. In: *Proceedings of the 6th World Rabbit Congress*, Toulouse, Vol. 2: 425 – 429.

15. ***Xiccato, G, Verga M, Trocino A, Ferrante V, Queaque PI and Sartoi A (1999).*** Effects of number and animal density in cages on productive performance, slaughter results and behaviour of growing rabbits. *8th French Rabbit Days, Paris*, 59 – 62.

16. ***Maertens L and De Groote G (1984).*** Influence of the number of fryer rabbits per cage on their performance. *Journal of Applied Rabbit Research*, 7(4), 151-153.

17. ***Aubret J and Duperray J (1992).*** Effect of cage density on the performance and health of the growing rabbit. *Journal of Applied Rabbit Research*, 15: 656 – 660.

18. ***Mbanya JN, Ndoping BN, Fomunyam RT, Noumbissi A, Mbomi ES, Fai EN and Teguia A (2004).*** The effect of stocking density and feeder types on the performance of growing rabbits under conditions prevailing in Cameroon. *World Rabbit Science*, 12, 259-268.

19. ***Onbasılar E Ebru and Onbasılar İlyas (2007).*** Effect of Cage Density and Sex on Growth, Food Utilization and Some Stress Parameters of Young Rabbits. *Scandinavian Journal of Laboratory Animal Science*, Vol. 34 (3): 1 – 7.

20. ***Lehmann M (1987).*** Interference of a restricted environment- as found in battery cages- with normal behavior of young fattening rabbits. In Auxilia, T. (Ed), Rabbit production systems including welfare. CEC Agriculture, ECSCEEC- EAEC, Brussels. 1987, 257-268.

21. ***NRC (1996).*** Guide for the Care and Use of Laboratory Animals. 7th Ed. Washington, DC: National Academy Press.

22. ***CoE (Council of Europe) (2004).*** Working Party for the preparation of the fourth Multilateral Consultation of Parties to the European Convention for the Protection of Vertebrate Animals Used for Experimental

and Other Scientific Purposes (ETS 123). Strasbourg: Council of Europe.

23.***NRC (1977).*** Nutrient Requirements of Rabbits National Academy of Science. Washington. 1214 – 1223.

24. ***Marai IFM, Ayyat M S and Abd El-Monem U M (2001).*** Growth performance and reproductive traits at first parity of New Zealand White female rabbits as affected by heat stress and its alleviation under Egyptian conditions. *Journal of Tropical Animal Health and Production*, 33: 1 – 12.

25.***Snedcor GW and Cochran WG (1982).*** Statistical Methods. 6th Edition, Lowa state University press, Ames, U.S.A.

26.***SAS (1998).*** SAS Procedure Guide. Release 6.03 Edition. *SAS Institute Inc.*, Cary NC, USA.

27.***Duncan D B (1955).*** Multiple range and multiple F-test. Biometrics. 11: 1 – 42.

28.***Habeeb AA, Marai IFM and Kamal TH (1992).*** European breeds arid zone climate. chapter, heat stress in farm animals and environment Edited by Phillips C. and Pagnes D., U.K., pp. 27-47.

29.***Marai IFM Ayyat MS, Gabr HA and Abdel – Monem UM (1996).*** Effect of summer heat stress and its amelioration on production performance of New Zealand White adult female and male rabbits, under Egyptian conditions. *6th World Rabbits Congress*, Toulouse, France, 2: 197-208.

30.***Abdel–Monem UM and Ayyat MS (2002).*** Effect of dietary protein level on growing and mature rabbits performance, under summer condition of Egypt. *3rd Sci. Con. On Rabbit Production in Hot Climates, Hurghada, Egypt*, 8-11 Oct: 287-300.

31.***Askar AA and Assaf IMM (2004).*** Biological performance of growing Japanese, Quail as affected by stocking density and dietary protein level. *Journal of Agricultural Science Mansoura Univ.*, 29 (2): 597 – 611.

32. ***Eiben CS, Szendrö ZS, Radnai I and Bir-Németh E (2002).*** Effect of weaning age and stocking density on the performance of fattening rabbits. *3rd Scientific Congress on Rabbit Production in Hot Climates*, 8 – 11 Oct., Hurghada, Egypt. Pp: 409 – 414.

33. ***Trocino A, Xiccato G, Queaque PI and Sartori A (2004).*** Group housing of growing rabbits: Effect of stocking density and cage floor on performance, welfare, and meat quality. *Proc. 8th World Rabbit Congress*, Mexico.

34.***European Food and Safety Authority (2005).*** Scientific Opinion of the Scientific Panel on Animal Health and Welfare on "The impact of the current housing and husbandry systems on the health and welfare of farmed domestic rabbit", EFSA-Q- 2004-023. *EFSA Journal*, 267: 1-31.

35.***Villalobos O, Guillén O and García J (2008).*** Effect of cage density on performance of fattening rabbits under heat stress. *9th World Rabbit Congress*, June 10-13, 2008 – Verona – Italy. Pp: 1631 – 1636.

36.***Rommers J and Meijerhof R. (1998).*** Effect of group size on performance, bone strength and skins lesions of meat rabbits housed under commercial conditions. *World Rabbit Science*, 6(3 – 4): 299 – 302.

37.***Davani A, Wineland MJ, Jones WT, llardi RL and Peterson RA (1986).*** Effect of population size floor space and feeder space upon productive performance external appearance and plasma corticosterone concentration of laying hens. *Poultry Science*, 66: 251 – 257.

الملخص العربى

تأثيرات كثافة الأقفاص والظروف المناخية علي أداء الأرانب النامية

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تم توزيع عدد ١٠٢ ذكر من أرانب النيوزيلندى الأبيض المفطومة عند عمر ٣٥ يوم وذات متوسط وزن جسم أولي متساوي على ٨ مجموعات لدراسة تأثير الفترة من السنة وكثافة الأقفاص علـى أداء الأرانب النامية. تم إجراء تجربة ذات تصميم عاملي ٢×٤ يشمل فترتين من العام (الفترة المعتدلـة من أكتوبر ٢٠٠٧ وحتي أبريل ٢٠٠٨، والفترة الحارة من مايو حتى سبتمبر ٢٠٠٨) مع ٤ كثافات مختلفة للأقفاص (٢، ٣، ٤، ٥ أرانب لكل قفص). وقد تم دراسة أداء النمو وصفات الذبيحة وبعض صفات الدم.

أوضحت النتائج غياب العبء الحراري غياب الفترة المعتدلة والتعرض للعبء الحراري الشديد خلاف الفترة الحارة من العام.

أيضا أظهرت النتائج المتحصل عليها أن الفترة الحارة من السنة أثرت سلبياً وبصورة معنوية (٠,٠٥، ٠,٠١) على وزن الجسم عند عمر ١١ أسبوع من العمر والزيادة في وزن الجسم في الفترات من ٨ – ١١، ٥ – ١١ أسبوع من العمر. سببت الفترة المعتدلة من العام حدوث تحسن في الغذاء المستهلك ومعامل تحويل الغذاء. كان للإردحام تأثير سيئ بشكل معنوي (٠,٠٥، ٠,٠١) علي وزن الجسم وكذلك الزيادة في وزن الجسم خلال جميع الأعمار المدروسة. تحسن استهلاك العلف وتحويل الغذاء بصورة معنوية (٠,٠٥، ٠,٠١) في مجموعات الأرانب ذات الكثافة المنخفضة في الأقفاص. أظهرت الأرانب المرباة في أعلي كثافة (٥ أرانب لكل قفص) في الفترة الحارة أقل وزن جسم بصورة معنوية (٠,٠٥، ٠,٠١) عند عمر ١١ أسبوع وأقل زيادة في وزن الجسم في الفترات ٨ – ١١، ٥ – ١١ أسبوع من العمر، أما تلك التي ربيت في في الفترة المعتدلة فقد حققت أعلي وزن وأعلي زيادة في وزن الجسم. تحسنت معنويا (٠,٠٥، ٠,٠١) معظم صفات الذبيحة المدروسة خلال الفترة المعتدلة من العام مقارنة بتلك المدروسة خلال الفترة الحارة من العام. أظهرت مجموعات الأرانب النامية والمرباة في أقل كثافة (٢ أرنب لكل قفص) أفضل صفات للذبيحة، بينما لوحظ أن أسوأ صفات للذبيحة كانت في مجموعات الأرانب المرباة في كثافة عالية (٤، ٥ أرانب في القفص). لم تظهر كل من البروتينات الكلية لبلازما الدم والألبيومين والجلوبيولين والكرياتينين واليوريا أى فروق معنوية نتيجة لتأثير الفترة من العام أو كثافة الأقفاص أو لتأثير التداخل بينهما.

ومن نتائج هذه الدراسة، يمكن التوصية بأنه يجب تعديل كثافة الأقفاص للارانب النامية خلال الفترة الحارة من العام، وأن أفضل نتائج يمكن الحصول عليها عندما يتم توفيرمساحة ٨٠٠ – ١٢٠٠ سنتميتر مربع لكل أرنب نامي.