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Effect of Stocking Density on the Behavior and Productive Performance of Growing Rabbits

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ABSTRUCT-**The present study was to assess the behavior and productive performance of 144 V-line White growing rabbits, reared from 5 to 11 weeks of age under different stocking densities: (12, 16, 20 and 24 rabbits/m²). 24-hrs video recordings were made every week on the same day. The actual behavioral form of each rabbit was recorded using scan sampling method. Based on the results it was found out, that the frequency of Feeding, drinking, body care, movement activities were significantly higher in rabbits stocked at 20 and 24 rabbits/ m² however the resting frequencies % were lower. Higher biting and aggression frequencies % were recorded in rabbit's stocked at 20 rabbits/ m². Productive traits as body weight and daily weight gain and relative growth rate showed a random fluctuation. Body weight, daily weight gain showed no significant differences at the 5th and the 6th weeks of age while a significant increase was recorded in rabbits stocked at 20 rabbits/ m² at weeks 7th and 8th than other groups and this increase remain till the end of the experimental period without significant increase at the last two weeks of the experiment (9th and 10th weeks).Daily weight gain showed significant increase in rabbits reared at 16 rabbits / m² at 7th week of age (56g / day) than other groups. On the other hand rabbits reared at 20rabbits/ m² achieved higher DWG during the last week of the experimental periods. It could be concluded that stocking density affect the frequency of the most important behavior forms of V-line rabbits and it could be increased till 24 rabbits / m2 (43.07 kg / m2) with no significant effect on final body weights.**

Key-words: **rabbits, behavior, stocking density, productive performance**

I. INTRODUCTION

Efficient and safe production concerning animal welfare and environmental aspects is a requirement in animal breeding becoming increasing widespread in the world. From the viewpoint of animal welfare the most common problems are the high stocking density, large group size and the restriction of the social and locomotors behaviors. Held et al. (1995) and Chu et al. (2004) reported that laboratory rabbits living in social isolation can display physiological symptoms of stress. In a recent study, individually housed rabbits were free to move between two cages (Dalle Zotte et al., 2009) the walls in one cage were covered with mirrors and the walls in the other were covered with plastic panels. Several experiments have been conducted to investigate the behavior of growing rabbits as a function of group size. Morisse and Maurice (1996) compared the behavior of growing rabbits in relation to stocking density (15.5 vs. 23 rabbits/ m²) they found that the behavior of young rabbits slightly affected by stocking density at 7 weeks of age. At 10 weeks of age, resting and comfort behavior increased as well as reductions in eating, drinking and locomotors activities were observed between densities of 15.5 rabbits (38 kg m²) and 23 rabbits (57kg/ m²). Social interaction and locomotors activities were reduced and the number of patterns of comfort behavior was increased above 15.5 rabbits (38kg /m²). Agonistic and investigatory behaviors also slightly increased. Morisse and Maurice (1996) stated that 40kg/ m² could be considered an acceptable threshold in terms of animal welfare. Stocking densities with less than 16 rabbits/ m²do not provide any positive effect on behavior. Comparing densities of 12 and 16 rabbits/ m² Trocino et al. (2004) did not observe any significant differences in the behaviors (resting, moving, eating and self-grooming) of growing rabbits. Szendrő and Dalle Zotte (2010) stated that the optimal stocking density is 16–18 rabbits/m² (final animal load 40–45 kg /m²), depending on final weight. Comparing two to six animals per cage solutions to larger groups, daily weight gain and body weight decreased by 2.67g / day and 125g on average showing a clear tendency of decreasing weight gain with increasing group size. The slower growth rate can be related to higher locomotors activity because part of the ingested energy is used for this purpose. The decline of some productive traits was significant in most experiments: in daily weight gain reduction was between 1.0 and 9.3g / day (Mirabito et al., 1999a; Maertens and Van Herck, 2000; Lambertini et al., 2001; Maertens and Van Oeckel, 2001; Dal Bosco et al., 2002; Jehl et al., 2003; Szendrő et al., 2009) and final weight reduction was between 33 and 445g (Mirabito et al., 1999b; Maertens and Van Herck, 2000; Maertens and Van Oeckel, 2001; Lambertini et al., 2001; Dal Bosco et al., 2002; Jehl et al., 2003; Combes et al., 2010; Szendrő et al., 2009). In other experiments, the effect of group size on weight gain or on final weight was not significant (Rommers and Meijerhof, 1998; Princz et al., 2009; Szendrő et al., 2009). The objective of the present study was to analyze the behaviors forms and the productive performance of growing rabbits kept on different stocking densities.

II. MATERIAL AND METHODS

Animals and housing conditions

The experiment was carried out at a private rabbit farm Alexandria province using 144 V- line white rabbits of both sexes. During the experiment rabbits were housed in 16 cages, each having a size of 50 × 50cm using a lighting regime of 16L/8D in a closed rabbit house. The temperature in the building was 16 - 24 ºC. Four different stocking densities were used (12, 16, 20 and 24 rabbits/m²). The feeder of each cage was 15cm long and water was available *ad-libitum* from nipple drinkers (two drinkers per cage). Rabbits were reared under this experiment from 5 to 11 weeks of ages. The growing rabbits received *ad-libitum* commercial pellet (16.0% crude protein, 16.0% crude fiber and 3.0% ether extract, according to the factory label).

Behavioral patterns

The behavior patterns were evaluated by using infrared camera 24h video recordings at 5.5 and 10.5 weeks of age. On the day of recording nobody entered the rabbitry avoiding disturbance to the rabbit behavior. Recording were made through 24 h / day time (dark and light periods) and were evaluated by recording the behavioral patterns of the rabbits with a frequency of 2 min using scan sampling methods. The following behaviors were analyzed as percentages of the observed time according to Trocino et al., (2013).

I. Ingestive behaviors.

A- Feeding: Consumption of feed from the feeder, gnawing the pellet

B- Drinking: Drinking water from nipple drinker

II. Resting (Crouched body, with abdomen in contact with the floor, or stretched body, with both fore and hind legs stretched beside the abdomen in contact with the floor).

III. Locomotors behaviors: Any voluntary change of position (walking or running)

IV. Body care behaviors:

C- Self grooming: Any behavior from connected with the own body of the animal (licking or scratching)

D- Allo-grooming: Any behavior from connected with the other animal body (licking or scratching).

V. Investigatory behaviors (Sniffing): Behavior forms connected to the cage or its equipments (rubbing, licking, gnawing, smelling, and marking with the chin) or other investigation the animal investigates other animal.

VI. Aggression: chasing or biting other animal

Growth Performance Parameters

Body weight (BW) was recorded weekly from 5 to 10 weeks of age, daily weight gain (DWG) and relative growth rate (RGR) also recorded for the same periods for the different groups of stocking densities.

Statistical analysis

Frequency differences of the behavior forms and the productive traits of rabbits kept under various stocking densities were determined by means applying SPSS 10.0 (2013) software package. The data of body weight BW, DWG and RGR were analyzed by Statistical Analysis System SAS (2002) using GLM. The ANOVA model included the following effects: Yij=μ+Fi+eij where μ is the general mean, Fi the effect of stocking density and eij is the random error.

III. RESULTS

Table 1: Mean± SE of the effects of different stocking densities on the behavioral patterns of V-line rabbits.

Item	Stocking density			
	12/ m²	16/ m²	20/ m²	24/ m²
Ingestive behavior				
Feeding	12..52±1.41 ^{b}	11.52±1.41 ^{b}	15.74± 1.30 ^{a}	14.10±0.71 ^{a}
Drinking	2.79±0.57^{b}	2.38±0.58^{b}	4.71±0.74^{a}	5.85±0.56^{a}
Resting behavior				
Total resting	77.36±2.31 ^{a}	77.85±2.29 ^{a}	57.65±2.00 ^{b}	62.10±1.44^{b}
Stretched body	47.20±2.66 ^{a}	50.87±2.55 ^{a}	10.59±1.61 ^{b}	14.58±0.92 ^{b}
Crouched body	30.95±2.13 ^{b}	27.271.95 ^{b}	46.76±2.13 ^{a}	47.52±1.34 ^{a}
Movement activities				
Walking	3.77±0.86 ^{bc}	2.53±0.66 ^{b}	5.00±0.88 ^{a}	3.12±0.44 ^{bc}
Running	0.40±0.28 ^{a}	0.15±0.15 ^{a}	0.74±0.32 ^{a}	0.40±0.18 ^{a}
Exploratory				
Sniffing	0.99±0.43 ^{c}	1.04±0.38 ^{b}	1.91±0.48 ^{a}	1.04±0.27 ^{b}
Body care behavior				
Self grooming	2.58±0.77 ^{b}	1.49±0.44 ^{b}	12.94±1.37 ^{a}	11.70±1.03 ^{a}
Alleogrooming	0.00±0.00 ^{d}	0.00±0.00 ^{c}	0.74±0.32 ^{a}	0.24±0.14 ^{b}
Aggressive behavior				
Biting	0.00±0.00 ^{b}	0.00±0.00 ^{b}	0.29±0.21 ^{a}	0.00±0.00 ^{b}
Aggression	0.00±0.00 ^{c}	0.00±0.00 ^{c}	0.29±0.01 ^{a}	0.08±0001 ^{b}

Means with in the same raw carry different superscripts are significantly different (*P<0.05*).

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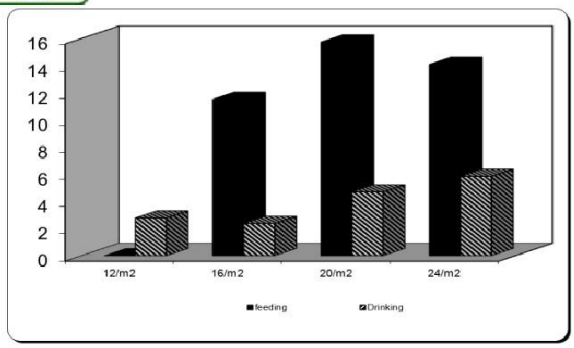

Fig (1) effect of stocking density on ingestive behavior of V-line rabbit

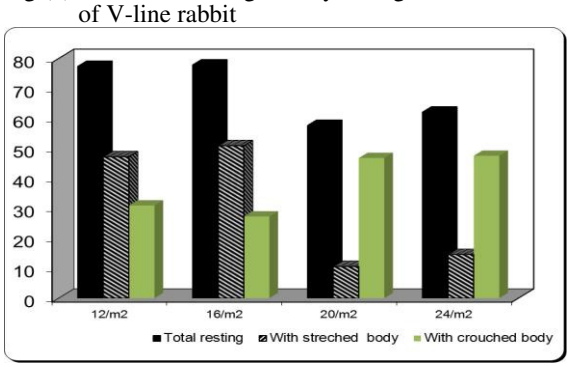

Fig (3) effect of stocking density on Locomotors & exploratory behavior of V-line rabbit

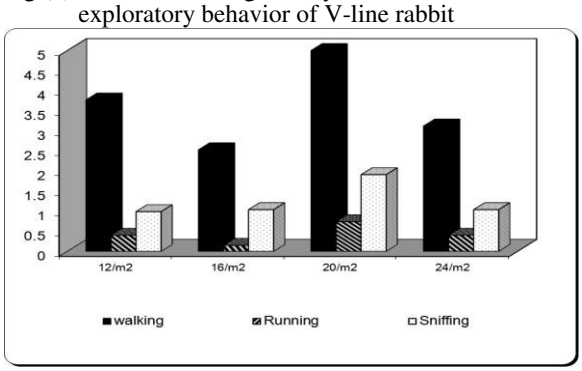

Fig (4) effect of stocking density on body care & aggressive behavior of V-line rabbit

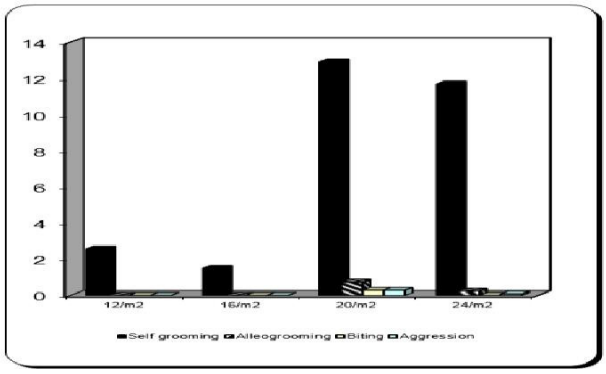

Fig (2) effect of stocking density on resting behavior of V-line rabbit

Data presented in table (1) revealed that the frequencies% of feeding was ranged between 11.52-15.74% in all groups, and it was significantly higher in rabbits reared at stocking of 20 rabbits / m² however; by increasing the density to 24 rabbits/ m² the eating frequency was decreased to only 14.10%. On the other hand, the lowest feeding frequency% (11.52%) was recorded for 16 rabbits/ m² (Table 1). Drinking frequencies % also showed the same trend as it was higher when at stocking density 24 and 20 rabbits / m². But, the lowest frequency was observed in 16 rabbits / m². Resting frequencies were significantly higher in the rabbits stocked at low numbers 12 and 16 rabbits/ m² (77.36% vs.77.85%) compared to those stocked at high numbers as 20 rabbits/ m², 24 rabbits/ m² (57.65% vs. 62.10%). However the highest resting time performed with stretched body in lower stocking density (12 and 16 rabbits/m²) while, in the higher stocked rabbits (20 or 24 rabbits/ m²) higher resting frequency % was performed with crouched body. Highest movement activities walking and running % and exploration (sniffing%) were observed in rabbits stocked at 20 rabbits/ m² however, the lowest walking and running % were observed in rabbits stocked at 16 rabbits / m². In our study body care behavior (self and Alleogrooming %) were higher in rabbits stocked 20 and 24 rabbits / m² than rabbits stocked at lower density at 12 and 16 rabbits /m². Rabbits stocked at 20 rabbits/ m² showed the highest aggressive behavior (aggression and biting %) than other groups.

Table (2): Mean ± SE of body weight, daily weight gain and relative growth rate of V-line rabbits under different stocking densities

Item	Stocking density			
	12/ m²	16/ m²	20/ m²	24/ m²
Body weight (g)				
5 week	576.67±42.45 a	562.50±36.76 a	581.00±32.88 a	586.67±30.02 a
6 week	750.00±54.76ab	732.50±47.42ab	655.00±42.42 b	773.50±38.72 a
7 week	1105.83±89.94 a	985.88±77.89 a	989.00±69.67 a	1111.50±63.60a
8 week	1484.17±87.71 a	1380.63±75.96ab	1243.00±67.94 b	1378.33±62.02ab
9 week	1694.17±87.06a	1627.50±75.39 a	1506.00±67.43 a	1644.58±61.56 a
10 week	1847.00±86.36a	1826.43±72.99 a	1847.78±64.37 a	1794.55±58.23 a
Final total biomass (kg)	22.16	29.22	36.96	43.07
Daily weight gain				
35-42 day	24.76±3.18 a	24.29±2.75 a	22.57±2.46 a	26.69±2.25 a
42-49 day	50.83±7.72 a	46.20±6.68 a	47.72±5.98 a	48.29±5.46 a

49-56 day	54.05±3.11 a	56.39±2.70 a	36.29±2.41 b	38.12±2.20 b
56-63 day	30.00±2.49 b	35.27±2.16 ab	37.57±1.93 a	38.04±1.76 a
63-70day	31.00±3.98 b	22.14±3.36 c	43.17±2.96 a	25.06±2.68 bc
Overall daily weight gain	37.23±1.68 a	35.47±1.42 a	35.75±1.25 a	34.88±1.13 a
Relative growth rate				
35-42 day	25.42±2.99 a	26.01±2.59 a	24.91±2.32 a	27.50±2.11 a
42-49 day	39.75±4.86 a	30.29±4.21 a	38.09±3.77 a	34.99±3.44 a
49-56 day	29.49±2.86 abc	33.85±2.47 a	24.08±2.21b c	22.41±2.02 c
56-63 day	13.18±1.60 b	16.58±1.39 ab	19.96±1.24 a	17.91±1.13 a
63-70day	12.44±1.81 a	8.65±1.53 b	18.39±1.35 a	10.33±1.22 a
Overall daily relative	109.38±3.31 a	103.48±2.80 a	102.64±2.47 a	103.26±2.23a

Means with in the same raw carry different superscripts are significantly different ($P<0.05$).

It was clear that the initial body weight in all groups showed no-significant difference table (2) Fig (5) however at six weeks of age a higher significant increase for body weight was recorded in rabbits stocked at 24 rabbits / m² and this increasing was remain till 7th week of age. At the eighth week of age a significant increase for body weight was recorded in the rabbits reared at lower stocking density (12 rabbits /m²). Regarding the effect of stocking density on final body weight no significant differences were recorded in final weight and the final total biomass for different stocking densities 12, 16, 20 and 24 rabbits/ m² (22.16, 29.22, 36.96 and 43.07 kg; respectively).

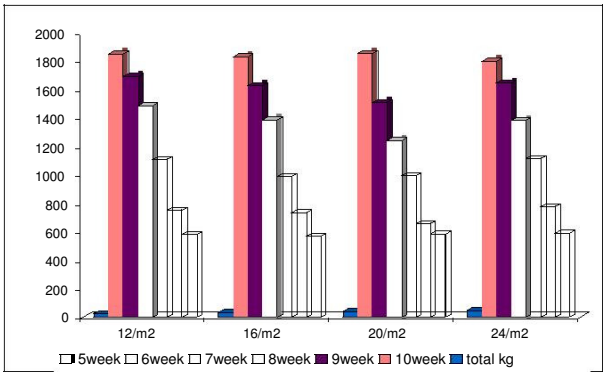

Fig (5) Effect of different stocking densities on the body weight of growing V-line rabbit.

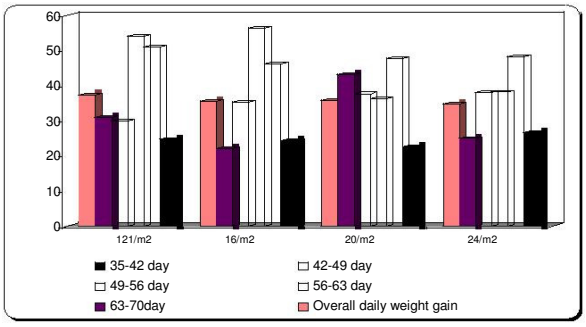

Fig (6) Effect of different stocking densities on the daily weight gain of growing V-line rabbit.

Data for the effects of stocking density on daily weight gain presented in table (2) Fig (6) revealed that, daily weight gain wasn't significantly different at the periods from 35-42 and from 42-49 day of age between different groups. It could be observed that, daily weight gain at the periods of 49-56 and from 56-63 days of age were significantly increased for rabbits stocked at 24 and 20 rabbits/ m² however; the significant differences disappeared at the last two weeks of age.

With the same trend the relative growth rate was non-significant at the beginning of the experiment 6 and 7 weeks of age. However the differences between stocking densities were significant at 8th and 9th week of age and this difference disappeared at the end of the experiment

IV. DISCUSSION

1-Behavior patterns: Animal production intensity depends partly on stocking density (number of animals per square meter in a cage, pen or building). When stocking density is higher than optimum, it can lead to a decline in production, impaired health status and

create stress and uncomfortable conditions for the animals. If lower than optimal, it may not give any benefit for the animals and may not be profitable. Housing growing rabbits in higher stocking density significantly increase feeding frequency % which was higher in rabbits stocked at 20 rabbits / m² than the other groups, moreover, the drinking frequency % was also higher and we hypothesized that, when stocking density increased the animal energy requirements also increased because their movements were increased,

they consume more feed and this feed required much drinking of water for swallowing and digestion. This results were disagreed with Rommers and Meijerhof, (1998); Princz et al., (2009); Szendrő et al., (2009) as they reported that, rabbits in larger groups consumed less pelleted feed than those in smaller groups. These results were in accordance with the results of Morisse and Maurice (1996), who observed the similar decrease in the frequency of eating and drinking during growing period for rabbits stocked at lower stocking densities 8 or 12 rabbits/ m². The resting behavior showed the highest frequency among the behavior forms reaching occasionally 78%. The effect of stocking density on the resting behavior presented in table 1; highly significant differences among all rabbit groups were observed. Rabbits stocked higher were showed the lower resting% and due to low space availability rabbits rested much time in crouched body. While rabbits kept in the smallest stocking density (12, 16 rabbits/ m²) had the highest resting frequency compared to rabbits kept in larger stocking densities and moreover due to space availability rabbits rested much time with their body stretched.

In an opposite trend Trocino et al. (2004) did not observe any significant differences in the behaviors (resting, moving, eating and self-grooming) of growing rabbits.

Movement behaviors (walking and running) showed a substantial decrease in frequency in lower stocking density compared to higher stocking density. Higher movement at higher stocking densities could be possibly explained by the higher number of animal and lower available feeding and drinking space so rabbit movements were increased to obtain their feed and water. Similar results were obtained by Morisse and Maurice (1996) they found that, in larger groups, rabbits rested less and were more active and they spent more time moving around. The body care behavior of young rabbits was significantly affected by stocking density as the self and allo-grooming were significantly higher at stocking of 20 and 24 rabbits/ m² than rabbits stocked in lower densities 12 and 16 rabbits/ m². Similar results were recorded by Morisse and Maurice (1996) they stated that, the agonistic, comfort and investigatory behaviors were slightly increased and the stocking density of 40kg m² could be considered as an acceptable threshold in terms of animal welfare. Stocking densities with less than 16 rabbits/ m² do not provide any positive effect on behaviors. Comparing densities of 12 and 16 rabbits/ m² Trocino et al. (2004) did not observe any significant differences in the behaviors (resting, moving, eating and self grooming) of growing rabbits.

2- Productive performance: Our examination of the stocking density effect on body weight revealed a significant increase in body weight at 6 and 7 weeks of age for rabbits stocked at 24 rabbits / m². While at eighth week of age a significant increase for body weight was recorded in rabbits reared under lower stocking density (12 rabbits /m²). Regarding the effect of stocking density on final body weight no significant differences were recorded for the final weight and the final total biomass for the different stocking densities (12, 16, 20 and 24 rabbits/ m²) at the periods from 35-42 and from 42-49 day of age. However non-significant increase was observed for rabbits stocked at 20 rabbits/ m² and total biomass was 36.96kg / m^2. Similar results were reported by Rommers and Meijerhof, (1998); Princz et al., (2009); Szendrő et al., (2009) they found that, stocking density had no significant effect on weight gain or final body weight. On the other hand,

Szendrő and Dalle Zotte (2010) stated that the optimal stocking density is 16–18 rabbits/ m² (final animal load 40–45 kg /m²).

It could be observed that daily weight gain at the periods of 49-56 and from 56-63 day of age were significantly increased for rabbits stocked at 24 and 20 rabbits/ m² however the significant difference disappeared at the last week of age. Similar results were observed by Princz et al., 2009 and Szendrő et al., 2009 they stated that, when stocking density was lower than 15–17 rabbits/ m², only a random fluctuation was observed. In contrast, Szendrő and Dalle Zotte (2010) stated that, a clear tendency was observed for increasing weight gain with increasing of group size, as slower growth rate can be related to higher locomotors activity because part of the ingested energy is used for this purpose. Moreover, Trocino et al., 2004 stated that when stocking density was higher than 15–17 rabbits/ m², daily weight gain and final body weight declined by 1.2–3.3 and 120–177g.

V. CONCLUSION

It could be concluded that stocking density affected the frequency of the most important behaviors of V -line rabbits and it could be increased till 24 rabbits / m^2 (43.07 kg / m^2) with no significant effect on final body weights.

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