World Rabbit Science, vol 10 (3), 103-109

# NON GENETIC FACTORS AFFECTING RABBIT REPRODUCTION IN ALGERIA

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**ABSTRACT:** Environmental variability of reproductive traits has been investigated on a pool of 51 does of different origin in a rabbit breeding unit in Tizi Ouzou region. The objective was to estimate the effects of different factors such as kindling season, parity, physiological state of does, and number born alive on characters such as acceptation rate, conception and kindling rate by female, total born alive, stillborn, litter size at weaning, pre-weaning and post-weaning mortality and weekly litter weights from birth to weaning. Mean bunny weight at birth, at weaning and 70 days of age, litter weight at 70 days of age and total litter gain during lactation have also been considered. Results show that kindling season affects only litter size at weaning with favourable effect of autumn and spring (7.8 *vs* 6.6). Highest mean weights at birth are recorded in autumn (16.2 g more than others) and highest litter weights at weaning during the three seasons other than summer (700 g more). The highest mean weight at 70 days is obtained in winter (1.9 Kg). For parity effect, we have recorded the greatest conception and kindling rates at the beginning of reproductive life (98.7 and 96.03% respectively). Other performances did not vary according to this factor. Lactating females at mating had the same acceptation, conception and kindling rate and similar litter sizes as no lactating; however, superior values were obtained for non lactating does for litter size. Moreover, differences due to effect of number born alive on weekly mean weights were significant. However, this effect fades down at 70 days of age.

**RÉSUMÉ: Facteurs non génétiques affectant la reproduction du lapin a l'Algérie.**
Une étude de la variabilité des caractères de reproduction a été réalisée dans un élevage cunicol de la région de Tizi-ouzou (Algérie) sur un effectif de 51 femelles. L'objectif étant de mettre en évidence la variation due aux facteurs de l'environnement (saison de mise bas, ordre de portée, état physiologique de la femelle au moment de la saillie et le nombre de nés vivants). Les caractères étudiés sont les taux de réceptivité, de fertilité et de mise bas par femelle, les nés totaux, nés vivants, nombre de sevrés et de vivants à 70 jours d'âge, la mortinatalité, mortalité présevrage et post-sevrage, les différents poids de portées hebdomadaires de la naissance au sevrage ainsi que les poids moyens du lapereau à la naissance, au sevrage et à 70 jours d'âge et le gain total de la portée en présevrage. Les résultats montrent que la saison de mise bas affecte la taille de portée au sevrage en faveur des naissances automnales et printanières (7.8 *vs* 6.6). Aussi, en automne, on a enregistré les meilleurs poids moyens à la naissance (116.2 g de plus par rapport aux autres) et les poids des portées au sevrage les plus élevés pendant les trois saisons par rapport à l'été (700 g de plus). Le meilleur poids moyen à 70 jours d'âge est obtenu en hiver (1.9 Kg). Pour l'ordre de portée, nous avons enregistré les meilleurs taux de fertilité et de mise bas en début de carrière (98.7 et 96.03% respectivement). Les autres performances ne varient pas selon le rang de mise bas. Les femelles allaitantes au moment de la saillie ont les mêmes taux de réceptivité, de fertilité et de mise bas et les mêmes tailles de portée que les non allaitantes; néanmoins des valeurs supérieures sont obtenues chez les non allaitantes pour la taille de portée. Aussi, des différences dues à l'effet du nombre de lapereaux nés vivants sur les différents poids moyens et hebdomadaires sont observées avec de meilleurs poids moyens au sevrage pour les portées inférieures à 4 par rapport surtout aux portées avec un effectif compris entre 8 et 13 lapereaux (183 g). Cet effet toutefois s'atténue à l'âge de 70 jours.

## INTRODUCTION

The productive and economic interest of reproduction traits has been reported by several authors (Bonnes *et al.*,1984; Baselga and Blasco, 1989). They are main objectives in rabbit genetic improvement for meat (Baselga *et al.*, 1984; Baselga and Blasco, 1989). The study of reproduction is complex as it involves simultaneously the mother's physiological functions and their offspring (Auran and Skjervold, 1979). On the other hand, environment, that contributes greatly to the variation of these characters, is the first component to study in order to design an eventual program of genetic improvement of medium or long term for our local populations of rabbits. The aim of this paper is to quantify the effects of different environmental and non-genetic factors on reproductive traits of a population of local rabbits raised in Algerian conditions.

## MATERIAL AND METHODS

The data came from 51 females (24 nulliparous

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and 27 multiparous at the start of the experiment) that are a sample of the rabbits commonly raised in Algeria with some influence of New Zealand White and California. They were housed in individual cages in an 80 $m^2$ commercial farm that was naturally lit and ventilated. Humidity went beyond 80% in winter and reached 50% in summer.

Females were first mated when they were 15-22 weeks and had a minimum weight of 2500 g. They were re-mated 10-12 days after kindling and also forced if they refused. Bucks were used three to five times/week. Palpation was made 12 or 14 days after mating. Females were culled when they permanently refused bucks and when their weights decreased .

For the whole trial period (July 1999-June 2000), animals were fed ad-libitum with a commercial feed containing 4% soya, 42% alfalfa flour, 32.5% bran, 16% barley, 0.5% feed blocks and 5% corn.

The traits recorded were acceptation rate, conception rate, kindling rate, litter size at birth (LSB), number of born alive (NBA), litter size at 70 days (LS70) and weekly weights of the litter from birth up to weaning at 30 days (LWB, LW1, LW2, LW3, LW30) and 40 days after weaning (LW70). Stillbirths, pre-weaning and post-weaning mortality were also recorded. Mean kit weights at birth, at 30 days and 70 days of age (MWB, MW30, MW70), and total litter gain during suckling (G) were calculated.

Three different models were considered. The first one was used for acceptation, conception and kindling rates:

$$Y_{ijk}=PO_i + PS_j + e_{ijk}$$

where PO is the parity effect with eight levels, and PS is the physiological state with two levels: lactating and non-lactating.

The second model was used for all litter sizes:

$$Y_{ijkl}= PO_i + PS_j + SK_k + e_{ijkl}$$

where PO is the parity effect with two levels: parities 1 and 2, and parities 3 to 8. PS is the physiological state and SK is the season of kindling.

The third model was used for litter weight and mean individual weights:

$$Y_{ijkl}= PO_i + CB_j + SK_k + e_{ijkl}$$

where PO is the parity effect as in Model 2, CB is the class of number born alive (with three levels: 1-4, 5-7 and 8-13) and SK is the season of kindling.

Statistical analyses were performed using the least squares method implemented in the general linear model (GLM) procedure of SAS (SAS, 1987).

## RESULTS AND DISCUSSION

Season of kindling (Table 1) did not affect significantly litter size at birth, number of born alive and litter size at 70 days of age. Seasonal differences were found for litter size at weaning (LSW), the greatest values were those related to temperate periods (autumn and spring, respectively) and the lowest value was obtained in summer. As it has been reported in literature, kindling season is a factor that influences most performances through differences in temperatures, humidity, photoperiod and other parameters (CHERIET, 1983). Our results are comparable with those of TORRES *et al.*, (1992) who noted the negative effect of heat season on litter size at weaning. KHALIL *et al.*, (1987) indicated that kits in this period are very sensitive to changes of external environment. However, AFIFI *et al.*, (1989) did not find differences for the number of kits at 30 days of age.

Table 2 shows that season did not affect litter weight when summer is not considered. Differences were significant ($P \leq 0.05$) on litter weight at weaning with the highest values in autumn and the lowest in summer. The decrease observed for litter weight at weaning in summer is in agreement with findings of RAFEL *et al.*, (1990). Many authors (YAMANI *et al.*, 1991) justify these results by a decrease in milk yield during this season. A seasonal effect was found for mean kit weight at birth and 70 days. MW70 had the highest values in winter and the lowest in spring with a difference of 285 g between them. YAMANI *et al.*, (1991) found that high mean weights at birth are those pertaining to kits born in autumn and winter which agrees with our results. BASELGA (1978) found the best individual mean weights at 70 days in autumn and winter. He assigned the result to modification of animals' appetite. ROUVIER (1978) and CHERIET (1983) noted that weight before weaning is more dependent on maternal effects, thus seasonal effects are more important after weaning.

The parity effects on acceptation rate, conception and kindling rates are showed in Table 3. Females accepted bucks whatever their age, and very high rates were noticed in the beginning of the reproductive life, although even later percentages are high. The 8th litter showed the lowest value. KEMOUCHE and OUYED (1998), RABIA and YACINI (1999) remarked that females accept better the bucks while they are young, in agreement with our results. There is not a clear pattern for the effect of parity order on conception and kindling, although, the highest ratios were obtained in the first parity. POUJARDIEU and THEAU-CLÉMENT (1995), RABIA and YACINI (1999) noted this decrease from the second and the third litter.

According to several authors, AFIFI *et al.*, (1989), RAFEL *et al.*, (1990), BRUN and SALEIL (1994), POUJARDIEU and THEAU-CLÉMENT (1995), litter size improves with the age of the does, the maximum being between the third and the fifth parity. However, we did not find differences between paritries.

Parity effect was non significant for kit litter weights and mean weights. KHALIL *et al.*, (1987) indicated that litter weight at birth increases until the sixth parity; and at weaning, YAMANI *et al.*, (1991) and POUJARDIEU and THEAU-CLÉMENT (1995) showed that mean weight of kits was higher for the first, second and third litters than for the fourth and fifth ones but the reverse was true for litter weight. They justify these results by an improvement of litter sizes at birth and weaning as the age advances. Our results however did not reveal any effect during the whole period, and they are in agreement with those of HASSAN *et al.*, (1994).

Acceptation, conception and kindling rates were not significantly affected by the fact that females were lactating or non lactating at the re-mating time. This

**Table 1:** Least square means of season effect for litter size at birth (LSB), number of born alive (NBA), litter size at weaning (LSW) and litter size at 70 days (LS70).

| Season | LSB | NBA | LSW | LS70 |
|---|---|---|---|---|
| Summer | 8.84 ± 0.70 | 8.29 ± 0.71 | 6.25 ± 0.54$^{a}$ | _ |
| Autumn | 8.74 ± 0.40 | 8.87 ± 0.42 | 7.92 ± 0.32$^{b}$ | 5.38 ± 0.48 |
| Winter | 8.70 ± 0.40 | 8.33 ± 0.41 | 6.95 ± 0.31$^{ac}$ | 5.06 ± 0.40 |
| Spring | 9.43 ± 0.38 | 8.08 ± 0.40 | 7.70 ± 0.34$^{cb}$ | 5.40 ± 0.52 |
| Significance | NS | NS | ** | NS |

Means within a column with different superscripts differ.
**$P < 0.01$; NS: no significant.

**Table 2:** Least square means of season effect for different litter weights, mean weights and total litter pre-weaning gain.

| Season | Summer | Autumn | Winter | Spring | Significance |
|---|---|---|---|---|---|
| LWB | - | 375 ± 40 | 308 ± 19 | 305± 16 | NS |
| MWB | - | 66± 5$^{b}$ | 56± 2$^{cb}$ | 53 ± 2$^{c}$ | * |
| LW1 | - | 735± 44 | 793± 37 | 771 ± 41 | NS |
| LW2 | - | 1416 ± 76 | 1329 ± 71 | 1391 ± 78 | NS |
| LW3 | - | 2204 ± 100$^{a}$ | 2068 ± 97$^{a}$ | 2069± 114$^{a}$ | NS |
| LW30 | 2600 ± 239$^{a}$ | 3482 ± 149$^{b}$ | 3233 ± 158$^{b}$ | 3327 ± 185$^{b}$ | * |
| MW30 | 569 ± 31 | 602 ± 19 | 626 ± 20 | 589 ± 24 | NS |
| LW70 | - | 8721 ± 767 | 8326 ± 733 | 6801 ± 919 | NS |
| MW70 | - | 1865 ± 51$^{a}$ | 1989 ± 50$^{b}$ | 1704 ± 62$^{c}$ | ** |
| G | - | 3381 ± 17 | 3643 ± 11 | 3402 ± 10 | NS |

LWB: Litter weight at birth (g); MWB: mean kit weight at birth (g); LW1, LW2, LW3: Litter weight at one,two and and three weeks respectively (g); LW30: Litter weight at weaning (g); MW30: Mean kit weight at weaning (g); LW70: Litter weight at 70 days (g); MW70: Mean kit weight at 70 days (g); G: Total preweaning gain (g).
Means within a row with different superscripts differ.
*$P$<0.05;** $P$<0.01; NS: no significant.

agrees with (THEAU-CLÉMENT and POUJARDIEU 1994), but THEAU-CLÉMENT and ROUSTAN (1980, 1991) found in previous studies a greater conception rate when females are not lactating. It is well known that females accept bucks better just after kindling and become less receptive 3-5 and 10-12 days after delivery than no lactating females (THEAU-CLÉMENT *et al.*, 1990).

Physiological state had no significant effect on litter size during the whole period (0-70 days). This agrees with ESTANY *et al.*, (1989) who suggested that it was due to competition between lactation and gestation. RABIA and YACINI, (1999) also gave similar results in nearly the same conditions. However a positive effect of lactation on ovulation rate has been noted by PLA, (1984).

Significant effects on the classes of number of born alive were observed for the different litter weights, that increased with the number of born alive, but this effect was not significant for total litter gain during lactation. It is well known that, when kits are under the mother, their growth depends mainly on maternal effects (AURAN and SKJERVOLD, 1979; CHERIET, 1983). The mean kit weight at weaning (Table 4) was the only mean kit weight significantly affected by the classes of litter size. The greater the litter size, the lower the weight at weaning. The value for the class of 1-4 born alive showed a difference of 183 g with the class 8-13. This influence of litter size has been reported by several authors (ROUVIER, 1978; VRILLON *et al.*, 1979; DELAVEAU, 1982; MASOERO, 1982; ESTANY *et al.*, 1992) and it is due to the amount of milk offered to each kit. ROUVIER *et al.*, (1973) and BOLET *et al.*, (1996) reported that the effect of this factor along lactation persists beyond weaning. OUHAYOUN (1978) noted that effects on mean kit weight at slaughtering are the consequence of the litter size effect on weight during the lactating period, but in our results, mean kit weight at 70 days of age did not change significantly with litter size, althought litter size had an influence on litter weight at 70 days. Mean weight at birth was not significantly influenced by the number born alive.

**Table 3:** Least square means of parity effect on acceptatio, conception and kindling rates.

| Parity order | Acceptation rate (%) | Conception rate (%) | Kindling rate (%) |
|---|---|---|---|
| 1 | 99.41 ± 3.34$^{a}$ | 98.72 ± 6.53$^{a}$ | 96.03 ± 6.94$^{ad}$ |
| 2 | 95.12 ± 3.04$^{a}$ | 68.92 ± 5.95$^{cb}$ | 64.24 ± 6.31$^{bc}$ |
| 3 | 91.29 ± 3.43$^{ab}$ | 73.98 ± 6.72$^{cb}$ | 70.93 ± 7.13$^{b}$ |
| 4 | 99.15 ± 3.72$^{a}$ | 82.07 ± 7.28$^{ab}$ | 78.33 ± 7.72$^{ab}$ |
| 5 | 94.97 ± 4.18$^{a}$ | 69.89 ± 8.19$^{cb}$ | 57.50 ± 8.69$^{bc}$ |
| 6 | 89.58 ± 4.55$^{ab}$ | 69.02 ± 8.91$^{bc}$ | 63.61 ± 9.46$^{bc}$ |
| 7 | 98.93 ± 5.23$^{a}$ | 84.62 ± 10.23$^{ac}$ | 83.86 ± 10.86$^{ab}$ |
| 8 | 78.97 ± 6.55$^{b}$ | 47.24 ± 12.82$^{c}$ | 36.50 ± 13.61$^{c}$ |
| Significance | * | ** | ** |

Means within columns with different superscript differ.
*$P$<0.05; ** $P$ <0.01.

The only mortality trait exhibiting a clear trend over season of kindling was stillbirths ($P$≤0.001). An effect was observed on pre-weaning mortality ($P$≤0.05), but post-weaning mortality was not affected by the factors studied. According to some authors (KHALIL *et al.*, 1987 ; YAMANI *et al.*, 1991 ; HAMADÈNE, 1996), mortality is the most obvious sign of heat stress, heat stress that also causes poor weights gains, impaired feed conversion and increased diseases incidence. Our results are similar to those of YAMANI *et al.*, (1991). It was during post-weaning period when the highest mortality took place (26.2% after weaning, 10.2% before weaning). A negative effect due to physiological state on mortality has been indicated by some authors (RAFEL *et al.*, 1990) which is associated with the more important stress in lactating does, however this does not agree with our results. Several authors (ROUVIER *et al.*, 1973; HULOT and MATHERON,

**Table 4**: Least square means of classes of number of born alive (NBA) effect on different litter weights, mean weights and total litter preweaning gain.

| Classes of NBA | 1-4 | 5 -7 | 8 -13 | Significance |
|---|---|---|---|---|
| MWB | 60 ± 4 | 60 ± 2 | 57 ± 2 | NS |
| LW1 | 385 ± 81$^{a}$ | 840 ± 32$^{b}$ | 1075 ± 25$^{c}$ | *** |
| LW2 | 845 ± 153$^{a}$ | 1507 ± 56$^{b}$ | 1778 ± 43$^{c}$ | *** |
| LW3 | 1467 ± 193$^{a}$ | 2247 ± 85$^{b}$ | 2628 ± 64$^{b}$ | *** |
| LW30 | 2137 ± 289$^{a}$ | 3225 ± 131$^{b}$ | 4119 ± 109$^{c}$ | *** |
| MW30 | 698 ± 37$^{a}$ | 576 ± 17$^{b}$ | 515 ± 14$^{b}$ | *** |
| LW70 | 5267 ± 1543$^{a}$ | 7910 ± 651$^{a}$ | 10611 ± 434$^{b}$ | *** |
| MW70 | 2052 ± 185 | 1844 ± 73 | 1752 ± 92 | NS |
| TLGb-w | 2803 ± 824 | 2921 ± 366 | 3864 ± 435 | NS |

MWB: Mean kit weight at birth (g); LW1, LW2, LW3: Litter weight at one,two and and three weeks respectively (g); LW30: Litter weight at weaning (g); MW30: Mean kit weight at weaning (g); LW70: Litter weight at 70 days (g); MW70: Mean weight at 70 days (g); G: Total pre-weaning litter gain (g).
Means within a row with different superscripts differ.
*$P$<0.05;** $P$<0.01; NS: no significant.

1981; YAMANI *et al.*, 1991) have found a parity effect on mortality. They justify the findings by the exhaustion of females with advancement of age, but our results do not corroborate those, as the effect was not significant in our case.

## CONCLUSION

Our results concern populations adapted to real local conditions in Algeria. We found seasonal effects of kindling only on litter size at weaning, mean weights at birth and weaning, and in stillbirth and preweaning mortality. Conception and kindling rate are mainly affected by parity. We did not find any effect of physiological state at re-mating for all studied characters. Finally, litter size at birth affected nearly all measured weights.

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