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# EFFECT OF THE GENOTYPE, DAY LENGTH, SEASON AND PHYSIOLOGYCAL STAGE ON THE REPRODUCTIVE PERFORMANCE OF DOE RABBITS REARED IN GUADELOUPE (F.W.I.)

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**ABSTRACT** : The aim of this study was to compare under tropical climate conditions the reproductive performance of doe rabbits as affected by the genotype (NZ *vs* NZxCAL), lighting conditions (11h of natural light + 5h of artificial light per day *vs* 11h of natural light), the season (hot and wet *vs* cool and dry) and the physiological stage (nursing or non nursing females at mating ). A total of 272 matings were analysed. Fertility was not affected by any of these factors. The litter size of crossbred females (NZxCAL) was higher than that of purebred ones (NZ) (8.2 *vs* 7.1; P<0.05). However, this superiority was only observed during the dry and cool season (P<0.05). The analysis also showed the effects of significant interactions between the genotype and the physiological stage for the mean live weight at weaning (P<0.01). Increasing the day length enhanced the litter size at birth (8.4 *vs* 6.9; P<0.001) and at weaning (6.6 *vs* 5.5; P<0.05). However, the beneficial effect of lighting conditions was only observed during a dry and cool birth season (P<0.05). The wet and hot season (May-November) had an unfavourable effect on the litter size at birth and at weaning (7.1 *vs* 8.2; P<0.05 and 5.5 *vs* 6.6; P<0.05). Moreover, the physiological stage affected the mean birth weight of the young, the mortinatality and the post-natal mortality. It was concluded that the genotype and lighting conditions were efficient means of improving the reproductive performance of doe rabbits during the dry and cool season in a tropical environment. However, they were not sufficient to counterbalance the unfavourable effects of the wet and hot season.

***RESUME : Effet du type génétique, de la durée d'éclairement, de la saison et du stade physiologique sur les performances de reproduction de lapines élevées en Guadeloupe.***
*L'objectif de cette étude est de comparer, en milieu tropical, les performances de reproduction de lapines en fonction du type génétique (NZ vs NZxCAL), du traitement lumineux (lumière naturelle + 5h de complément en lumière artificielle par jour vs lumière naturelle), de la saison (chaude et humide vs fraîche et sèche) et du stade physiologique au moment de la saillie (allaitante vs non allaitante). 272 saillies sont analysées dans cette expérience. La fertilité n'est influencée par aucun des effets étudiés. Les femelles NZxCAL ont une taille de portée à la naissance plus élevée que les NZ (8,2 vs 7,1; P<0,05). Cependant, la supériorité de la taille de portée à la naissance ne s'exprime qu'en saison sèche et fraîche (P<0,05). L'analyse met également en évidence des effets d'interactions significatifs entre le type génétique et le stade physiologique pour le poids moyen au sevrage (P<0,01). L'allongement de la durée d'éclairement augmente la taille de portée à la naissance (8,4 vs 6,9; P<0,001) et au sevrage (6,6 vs 5,5; P<0,05). Cependant, l'effet bénéfique du traitement lumineux ne s'exprime que pour la saison sèche et fraîche (P<0,05). La saison humide et chaude (Mai-Novembre) influence défavorablement la taille de portée à la naissance et au sevrage (7,1 vs 8,2; P<0,05 et 5,5 vs 6,6; P<0,05). Par ailleurs, notre étude montre que le poids moyen des lapereaux à la naissance, la mortinatalité et la mortalité postnatale sont influencés par le stade physiologique.*
*On peut donc conclure que le type génétique et l'allongement de la durée d'éclairement sont des moyens utiles pour améliorer la productivité des lapines pendant la saison sèche et fraîche en milieu tropical. Cependant, leurs effets ne sont pas assez puissants pour neutraliser les effets défavorables de la saison humide et chaude.*

## INTRODUCTION

Raising rabbits for meat production is of particular interest for modest populations living in suburban and rural areas and practising subsistence farming. For that reason, rabbit production development programmes have recently been launched by developing countries (LUKEFAHR and CHEEKE, 1991).

In the Caribbean islands, rabbit production is developing rapidly. Several attempts have been made recently in different countries to develop and intensify this activity. They were faced with limiting factors such as farmers'training, need for equipment, production of animal feeds and isolation of some raising units. However, most of the results obtained in this area show that performance remain relatively small compared to results obtained in temperate environment (MATHERON et al, 1985; RASTOGI, 1991, DEPRES *et al.*, 1991). Besides, the level of intensification is extremely variable among islands and the results obtained are not always transposable from one country to another.

In the French West Indies rabbit raising is expanding and tends towards an increasing intensification with the massive importation of hybrid strains and of modern equipment. This raises the question of choosing the genotype and the optimum reproduction rhythm to be used. It has also to be determined whether the lighting conditions used in temperate climates are efficient to induce a high receptivity of does under wet tropical climate conditions. MATHERON *et al.* (1985) have shown the interest of using heavy producing strains under wet tropical conditions, especially the New-Zealand White breed. These authors have demonstrated the unfavourable effects of rainy months on the litter size at weaning. Recently, BEREPUBO *et al.* (1993) and DEPRES *et al.* (1994) have shown the interest of increasing the day length to enhance the receptivity of nulliparous females raised in tropical environment under extensive and semi-extensive conditions.

The purpose of this study was to estimate more accurately the effect of the genotype, season of parturition, increased day length and physiological stage on the reproductive performance of doe rabbits multiparous raised under semi-intensive conditions in Guadeloupe (French West Indies).

## MATERIAL AND METHODS

**Guadeloupe 's climate :**

Guadeloupe is located at a latitude of 16° north. Its climate is of the tropical wet island type like that of Djakarta, Colombo or Singapore (LASSERRE, 1980). Figure 1 shows that all the temperature curves (maxima, minima and mean) have the same profile and that two seasons can be distinguished: a hot season (May to November) characterized by monthly means higher than or close to 25°C, mean minima exceeding 22°C and mean maxima higher than or equal to 29°C and on the other hand a cold season (December to

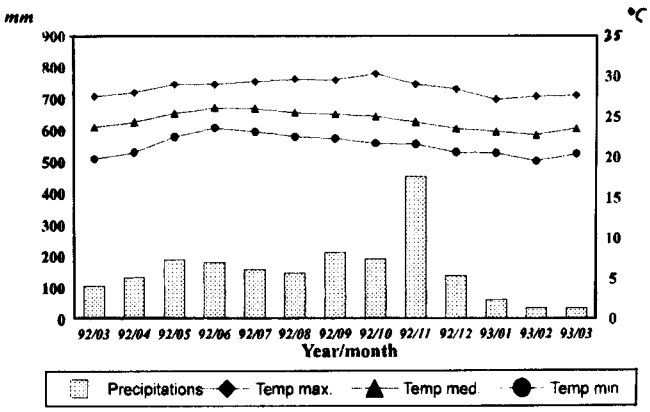


**Figure 1 : Characteristics of the Guadeloupe's climate (Period : March 1992 - March 1993)**

April) characterized by monthly means much lower than 25°C, mean minima very close to 20°C while mean maxima are below 29°C. Moreover, the double relationship between hot season and rain season on the one hand and cool season and dry season on the other hand stresses the alternation between two seasons locally called "hivernage" and "careme".

All the year long, at this latitude, the magnitude of variation in the day length is limited to 2 hours. The mean day length ranges between 11 (December) and 13 hours (June).

**Animals :**

Data were collected from the INRA experimental herd of the Station de Recherches Zootechniques (Guadeloupe) between March 1992 and March 1993. They concerned 272 matings and 166 kindlings. All the does were kept in a semi-open building including commercial hutches (0.60 x 0.55 x 0.40). All of them were equipped with a feeder (capacity: 2kg), an automatic watering device and a nest box. All the does were multiparous and were fed ad libitum and received all over the experiment commercial pellets based on cereals and cakes containing 2370 Kcal of digestible energy and 165 g of crude protein per kg (Table 1).

At the beginning of the experiment, does were distributed according to their genotype (New-Zealand or New-Zealand x Californian) into two similar cells. The experimental compartment (Lux+) was fitted with a programmed lighting system (250 Lux) which made it possible to increase day length up to 16h/day all over the experiment (5 h to 7h a.m. and 6h-9h p.m.). The control group (Lux-) was raised under natural lighting conditions.

Nest boxes were inspected every morning and dead young were removed. Does were mated between 0 and 48 h after kindling by Californian males. However, mating was delayed by 10 days if the litter size exceeded 9 youngs and if the physiological conditions of the doe were not satisfactory. Pregnancy was determined by palpation diagnosis between 12 and 14 days after mating. Nonpregnant does were rebred until they were diagnosed as pregnant. The young were weaned at 28 days old.

**Table 1: Chemical composition and nutritional characteristics of the diet**

| | |
|---|---|
| Digestible energy | 2370 |
| Moisture content | 12,00 |
| *% dry matter* | |
| Crude protein | 16,50 |
| Lysine | 0,74 |
| Methionine + Cystine | 0,50 |
| Crude fibre | 14,50 |
| Fat | 3,60 |
| Ash | 9,50 |
| Calcium | 1,00 |
| Phosphorus | 0,50 |
| Sodium | 0,50 |

**Statistical analysis :**

We have considered two modalities for the season (LASSERRE, 1980) : a wet and hot season (May-November) and a dry and cool season (December-April)(Fig.1The main variables measured were: the fertility rate (% of positive palpations and % of kindlings), the litter size at birth (total number of young born and born alive) and at weaning, the mean live weight of the young at birth and at weaning, the mortinatality rate (% of stillborn) and the post-partum mortality rate (% of young dead between kindling and weaning).

Litter sizes and weight variables were studied using an analysis of variance (GLM procedure of the SAS software; SAS, 1987) integrating the genotype (two modalities: NZ or NZ x Cal), the lighting treatment (Lux+ or Lux-), the birth season (two modalities: wet and hot season or dry and cool season) and the physiological stage (two modalities: nursing or no-nursing) as well as the significant interactions. The mean live weight at weaning was analysed using the live weight at birth as covariable. The qualitative variables and the mortality were analysed using contengency tables (FREQ procedure of SAS ). Afterwards either a chi-square or a Fisher's test were used.

## RESULTS

**1) Effect of the genotype**

The genotype significantly affected the total number of young born ($P<0.05$). The litter size of crossbred does of the New Zealand x Californian breed (NZxCAL) was higher than that of the New Zealand pure breed (8.2 *vs* 7.1)(Table 2). Moreover, the analysis of variance stressed the effects of significant interactions between the genotype and the physiological stage for the mean weight at weaning ($P<0.01$)

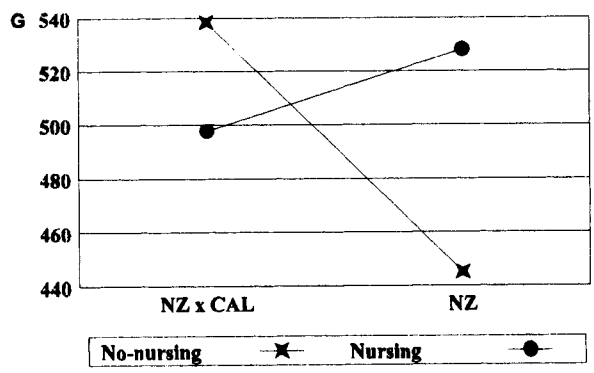


**Figure 2 : Effect of the interaction between genotype (NX x CAL or NZ) and physiological stage for weight of young at weaning.**

**Table 2 : Results of the analysis of variance (simple effects). Estimated means of the litter size and litter weight performance.**

| Variable | Born | Born alive | Weaned | Mean live weight (g) | |
|---|---|---|---|---|---|
| | | | | birth | weaning |
| Global mean : | 7,5 | 6,5 | 5,8 | 58 | 500 |
| N° observations : | 166 | 164 | 150 | 133 | 95 |
| R.S.D. : | 2,5 | 2,9 | 2,6 | 11,2 | 104,9 |
| *Genotype* : | | | | | |
| NZx CAL | 8,2 | 7,3 | 6,5 | 59 | 519 |
| NZ | 7,1 | 6,4 | 5,7 | 58 | 487 |
| | * | T | T | NS | NS |
| *Lighting conditions* : | | | | | |
| Lux + | 8,4 | 7,2 | 6,6 | 57 | 505 |
| Lux - | 6,9 | 6,5 | 5,5 | 59 | 501 |
| | *** | NS | * | NS | NS |
| *Season of parturition* | | | | | |
| Cool and dry | 8,2 | 7,2 | 6,6 | 57 | 500 |
| Hot and wet | 7,1 | 6,5 | 5,5 | 59 | 506 |
| | * | NS | * | NS | NS |
| *Physiological stage* : | | | | | |
| Nursing | 7,6 | 6,5 | 6,3 | 55 | 511 |
| No-nursing | 7,6 | 7,1 | 5,9 | 61 | 495 |
| | NS | NS | NS | ** | NS |

NS : non significant; T : P<0,1; * : P<,05; **: P<0,01; *** : P<0,001.
R.S.D. : Residuel Standard Deviation

(Figure 2). Thus, only the young from no-nursing does at mating had a mean live weight at weaning significantly different according to the genotype. However, the higher litter size at birth of crossbred does (NZxCAL) was only observed during the dry and cool season (Fig.3, P<0.05). The genotype had no effect on fertility rate, the perinatal mortality and the live weight of the young at birth and at weaning (Tables 2 and 3).

**2) Effect of lighting conditions**

The analysis of variance revealed a significant effect of lighting conditions on the total number of young born (P<0.001) and weaned (P<0.05). As compared to natural lighting conditions, increasing the photoperiod led to a significant increase in the litter size at birth (8.4 *vs* 6.9) and at weaning (6.6 *vs* 5.5)(Table 2).

Moreover, we demonstrated the existence of effects of significant interactions (P<0.05) between the day length and the birth season for the number of weaned young (Fig.4).

Litter size at weaning depended on day length during pregnancy and on the season. The young subjected to a day length of 16h were more numerous at weaning when the birth took place during the dry and cool season. In contrast, the number of young was similar whatever the season for females subjected to natural lighting conditions. Day length had no effect either on the fertility and number of live-born or on the mortality rate and live weight of the young at birth and at weaning (Tables 2 and 3).

**3) Effect of the season of parturition**

The analysis of variance revealed a significant effect of the season of parturition on the litter size at kindling and at weaning (P<0.05). An unfavourable effect of the wet and hot season (May-November) was observed on the total number of young born and weaned (7.1 *vs* 8.2; 5.5 *vs* 6.6)(Table 2). Let us notice that the percentage of stillborn young was slightly higher during the dry and cool season (P<0.10)(Table 3). The already mentioned effects of interactions between the genotype and the season for the total number of young born indicated that the litter size was significantly higher in crossbred does only during the dry and cool season (Fig.3). Likewise, increasing the day length significantly enhanced the litter size at weaning only during the dry and cool season (Fig.4). Moreover, whatever the season of parturition, the number of weaned young was similar for the does kept under natural lighting conditions. In contrast, the season did not seem to affect fertility, number of young born alive, postnatal mortality and the mean weight of the young at birth and at weaning (Tables 2 and 3).

**4) Effect of the physiological stage**

The mean birth weight of young rabbits was significantly affected (P<0.05) by the physiological stage. Young rabbits born from nursing does at mating weighed 55.5g whereas those issued from non-nursing does at mating weighed 61.7g (Table 2).

Table 3 shows that the physiological stage has an effect on mortinatality (P<0.05) and postnatal mortality (P<0.001). The percentage of young born dead was 13.3% when does were nursing at mating versus 9.4% for non-nursing does. In contrast, the mortality rate between birth and weaning was significantly lower in young issued from nursing does than in those issued from non-nursing does (10.4% versus 20.5%). Moreover, the physiological stage had no significant effect on fertility, litter size at birth (total number of young born and born alive) and at weaning and the mean live weight of the young at weaning (Tables 2 and 3).

## DISCUSSION

MATHERON *et al.*(1985) have shown the effect of the genotype on the reproductive performance of does raised in Guadeloupe. They also showed the superiority of the New

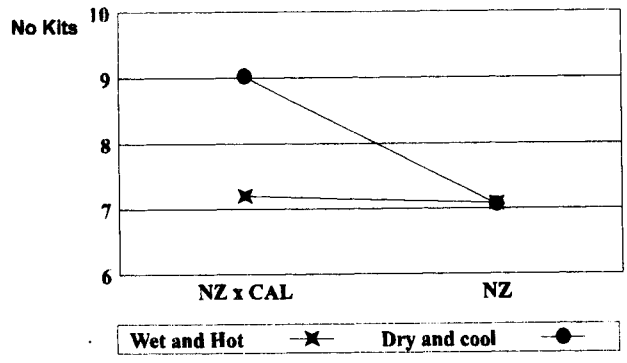


**Figure 3 : Effect of the interaction between genotype (NZ x CAL or NZ) and birth of parturition for total number of young born.**

**Table 3 : Results of comparaison tests of fréquencies.**

| Variable | Diagnosis of pregnancy Palp. + /matings (%) | Kindlings /Matings (%) | Mortality at birth (%) | Mortality Post-natal (%) |
|---|---|---|---|---|
| *Genotype* : | | | | |
| NZx CAL | 75,8 (120) | 64,2 (120) | 12,2 (601) | 14,0 (528) |
| NZ | 78,9 (152) | 58,5 (152) | 11,5 (549) | 14,6 (486) |
| | NS | NS | NS | NS |
| *Lighting conditions* : | | | | |
| Lux + | 76,5 (115) | 55,6 (115) | 12,7 (464) | 15,3 (405) |
| Lux - | 78,5 (157) | 65,0 (157) | 11,2 (686) | 13,6 (609) |
| | NS | NS | NS | NS |
| *Season (1)* | | | | |
| Cool and dry | 80,1 (186) | 59,1 (186) | 10,4 (683) | 14,2 (612) |
| Hot and wet | 72,1 (86) | 65,1 (86) | 13,9 (467) | 14,4 (402) |
| | NS | NS | T | NS |
| *Physiological stage* : | | | | |
| Nursing | 75,5 (102) | 60,8 (102) | 9,4 (437) | 20,5 (396) |
| No-nursing | 78,8 (170) | 61,2 (170) | 13,3 (713) | 10,4 (618) |
| | NS | NS | * | *** |

NS : non significant; T : P<0,1; * : P<,05; *** : P<0,001.
( ) : Number of observations
(1) : Mating season for fetility and birth season for mortality.

Zealand White doe over the other existing breeds (local and crossbred). At that time, crossbred females had not yet been imported in this area. The present study shows the interest of the crossbred NZxCAL female relative to the New Zealand White pure breed as regards the litter size at birth.

However, we did not demonstrate any significant difference as regards the other parameters of the litter performance.

Increasing day length affected the litter size at birth and at weaning. These results agree with those of THEAU-CLEMENT *et al.* (1991) and Uzcategui and Johnston (1992) who have demonstrated in temperate climate the favourable effect of increasing day length on the number of weaned young rabbits. Moreover, HUDSON and DISTEL (1990) have shown the effect of day length on the behaviour of young rabbits and on the emission of pheromones. They compared several day lengths and noted that a 16-h day length increased the emission of pheromones, the receptivity of the doe and the litter size. They also observed that a slight variation in the day length (±2h) was sufficient for inducing significant behavioural responses in the doe.

Our experiment indicates that under tropical climate conditions controlling the genotype and day length makes it possible to increase the productivity of does in semi-intensive farming conditions. However, the effects of interactions evidenced in our experimental conditions suggest that the season is a particularly limiting factor which attenuates the favourable effects of increasing the day length and of the genotype on the litter size. Our results show that day length significantly affected the number of weaned young only during the dry and cool season (December-April) and on the other hand, that crossbred females totally expressed their potentialities also during this season.

Our experiment clearly demonstrates an effect of the birth season on the litter size at kindling and at weaning which confirms previous results reported in the literature and obtained either in temperate environment (SCHOLAUT, 1985; LEBAS *et al.*, 1986; BARRETO and De BLAS, 1993) or in hot environment (SITTMANN *et al.*, 1964; MATHERON *et al.*, 1986; KHALIL *et al.*, 1987; YAMANI *et al.*, 1991).

It should be noticed that under temperate climate conditions, the differences between seasons are mainly of thermal origin (cold winter, warm summer) and numerous studies have shown that most components of reproductive performance are altered when does are subjected to extreme temperatures higher or equal to 30°C. The effect of high temperatures on spermatogenesis (OLOUFA *et al.*, 1951; El Sheikh and Casida, 1955) and embryonic mortality (BURFENING and ULBERG, 1968) has been demonstrated. Besides, LEBAS *et al.* (1986) and BARETTO and De BLAS (1993) have observed that high temperatures reduced feed intake which led to a decrease in the live weight of does and indirectly affected prolificacy.

In tropical areas, the thermal environment is relatively stable and even though heat plays a determining part, the unfavourable effects observed on the litter size during the wet season cannot be exclusively attributed to high temperatures. The double relationship between the hot and wet period and the cool and dry period on the other hand should also be considered. Our results confirm the observations made by LUI *et al.* (1980) in another species. These authors have shown the unfavourable effect of the hot and wet season on the reproductive performance of pigs raised in Brazil.

The favourable effect of an increased day length evidenced in the present study together with the effects of interactions between day length and season suggest that the small variation in the day length throughout the year can be considered as a limiting factor to intensive raising of rabbits. Further research should be made into the effect of different components of the tropical climate on the reproductive performance of does. Let us mention that the dry and cool season corresponds to an increasing day length.

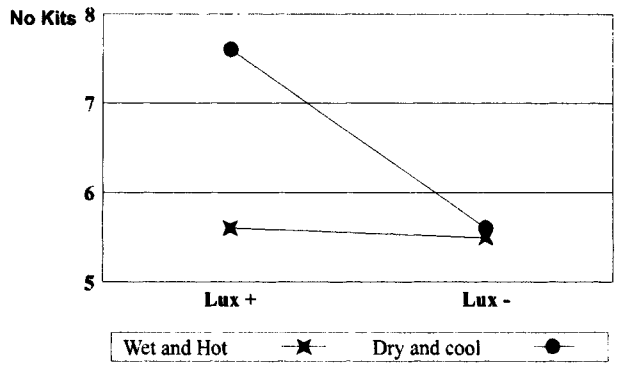


**Figure 4 : Effect of the interaction between lighting (Lux+ or Lux-) and season of parturition for the No of Kits at weaning.**

This study showed that the physiological stage at mating affected the live weight of the young at birth and perinatal mortality and restricted in some cases the effect of the genotype on the mean weight at weaning. Thus, in our conditions, the fact of breeding nursing does led to a decrease in the mean birth weight and to a higher mortality rate. Our results confirm those of THEAU-CLEMENT and ROUSTAN (1992) who observed a higher embryonic mortality in nursing females.

The reproductive performance obtained in our study are on the overall higher than those reported in multiparous does of the New Zealand White breed in tropical environment (DAMODAR and JATKAR, 1985; MATHERON *et al.*, 1986).

## CONCLUSION

This study clearly shows that using crossbred NZxCAL females and increasing the day length (16h/day) can be efficient means of improving the reproductive performance of does raised under semi-intensive conditions in tropical environment during the dry and cool season. However, in Guadeloupe, the fact that the hot and wet season spreads from May to November is a particularly unfavourable factor that limits the positive effects of the genotype and day length.

The season is a combination of effects related to the day length, temperature and hygrometry, particularly in tropical environment. According to the observations of KASA and TWAITES (1990), when the temperature exceeds 32°C and the ambient humidity 18mm Hg vp, which are usual values in Guadeloupe during the rain season, the heat stress experienced by rabbits leads to a reduction in the performance. It is obvious that solutions have to be found to limit the effect of the temperature and hygrometry on the reproductive performance of does. It would be useful to study the effect of the housing design on the environmental parameters and to select heat tolerant animals. Moreover, our study shows that the slight variation in the day length is one of the component of the tropical climate the importance of which should not be neglected.

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