INFLUENCE OF COAT COLOUR, SEASON AND PHYSIOLOGICAL STATUS ON REPRODUCTION OF RABBIT DOES OF AN ALGERIAN LOCAL POPULATION.

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ABSTRACT

In Algeria, rabbit meat production is low. It is mainly obtained in small farms with rabbits from local populations whose productivity and growth are rather low, but which are well adapted to local environment. Among them, farmers use to prefer white animals, with the albino or himalayan alleles of gene C. The objective of this experiment was to verify the validity of this preference for white rabbit does during a large enough period to check also the effect of season. From September 2006 to June 2010, reproduction data from 209 females (138 white and 71 coloured) mated by 51 males (35 white and l6 coloured) were recorded. There was no effect of sire colour and no interactions between coat colour, season and physiological status of does. There was a significant relationship between coat colour (white *vs.* coloured) on most reproductive traits, except receptivity and fertility (and subsequently interval between kindling), in favour of coloured females. Litter size was higher by 0.63 kits born (P=0.045), 1.25 born alive (P<0.001) and 1 weaned (P=0.003). There was a highly significant effect of season on all measured traits. Receptivity, fertility and prolificacy were significantly higher before the hot period; in summer, reproductive performances were depressed, but no more than during the following period, which confirms the good adaptation of this local population to hot conditions. We can also conclude that there is in this population an unfavourable genetic association between reproduction and albino and himalayan alleles of C gene which has to be confirmed and explored more in details.

Key words: Algeria, rabbit, reproduction, coat colour, season.

INTRODUCTION

In Algeria, rabbit meat production is low. It is mainly obtained in small farms with rabbits from local populations whose productivity and growth are rather low, but which are well adapted to local environment (Daoud-Zerrouki, 2006). During the 80's, attempts were made to introduce rabbits from European selected strains. But these strains were not maintained in pure breeding because of lack of organization and they gradually mixed with the local populations. As they were Albino or Himalayan (alleles c and ch of the C gene for coat colour), these alleles are now in segregation in the local populations and white animals (albino or himalayan) often appear in the progeny of white or coloured parents. In Djebla (Kabylia), a cooperative breeds a local population and sells males and females to farmers. As farmers prefer white animals, this cooperative favours this colour and obtained a mainly white population.
The objective of this experiment was to verify the validity of this preference for white rabbit does during a large enough period to check also the effect of season.

MATERIALS AND METHODS

Animals

At the ITMAS (Agricultural Technical Institute) of Tizi-Ouzou (Algeria), an experimental herd was constituted from the local population and managed from September 2006 to June 2010 as a closed herd, restocking without any introduction of animals. Reproduction data from 209 females (138 white and 71 coloured) mated by 51 males (35 white and l6 coloured) were recorded.

The livestock building was opened to daylight by windows. It included a maternity cell with a capacity of 80 cages and a fattening cell with 100 cages. The animals were housed individually in wired cages in flat-deck. Environmental conditions, temperature, humidity and lighting were naturals. Animals were fed *ad libitum* with a commercial pellet feed (16.6% crude protein and 12.3% crude fibre). Watering was automatic.

Females were mated first time between 4 and 5 months of age according to their weight. At mating, weight was recorded. If the female was not receptive, it was mated again 3 or 4 days after. Gestation was checked by abdominal palpation 12 days after mating; if it was negative, rabbit does were immediately mated again. At birth, alive and stillborn kits numbers were counted, as well as their number at weaning, at about 30 days after, which allowed analysing the survival rate at birth and at weaning. Weight and growth of kits were also recorded (Abdelli-Larbi *et al.*, 2012).

Statistical analysis

Recorded data were analyzed with an analysis of variance procedure (GLM/SAS). The statistical model included the fixed effect of coat colour (two levels: albinos *vs.* coloured), the season of mating with 3 levels (February to May: before hot season, June to September: hot season, October to January: after hot season), the year of mating (2006 to 2010), the physiological status of the doe at mating (5 levels: nulliparous, lactating or not lactating primiparous, lactating or not lactating multiparous). The significance of the effect of phenotype was tested using as an error term female within phenotype random effect which was also included in the model.

Preliminary analyses allowed discarding from the model the effect of the phenotype of the sire and all the interactions, which were far from statistical significance.

RESULTS AND DISCUSSIONS

The average reproductive performances observed in this herd are rather low (Table 1), in agreement with previous studies of this local population in different conditions (Zerrouki *et al.*, 2003, 2005; Belhadi, 2004; Daoud-Zerrouki, 2006; Gacem *et al.*, 2009; Lebas *et al.*, 2010).

Coat colour

There was a significant relationship between coat colour (white, i.e. albino or himalayan *vs.* coloured) on most reproductive traits, except receptivity and fertility (and subsequently interval between kindling), in favour of coloured females (table 1). Litter size was higher by 0.63 kits born (P=0.045), 1.25 born alive (P<0.001) and 1 weaned (P=0.003). If we consider only litters with at least one young born alive, or one young weaned, to discard accidental events, the difference was lower but highly significant (+0.67, P=0.006 for litter size at birth and +0.43, P=0.024 for litter size at weaning). The survival rate at birth was significantly higher in coloured females than in white ones (86.7% *vs.* 75.8% of all litters born, P<0.005). There was no significant difference for the survival rate in weaned litters, but the proportion of litters weaned was slightly significantly higher in coloured does than in white ones (73.9% *vs.* 64.5%, P<0.075). We must notice that testing the coat colour effect with female within phenotype as a random effect instead of the residual increases the accuracy of the test (by taking into account the variability between females within coat colour) and decreases the value of F.

Table 1: Reproductive performances of rabbit does: Results of the analysis of variance for the coat colour and season effect (Least square means (number of data))

	Number of data	Mean	*RSE*	Coat colour		P[1]	Season			P Season
				albino	coloured	Coat color	Before hot season	Hot season	After hot season	
Dam weight at mating	3299	3316	284	3336 (1956)	3197 (1343)	0.062	3203^{a} (1144)	3215^{a} (971)	3382^{b} (1184)	<0.001
Receptivity (%)	3635	38.6	44	46.9 (2209)	43.8 (1426)	NS	58.5^{a} (1247)	43.4^{b} (1024)	34.1^{c} (1364)	<0.001
Fertility (%)	1405	62.8	45	59.4 (883)	62.4 (522)	NS	70.8^{a} (601)	57.0^{b} (335)	54.8^{b} (469)	<.0001
Interval between kindlings	677	67.5	27.5	66.6 (425)	69.1 (252)	NS	60.4^{a} (326)	64.2^{a} (150)	78.9^{b} (201)	<0.001
Total litter size at birth	882	6.97	2.19	6.71 (560)	7.34 (322)	0.045	7.43^{a} (391)	6.85^{b} (186)	6.79^{b} (305)	0.006
Live litter size at birth (all litters)	882	5.81	2.79	5.30 (560)	6.55 (322)	0.001	6.63^{a} (391)	5.75^{b} (186)	5.40^{b} (305)	<0.001
Survival rate at birth % (all litters)	882	80.9	31.3	75.8 (560)	86.7 (322)	0.005	87.43^{a} (391)	80.4^{b} (391)	75.9^{b} (391)	0.002
Live litter size at birth (at least 1 born alive)	780	6.57	2.21	6.16 (495)	7.03 (285)	0.006	7.01^{a} (355)	6.26^{b} (170)	6.52^{b} (255)	0.006
Survival rate at birth % (at least 1 born alive)	780	91.4	15.9	89.2 (495)	93.8 (285)	0.016	93.0^{a} (355)	88.4^{b} (170)	93.2^{a} (255)	0.014
Litter size at weaning (all litters born alive)	780	4.03	2.82	3.33 (495)	4.33 (285)	0.003	4.79^{a} (355)	3.88^{b} (170)	2.82^{c} (255)	<0.001
Survival rate at weaning % (all litters born alive)	780	61.1	37.1	52.4 (495)	59.2 (285)	NS	67.4^{a} (355)	60.1^{a} (170)	39.9^{b} (255)	<0.001
Litter size at weaning (at least 1 weaned)	589	5.34	2.04	5.18 (368)	5.61 (221)	0.024	6.10^{a} (286)	5.27^{b} (137)	5.32^{b} (166)	0.002
Survival rate at weaning % (at least 1 weaned)	589	80.9	20.7	81.4 (368)	80.2 (221)	NS	85.7^{a} (286)	80.5^{b} (137)	76.2^{b} (166)	0.005
Litters weaned /litters born alive (%)/	780	75.5	41	64.5 (495)	73.9 (285)	0.075	79.3^{a} (355)	75.8^{a} (170)	52.4^{b} (255)	<.0001

RSE : Residual standard error
P: Pr>F [1] Female within phenotype random effect used as an error term NS : not significant (P>0.10)
Means with different letters on the same row differ significantly

In rabbits, up to now and contrary to other species, no effect of major genes on reproduction was found, even in divergent lines (Argente *et al.*, 2010). Only some unexplained relations were found, such as the κ casein gene (Bolet *et al.*, 2007). Any relationship between coat colour genes and reproductive performance was ever evidenced.
In this experiment, an unfavourable effect of the c or ch alleles (albino and Himalayan) was found. On the contrary, a comparison of two local populations, one coloured and the "white" one from Djebla cooperative evidenced a superiority of the "white" population over the coloured population (Gacem *et al.*, 2009 ; Lebas *et al.*, 2010). However, in their experiment, "white" and coloured animals came from different breeds, so that the difference is more due to the genetic value of populations than to a relation with coat colour. In our experiment, white and coloured does belonged to the same population. We verified on a subsample of daughters of coloured dams (in this case, white and coloured females came from the same dams) that the effect of coat colour was confirmed (unpublished data). So, this relation between C gene alleles and reproduction has to be more investigated and confirmed.

Season

To take into account the whole hot season, the season effect was not based on the four calendar seasons, but on the effective hot period, i.e. from June to September, flanked by a "before hot period", from February to May, and an "after hot period" from October to January.
There was a highly significant effect of season on all measured traits (table 1). Receptivity, fertility and prolificacy were significantly higher before the hot period, whereas they were not significantly

different between the hot period and after, except for receptivity and litter size at weaning. These results are in good agreement with those of Marai *et al.* (2002), Belhadi (2004), Moulla *et al.* (2007). The effect of season reported by Zerrouki *et al.* (2008), Gacem *et al.* (2009) and Lebas *et al.* (2010) on the local populations was not as pronounced as in our study probably because of environmental conditions which are less controlled and more natural in our study.
In particular, the effect of controlled lighting on the induction of receptivity has been demonstrated (Theau-Clément, 2008). In our experiment, receptivity and fertility were significantly higher from February to May, during increasing days.
No interaction between coat colour and season was evidenced, which means that the effect of coat colour is not due to a better adaptation of coloured females to hot periods.

Physiological status

Table 2: Effect of physiological status of does on their reproductive performances: Least square means (number of data)

	n	*RSE*	Nullip.	Primip. non lactating	Primip. lactating	Multip. non lactating	Multip. lactating	P
Dam weight at mating (g)	3299	284	3036 [a] (438)	3293 [b] (420)	3268 [b] (252)	3353 [c] (1284)	3383 [d] (905)	<0.001
Receptivity (%)	3635	44	57 [a] (547)	55 [a] (483)	37 [c] (280)	47 [b] (1358)	31 [c] (967)	<.0001
Fertility (%)	1405	45	82 [a] (266)	78 [a] (208)	42 [c] (80)	65 [a] (544)	37 [c] 307)	<.0001
Total litter size at birth	882	2.19	6.77 [a] (209)	7.13 [ab] (141)	7.32 [ab] (35)	7.38 [b] (361)	6.51 [a] (136)	0.005
Live litter size at birth (all litters)	882	2.79	5.51 [a] (209)	6.14 [ab] (141)	5.86 [ab] (35)	6.61 [b] (361)	5.50 [a] (136)	0.002
Live litter size at birth (at least 1 born alive)	780	2.21	6.38 (182)	6.63 (128)	6.72 (33)	6.97 (320)	6.27 (117)	0.091
Litter size at weaning (at least 1 born alive)	780	2.82	3.38 [a] (182)	3.99 [ab] (128)	3.62 [ab] (33)	4.61 [b] (320)	3.54 [a] (117)	0.006
Litter size at weaning (at least 1 weaned)	589	2.04	5.13 (130)	5.63 (93)	5.99 (25)	5.73 (248)	5.35 (93)	NS
Litters weaned/litters born alive (%)	780	41	67 [a] (182)	71 [ab] (128)	59 [a] (33)	80 [b] (320)	68 [a] (117)	<.0042

RSE : Residual standard error
P : Pr>F NS : not significant (P<0.10)
Means with different letters on the same row differ significantly

Females have been splitted into five groups: nulliparous, lactating or not lactating primiparous and lactating or not lactating multiparous, according to the main effects on fertility and prolificacy evidenced by Theau-Clément (2008). We confirmed her observations concerning the favourable effect of nulliparous and the unfavourable effect of lactation on receptivity and fertility (Table 2). Litter size did not differ significantly between nulliparous and primiparous does, whatever their lactation status; it was only significantly higher in multiparous non lactating does. These results are in good agreement with those of Belhadi (2004) concerning spring and autumn.

CONCLUSION

Two main points are evidenced by this experiment:

- the favourable effect of spring period (from February to May) on reproduction, whereas there are few differences between the hot (from June to September) and autumn-winter (from October to January) periods. In summer, reproductive performances are depressed, but no more than during the following period. It confirms the good adaptation of this local population to hot conditions and does not justify stopping reproduction during summer, as many farmers use to do.

- the original and unexpected superiority of coloured females over white one (albino or himalayan), which carry the c or ch allele of C gene. As there is no interaction between season and coat colour, we can conclude that it is not some environmental effect such as a better resistance to heat of coloured females, but really a genetic association between reproduction and this locus which as to be explored more in details.

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