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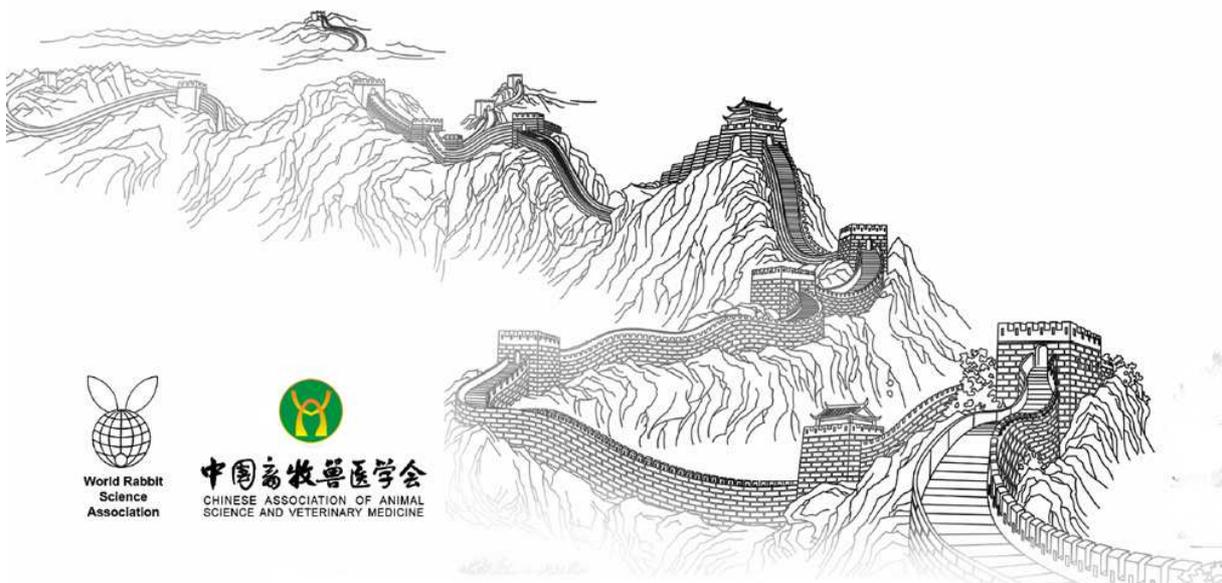
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EFFECT OF LITTER SIZE AT BIRTH AND OF NUMBER OF SUCKLED KITS ON THE MILK PRODUCTION IN TWO GENOTYPES OF RABBIT DOES RAISED IN ALGERIA

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ABSTRACT

In a commercial rabbit production unit located in Tizirt (Tizi-Ouzou, Algeria), 85 litters of two genotypes (42 white population WP and 43 synthetic strain SS) were divided in 3 classes according to the number of kits born alive: <6, 6-8, >8. Thanks to fostering and withdrawal of kits just after kindling within each class of kits born alive, litters were divided again into 3 suckling groups with the same limits of classes, which led to an experimental factorial design 2 x 3 x 3. During the 21 days after kindling, milk production of does increased with the number of the suckled kits (121, 160 and 194 g/d for the 3 classes, respectively). As against, milk production does not vary significantly depending on the number of kits born alive (being a mean of 158 g of milk / day). With identical number of kits born alive or suckled (7.1 on average), SS rabbit does had a higher milk production by 13% to that of WB genotype ($P = 0.05$). None of the 3 interactions between the three factors, taken in pairs was significant.

Key words: milk, born alive, suckled kits, genotype, litter size.

INTRODUCTION

The growth of young rabbits during the 3 weeks just after birth depends mainly of the milk production from their mother (Szendrő, 2000). Milk production depends particularly of the genetic potential of the doe strain, of the feeding conditions and especially of the size of the suckled litter (Lebas, 1969; Lukefahr *et al.*, 1981; Garcia- Dalmán *et al.*, 2012).

Already old work, in goat or mouse for example, have shown that maternal milk production is also influenced by the number of fetuses carried during gestation (Hayden *et al.*, 1979; Eisen *et al.*, 1980). This effect is a consequence of the development of the mammary gland at the end of pregnancy under the influence of placental hormones. However this positive link between the number of fetuses and the rate of placental lactogen hormone has not been clearly established in the case of the rabbit (Khalil, 1994).

In order to clarify the relative role of the number of rabbits in late pregnancy and the litter size effectively suckled, a study was conducted on milk production of does belonging to 2 strains with different prolificacy which were allowed to suckle litters of different sizes obtained by addition or removing some kits just after kindling.

MATERIALS AND METHODS

Animals and experimental design

In a commercial rabbitry of Tizirt (Wilaya of Tizi-Ouzou, Algeria), between June and December 2013, successive litters were divided after kindling into 3 classes **S**, **M** & **L** according to litter size at birth: **Small** <6, **Medium** 6-8 and **Large** > 8 kits born alive. Within each class, litter size was modified by adoption-withdrawal of kits to get three classes of nursed litters, with the same class limits **S**, **M** and **L**. This distribution made possible to get a 3 x 3 factorial design matching three size classes of litters born alive and three classes of suckled litters. This pattern was applied to rabbit does of two genotypes: White Population (WP) with moderate prolificacy and Synthetic Strain (SS) with an average of 1.5 to 2.0 kits born alive more per litter (Bolet *et al.*, 2012; Zerrouki *et al.*, 2012, 2014). In total the study involved performance of 85 litters: 42 WP, 43 SS, from 38 and 35 females respectively.

Controls

Litter size was adjusted within 2-3 days after birth with kits of the same genotype. Until 21st day after kindling, litter size and doe milk production were estimated weekly, with 1-3 measures spread over each week, but not necessarily on the same day for all does. Milk production was estimated by weight loss of the mother during the daily suckling, with a precise balance ± 1 g (Lebas et al., 2011). Milk production of a week was calculated from the average of the different measures made during this week. This methodology, certainly less accurate than an everyday determination, was the only relevant in that commercial farm, but it does not create any bias in the estimate of the milk produced (Lebas, 1968). Milk intake of kit was calculated by dividing doe's milk production /number of suckling kits.

Statistical Analysis

Data were analyzed with SAS software according to the factorial design 3 x 3 x 2 corresponding to 3 litter sizes at birth, 3 litter sizes of suckling kits and 2 genotypes with different interactions taken 2 to 2. Given the differences of data number for the different cells of the factorial design, results are expressed as mean adjusted by the least squares method (lsmeans GLM procedure of SAS). In presentation, when averages are assigned a different letter, they differ from each other at $P = 0.05$.

RESULTS AND DISCUSSION

None of the calculated interaction has reached the level of significance ($P > 0.10$). Thus, each factor is presented separately.

Effect of litter size at birth (born alive)

Milk production of does

The average milk production of rabbits does during the first 3 weeks of lactation (Figure 1) increased with the number of week, as it is classically observed in rabbits (Maertens *et al.*, 2006).

On the other hand, the number of born alive failed to affect significantly the milk production for any of week considered or for the 21 days control (Table 1). So, milk production of does appears to be independent of the litter size at birth, in contrast to what has been described for example in mice where a positive correlation of 0.17 (0.06 to 0.30) was observed on average over a set of 17 genetic lines (Eisen *et al.*, 1980).

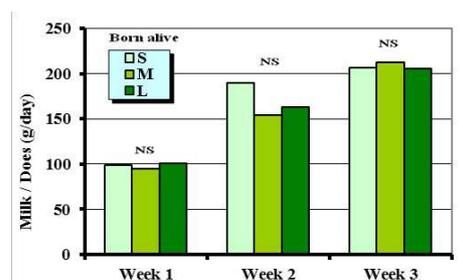


Figure 1: Effect of litter size at birth (S<6, M 6-8 and L>8 kits) on weekly milk production

Table 1. Average milk production in 21 days of does and average milk intake of kits depending on the litter size at birth (born alive) or after equilibration (after kits adoption or withdrawal of some kits) - .

Least square means	Classes of litter size - Born alive			Resi coef. variation %	Probability litter size effect
	Small	Medium	Large		
<i>Number of litters</i>	16	26	46	-	-
Born alive / litter	3.05 a	7.44 b	10.69 c	15.1	<0.001
Number of kit/litter after equilibration	6.80	7.38	7.29	10.9	0.115
Milk / does (g/day)	165.0	153.5	156.2	25.6	0.796
Milk / kit (g/day)	25.7	22.4	23.0	22.5	0.311
	Classes of litter size - Allowed to suckled				
	Small	Medium	Large		
<i>Number of litters</i>	28	23	34	-	-
Born alive / litter	7.26	6.94	6.98	15.1	0.141
Number of kit/litter after equilibration	4.85 a	7.06 b	9.40 c	10.9	< 0.001
Milk / does (g/day)	120.8 a	160.4 b	193.5c	25.5	< 0.001
Milk / kit (g/day)	24.8	24.3	22.0	22.5	0.356

Milk intake of kits

Kits suckled by rabbit females which had small litters at birth (5 rabbits born alive or less) have more milk per head during the first week (Figure 2). This advantage is still partly observed during the second week, but disappears completely during the 3rd week of lactation. On average for the 21 days

of controlled lactation, the small differences between the 3 groups of born alive, is not significant (Table 1). It should be emphasized that the S class has only 16 data, which makes the mean very sensitive to the effect of the dairy potential of one or two does.

We shall retain that, in our experimental conditions, on average for 21 days of lactation, nor the does milk production, nor the milk available per kit, were significantly influenced by litter size at kindling (born alive) when suckled litter sizes was equilibrated

Influence of the suckled litter size

Milk production of does

As generally described in rabbits (Lebas, 1969; Maertens *et al.*, 2006; Zerrouki *et al.*, 2012), the milk production of rabbits does increases with the number of suckling kits (Table 1). The superiority of milk production in the L group compared to the S group is +48% during the first week and increases up to +81% during the 3rd one (Figure 3).

Milk intake of kits

Contrary to what has been described in further conditions (Lebas, 1969, Maertens *et al.*, 2006) the quantity of milk available per suckled kit during the 21 days of lactation does not vary so as significantly according to the suckled litter size (Table 1). A reduction of the milk quantity available per kit with increasing litter size is still observed during the second week of lactation ($P = 0.029$), but disappears totally during the third week ($P = 0.975$) (Figure 4)

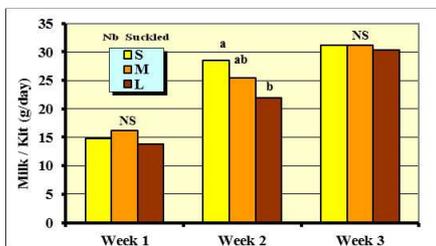


Figure 4: Evolution of the average milk intake of kit (g/day) during the three weeks of lactation for the 3 classes of suckled litters

for suckled kits (Table 2). Milk production in 21 days was higher in the synthetic strain does SS (+13%; $P=0.05$). This superiority is clear during the first week of lactation (+21%; $P=0.046$) but then disappears (Figure 5).

Nevertheless, the differences between the two genotypes for the quantity of milk available per suckled young rabbit were not significant (Figure 6) even during first week of lactation ($P = 0.092$). We retain that for the synthetic strain described by Bolet *et al.*,(2012), in field situation, rabbit does have a greater capacity of milk production than those of the white population, as it had been previously supposed in a comparison of reproductive performance of the same lines without direct measure of milk production (Zerrouki *et al.*, 2014).

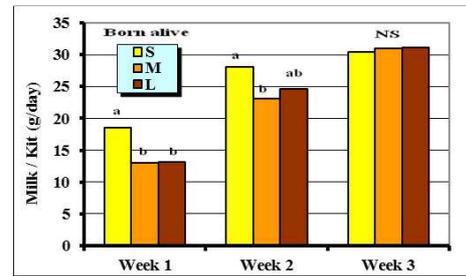


Figure 2. Effect of litter size at birth (S <6, M6-8 and L>8 kits) on daily milk intake of kits during the 3 weeks of suckling.

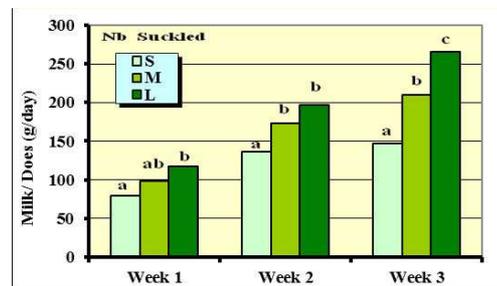


Figure 3: Evolution of milk production of rabbit does during the 3 weeks of suckling for the 3 classes of suckled litter size.

We will retain that, in our experimental conditions, on average for a 21 days lactation, milk production of females rabbit classically increases with the number of suckled kits, but in our case, throughout the study period, it does not occur to the detriment on the quantity of milk available for each rabbit young.

Effect of genetic type

The distribution in classes of litter sizes of both genotypes resulted in the sample studied, in litters of identical sizes for both genotypes, for kits born alive as

Table 2. Average milk yield in 21 days of does and average milk intake of kits for the 2 studied genotypes.

Least square means	Génotype		Residual CV %	Probability of genotype effect
	White Population	Synthetic Strain		
Number of litters	42	43	-	-
Born alive / kindling	7.04	7.08	15.6	0.908
Number of kit suckled /litter	7.10	7.10	10.9	0.976
Milk / does (g/day)	148.3	168.2	25.6	0.050
Milk / kit (g/day)	23.1	24.3	22.5	0.347

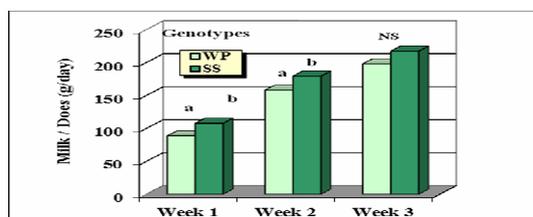


Figure 5: Evolution of milk production of rabbits does during the 3 weeks of nursing for the 2 genotypes (WP and SS).

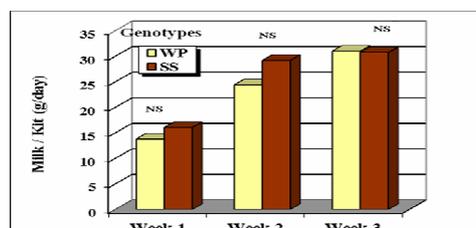


Figure 6: Evolution of average milk intake per kit and per day during the three weeks of lactation for the 2 genotypes (WP and SS)

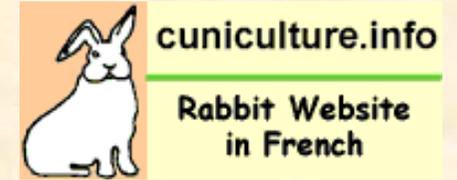
CONCLUSION

In this work on two genotypes, we were able to confirm the increase in milk production of females with the number of suckled rabbits, whatever the initial litter size at birth. As against the latter seems to have no significant effect on milk production capacity of does during the 21 days following kindling. In practical terms it means, that when adopting or withdrawal of kits in order to equalize litter sizes, only the number of kits able to suckle will have a significant impact on doe milk production and thus on the growth of young rabbits. Note, however, that this work was carried out on a limited number of litters and therefore deserves confirmation in a larger number of litters and, above all, other genotypes.

ACKNOWLEDGMENTS The authors wish to thank Mr Bouhadoun, breeder in Tizgirt for access and testing facilities in his rabbitry.

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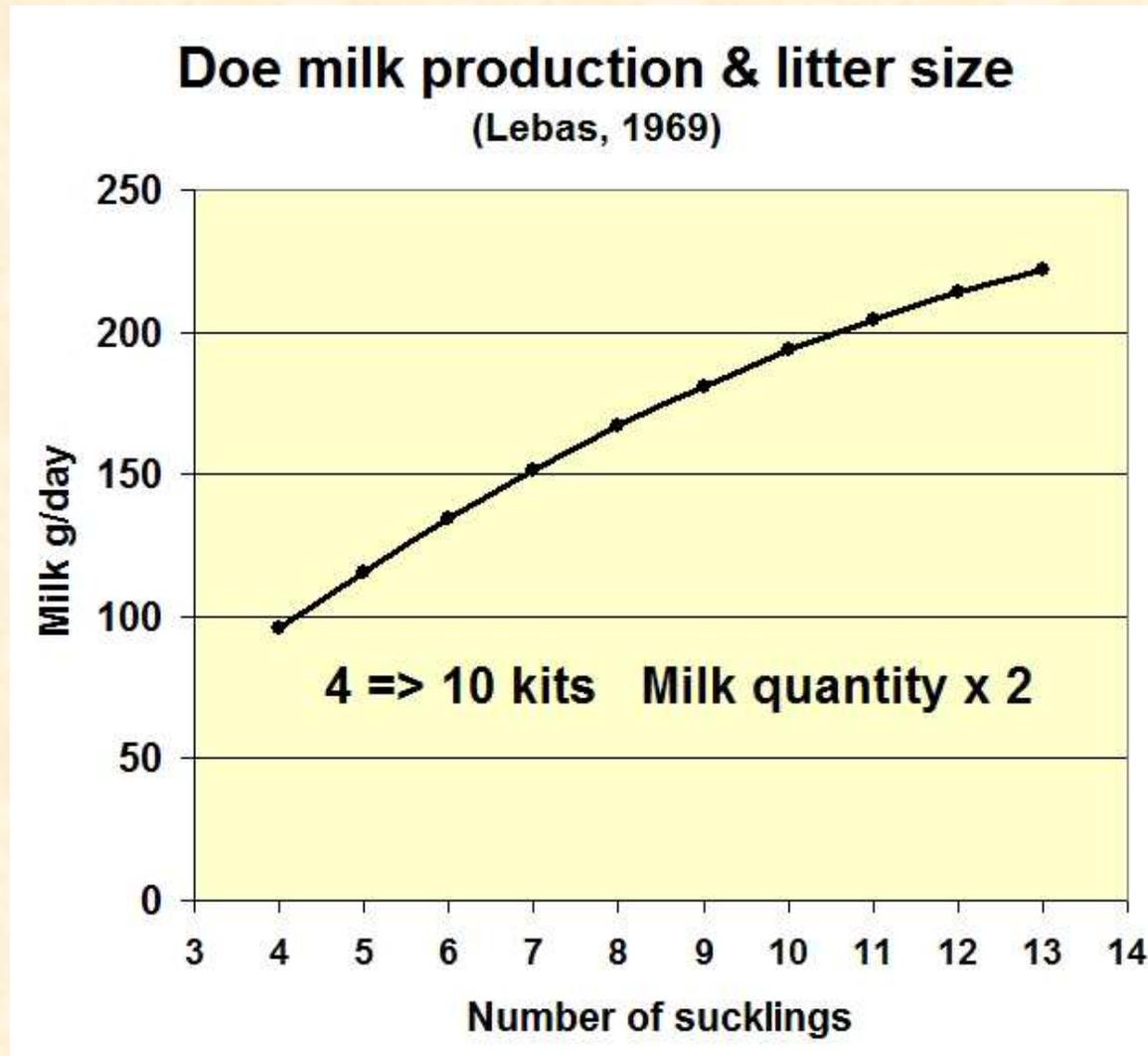
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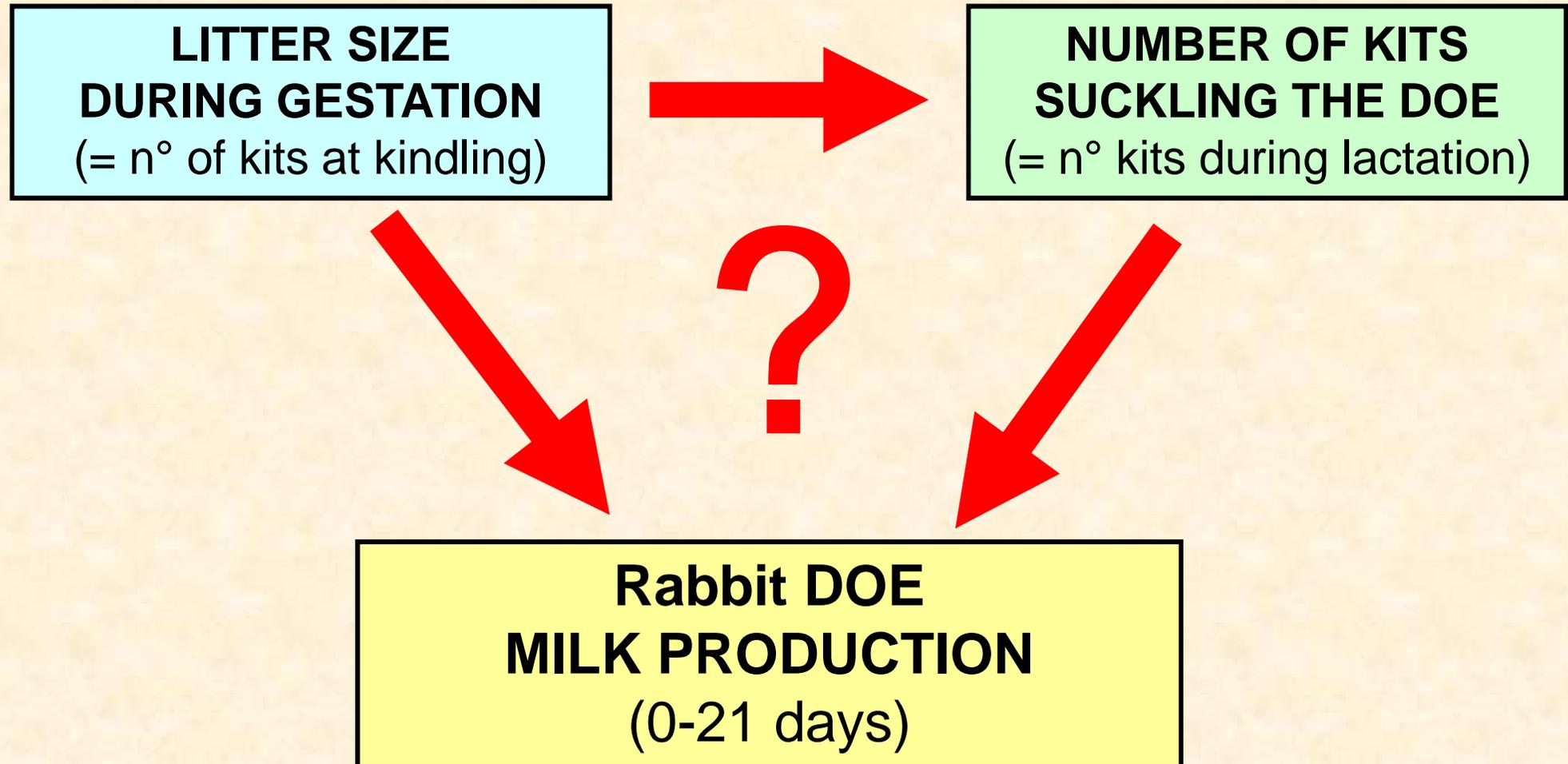
Background

↗ Suckling kits N° → ↗ Doe milk production

Lebas (1969), and many others since this time



Aim of the study



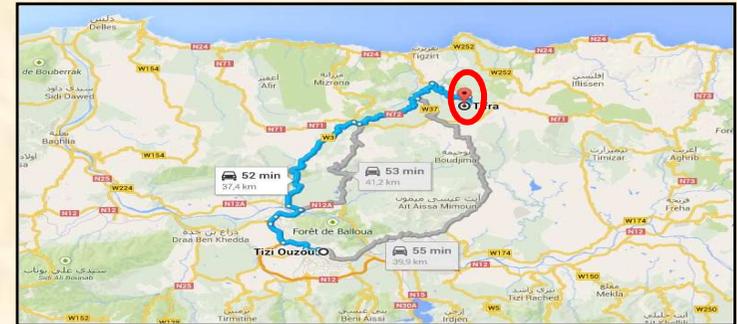
Material et Methods



Commercial rabbitry

Localisation of the study area in Algeria

June → December 2014



Near of the sea



42 + 43 Litters born from 73 does of 2 genetic populations (38 WP & 35 SS)

Number of litters		Born alive			TOTAL
		S (≤ 5)	M(6-8)	L (≥ 9)	
Suckling	S (≤ 5)	5	6	17	28
	M(6-8)	5	12	6	23
	L (≥ 9)	6	8	20	34
TOTAL		16	26	43	85

Litter size

Small = 2 to 5 kits

Medium = 6-8 kits

Large = 9 kits & more

Results

None of the calculated interaction has reached the level of significance ($P > 0.10$).

Thus, each factor is presented separately

**Effect of does
genotype on global
milk production**

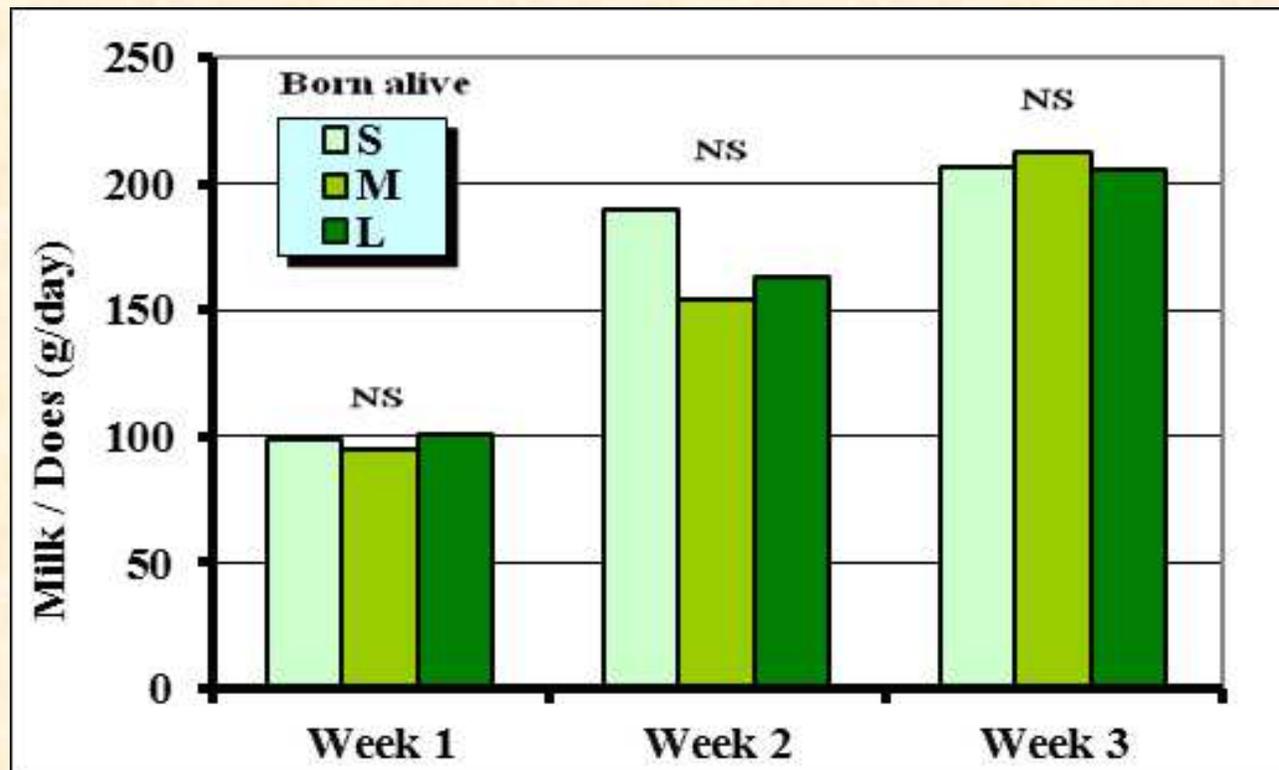
7.04 - 7.08 kits born alive
7.10 - 7.10 sucklings/litter

**Milk production / doe
in 21 days**

White Population	148 g/d	} P=0.05
Synthetic Strain	168 g/d	

Results

Effect on does milk production of number of
BORN ALIVE



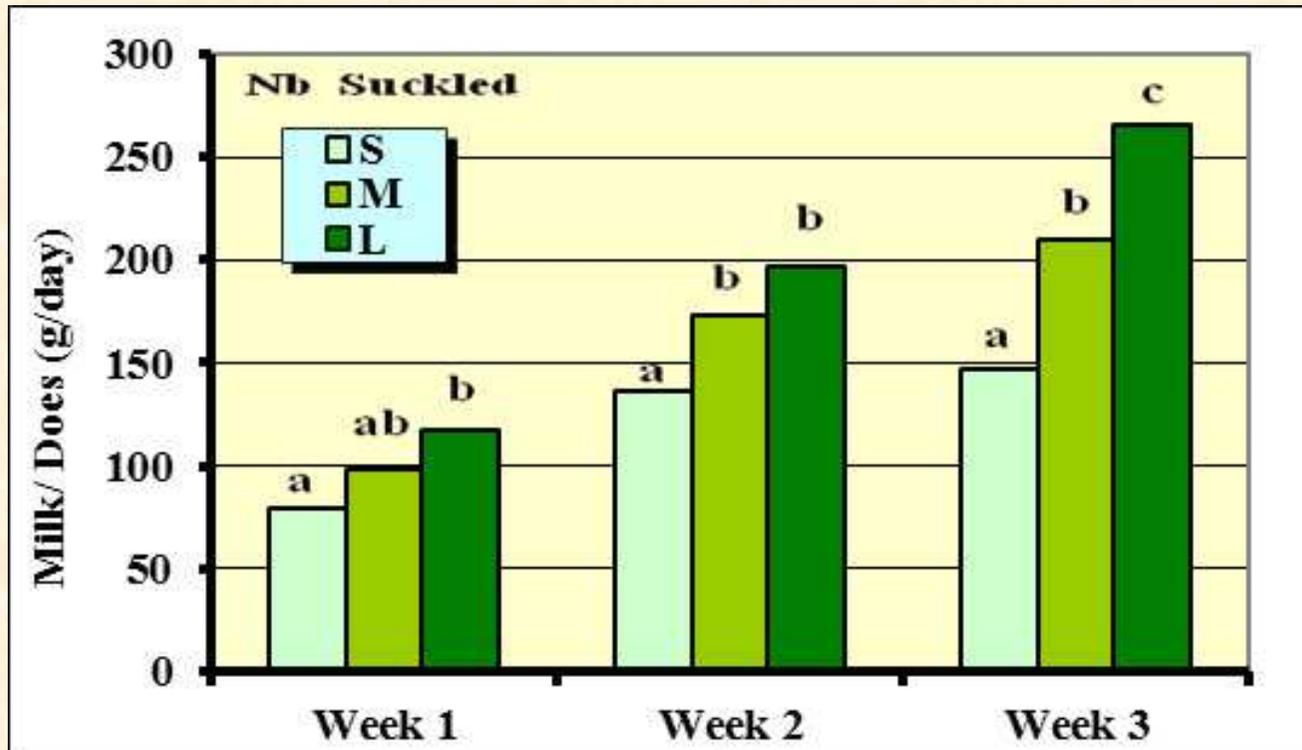
6.80 to 7.38 sucklings

**Milk Production
in 21 days**

S	165 g/d	} NS
M	154 g/d	
L	156 g/d	

Results

Effect on does milk production of **SUCKLED LITTER SIZE**



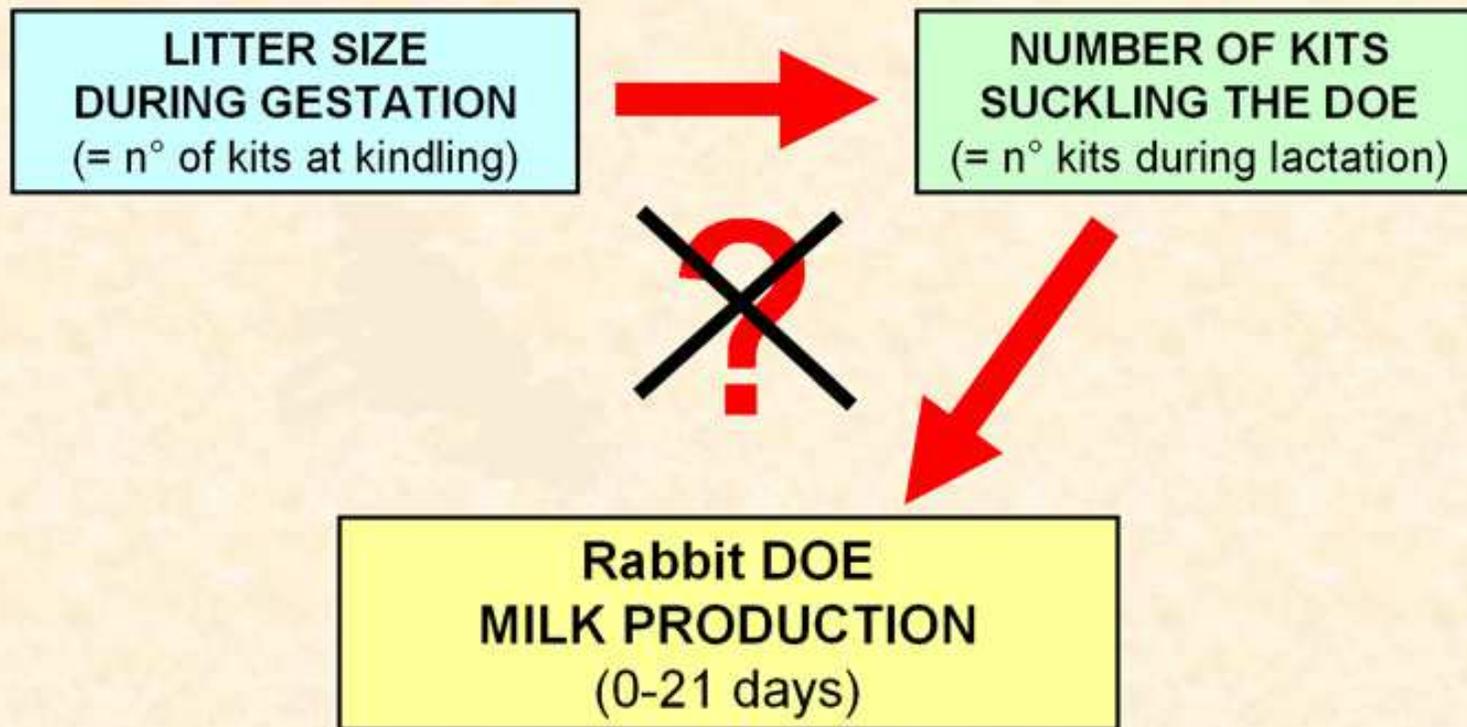
6.94 to 7.26 born alive

Milk Production in 21 days

S	121 ^a g/d	} P<0.001
M	160 ^b g/d	
L	194 ^c g/d	

Conclusion

- Milk production of does increases with the number of suckled rabbits, **regardless of the size of litter at birth.**



Thanks for your attention



11th WORLD RABBIT CONGRESS. JUNE 15 - 18, 2016, QINGDAO, CHINA