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Influence of non-genetic factors on gestation period and litter size at birth in German Angora rabbits

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Abstract
An attempt has been made to determine the reproductive performance of German Angora rabbits reared in Kangra Valley of Himachal Pradesh in the present study. A total of 361 records of female German Angora rabbits as well as progenies of a foundation stock of 8 bucks and 32 does of an imported improved strain of German Angora rabbit were analysed to estimate the reproductive traits in relation to non-genetic factors. The data were collected from Angora Rabbit Breeding Farm, Kandwari, Kangra (Himachal Pradesh) over a period of ten years, from 2000 to 2009. The data were analyzed by Harvey's least-squares method of fitting constants. The least-squares means for litter size and gestation period were 4.62±1.64 kits and 30.39±0.58 days, respectively. Litter size at birth was significantly affected by both year and season of kindling whereas; gestation period was significantly affected only by year of kindling. Winter appeared to be the most favourable season for breeding of Angora rabbits. Improvement can be achieved through proper selection and improved management practices. Therefore, pure breeding stock of German Angora rabbits can be introduced to maintain superior genotypes and variability in the farm.

Keywords: german angora, gestation period, litter size, season, year

1. Introduction
Angora rabbit production is being promoted in temperate and sub-temperate ecological regions of India to produce valuable and high quality fibre for the woollen textile industry. Angora fibre is suitable for the manufacture of woollen garments like sweater, shawls, scarves, stoles, mufflers, caps etc. Besides various uses of wool, the Angora rabbit itself is very easy and economical to rear, highly prolific with rapid growth rate and provides highly nutritious and tasty meat, which can be recommended for cardiac patients due to its high protein together with low cholesterol, fat and sodium contents. Growing worldwide interest is being witnessed in Angora rabbit farming with China promoting Angora rabbit rearing at large scale as self-sustaining farming enterprises for farmers with small capital and land holding capacity. In rabbit farming, the level of production directly depends on reproductive efficiency determining the overall profitability of commercial rabbit enterprises [1].

German Angora is among the most improved varieties of Angora rabbits reputed for its large body size, high prolificacy and higher annual wool yield ranging from 700-1200 g/ animal. The adult body weight ranges from 3 to 5 kg. The short gestation period and generation intervals are the nuts and bolts for early selection to bring rapid genetic improvement in this animal. In spite of the regulation of environmental conditions in rabbit houses, season plays a significant role in relation to the reproduction of rabbit does. Rabbit does are very sensitive to heat stress, which could be an important factor influencing their fertility. Although the doe is capable of producing 10 litters per year, but in a hot climate it has only 4 or 5 litters per year[2]. The effect of the season on reproductive performance of rabbits could be different in does and in growing rabbits. The highly influential effect of the season on gestation period, kindling interval and litter weight at weaning was reported in Chinchilla breed of rabbits under the agro-climatic conditions of North-Eastern region of India [3]. In Grey Giant rabbits, it was found that litter sizes as well as weight at birth and weaning were all higher during winter as compared to those during summer and the rainy season [4]. The present study was, therefore, carried on to determine the influence of certain non-genetic variables like year and season of kindling on litter size at birth and gestation period on the performance of German Angora rabbits maintained under sub-temperate Indian conditions.

2. Materials and Methods

2.1 Location and collection of data

Breeding data on 361 German Angora does maintained at Angora Rabbit Breeding Farm, Kandwari, Palampur, Distt. Kangra (Himachal Pradesh) belonging to Department of Animal Husbandry (H.P) over a period of 10 years (2000 to 2009) were utilized in the present study. The data pertained to subsequent generation progenies of a foundation stock (8 bucks and 32 does) of an imported improved strain of German angora rabbits from West Germany in 1994. This farm is located in sub-temperate mid-hill region of Himachal Pradesh at an altitude of 1300 meters above the mean sea level at 32° 6′ North latitude and 76° 32′ East longitude. The average maximum and minimum temperature of the location remains 28.4°C in summers (May - June) and 7.2°C in winters (usually in January) with 50-70% relative humidity. The entire data was classified into 10 years of kindling *i.e.* from 2000 to 2009, where each year further subdivided into 4 seasons *viz.*, winter (November-February), spring (March-April), summer (May-August) and autumn (September-October) depending upon the local agro-climatic conditions.

2.2 Management practices

All the animals were maintained under uniform housing and management conditions throughout the period. The adult does were housed in individual flat deck standard-sized wire mesh cages fitted with the wall of the house with top entry and provided feeding and watering fixtures in the front sides. For breeding stock and nurseries, nest box (made up of wooden material) of 36 × 36 × 30 centimetre is placed in front of the cages 4-5 days prior to kindling. The advantages of this system of housing include entry of fresh air in the house and easy shifting of the hutch as per the climatic conditions, which is very necessary in that particular climate. For breeding does, the size of the cage was 60 × 60 × 40 centimetre and floor was 2.5 × 1.25 centimetre. Apart from feeding of available seasonal green forages and grasses *viz*., oats in winter and, maize and soya bean in summer season to meet approximately 20% of the nutritional requirements, the adult animals (above 6 months of age) were offered pelleted concentrate feed @ 175 gm/doe/day and each lactating doe was offered @ 275gm/doe/day of pelleted feed having 18-20 % crude protein. The water was offered *ad libitum*. Animals were used for breeding only after full growth *i.e.* normally at around 8 months of age and the ratio of male and female was 1:5. Regarding shearing, hand shearing was done four times in a year at three months interval. The rabbits were kept under strict surveillance for all possible health care; culling and medication of affected animals were done whenever needed.

2.3 Statistical methods

The data were analysed at Department of Animal Breeding, Genetics and Biostatistics, Dr. G.C. Negi College of Veterinary and Animal Sciences, Palampur by least-squares method of fitting constants [5] with different fixed and regression effects, as observations on traits were unequally distributed in different sub-classes which would lead to non-orthogonality of the data. The statistical model used to analyze the data was –

$$Y_{ijl} = \mu + P_i + S_j + e_{ijl}$$

Where, Y_{ijl} is the observation on l^{th} animal which was born in jth season of i^{th} year,
μ is the overall population mean,
P_i is the effect of i^{th} year of birth,
S_j is the effect of j^{th} season of birth and
e_{ijl} is the random error attached to each observation.

The interactions among fixed effects were assumed to be absent. Duncan's Multiple Range Test (DMRT) was done to make pair wise comparison among the means wherever significant differences exist [6].

3. Results and Discussion

The estimates of least-squares means (LSM) and standard errors (SE) along with the results of Duncan's Multiple Range Test (DMRT) for litter size and gestation period, and least-squares analyses of variance showing the effect of different factors on the traits are presented in Table 1 and 2 respectively.

Table 1: Least-squares means and standard errors for litter size at birth and gestation period along with the results of Duncan's Multiple Range Test (DMRT)

Effect	No. of observations	Litter size at birth	Gestation Period
Overall Mean (μ)	361	4.62 ± 1.64	30.30 ± 0.58
Year of Kindling		**	**
2000	46	4.23 ±0.24^{b}	30.50 ±0.07^{cd}
2001	87	4.98 ±0.17c	30.46 ±0.05^{bc}
2002	42	4.51 ±0.24^{bc}	30.29 ±0.07^{b}
2003	22	5.07 ±0.32^{cd}	30.56 ±0.10^{cd}
2004	38	5.84 ±0.25^{d}	30.04 ±0.08^{a}
2005	16	4.13 ±0.38^{ab}	30.42 ±0.12^{bc}
2006	42	3.40 ±0.24^{a}	30.09 ±0.07^{a}
2007	41	4.85 ±0.25^{bc}	30.32 ±0.08^{bc}
2008	13	4.48 ±0.41^{bc}	31.88 ±0.13^{e}
2009	14	4.44 ±0.40^{bc}	30.77 ±0.12^{d}
Season of Kindling		*	NS
Winter	124	5.07 ±0.15^{b}	30.49 ±0.04
Spring	66	4.82 ±0.20^{b}	30.47 ±0.06
Summer	116	3.86 ±0.15^{a}	30.48 ±0.04
Autumn	55	4.63 ±0.24^{b}	30.68 ±0.07

** ($p<0.01$); * ($p<0.05$)

Table 2: Least-squares analyses of variance for litter size at birth and gestation period

Sources of variation	df.	Mean squares	
		Litter size at birth	Gestation period
Year of birth	9	15.54**	4.54**
Season of birth	3	28.26*	0.39
Error	348	2.23	0.23

*P<0.05, **P<0.01

3.1 Litter size at birth

The overall LSM ± SE for litter size at birth was found to be 4.62 ± 1.64 kits with a coefficient of variation of 32.32% in the present study (Table 1) which is in conformity with the findings of Bhasin *et al.* [7] in Russian Angora and Kumar *et al.* [1] in German Angora rabbits. However, the estimates reported by Sorensen *et al.* [8], Singh and Jilani [9], and Tuma *et al.* [10] respectively in Danish White Broiler rabbit, German Angora rabbit and European wild rabbits were much higher than the present estimates.

3.1.1 Effect of year of kindling

Least-squares analyses of variance revealed a significant effect of year of kindling (P <0.01) on litter size at birth (Table 2). Similar observations were obtained by Ehiobu *et al.* [11] and Sood *et al.* [12] in Nigerian broiler rabbits and German Angora rabbits, respectively. The litter size at birth was found to be the lowest (3.40±0.24) during the year 2006 and the highest (5.84±0.25) during 2004. On the other hand, non-significant effect of year of kindling on the trait was observed by El-Sayiad *et al*. [13] in broiler rabbits.

3.1.2 Effect of season of kindling

Significant effect of season of kindling (P<0.05) was observed on litter size at birth in the present study (Table 2) which is in agreement with the observations of Kumar *et al.* [1], Zapletal and Barabasz [14], and Tuma *et al*. [10] in German Angora, Rex and European wild rabbits, respectively. Among the seasons of kindling, the litter size at birth was recorded lowest in summers (3.86±0.15) and highest in the winter months (5.07±0.15) implying that the summer season with relatively high ambient temperature is not conducive for better reproductive performance of the Angora rabbits in this region. Summer has been reported as an unfavourable season in both temperate [15] and tropical [16] climates for breeding rabbits. The evaluation and corrections of such influences are important to standardize the variation in performance and to expose the role of hereditary and non-hereditary factors. However, non-significant effect of season of kindling on the trait was reported by Rastogi [17] in New Zealand White and Bhatt *et al.* [4] in Grey Giant rabbits.

3.2 Gestation period

The overall LSM ± SE for gestation period in the present study was recorded to be 30.39 ± 0.58 days with very low coefficient of variation of 1.58% (Table 1). The finding is in the flow of the findings of Sambher [18] and Tuma *et al.* [10] in German Angora and European wild rabbits, respectively. On the other hand, Kumar *et al.* [1] reported higher gestation length in German Angora rabbits as compared to the present study.

3.2.1 Effect of year of kindling

Year of kindling had significant effect (P<0.01) on gestation period in the present study (Table 2). Among years of kindling, the gestation period ranged between 30.04 ± 0.04 (2004) to 31.88 ± 0.13 (2008) days; the differences among years being statistically significant (P<0.01). Gestation period is a constant trait, which may not be affected by any genetic or non-genetic factor. Though significant effect of year of birth on gestation period had been reported by Khalil *et al.* [19] in Bauscat and New Zealand White rabbits but, Sambher [18] and Gaur *et al.* [20] observed non-significant effect of year of kindling on gestation period in German Angora and other strains of Angora rabbits.

3.2.2 Effect of season of kindling

In the present study, analyses of variance revealed non-significant effect of season of kindling on gestation period (Table 2). This result is supported by the reports of Gaur *et al.* [20] and Tuma *et al.* [10] in Angora and European wild rabbits, respectively. Among seasons, the shortest gestation period of 30.47±0.06 days was recorded in spring season and the longest (32.68±0.07 days) in autumn; but the seasonal differences were observed statistically to be non-significant. The influence of season observed in this study on reproductive efficiency may be attributed to changes in the photoperiod [21] and/or temperature [22]. The increase in day length, a comfortable temperature and the availability of a good roughage supply during spring may contribute to high reproductive efficiency of rabbits. Another reason for the comparatively better reproductive performance during spring may be a result of the rest period given to the does during winter. On the other hand, the comparatively high temperature and humidity in the summer season might have influenced the metabolic and hormonal status of the does and had a carry-over effect that is responsible for low reproductive efficiency [23]. Moreover, rabbits are susceptible to heat stress due to the fact that they have few functional sweat glands [24] and their feed and water intake decrease as temperature and humidity increase [25], which has an indirect effect on fertility and prolificacy. However, significant effect of season of kindling on the trait was observed by Kumar *et al* [1] in German Angora and Marai *et al.* [26] in Egyptian rabbits.

4. Conclusion

This study has revealed the importance of some non-genetic factors upon the litter size at birth and gestation period in German Angora does, which could be utilized for genetic evaluation of the animals. The results indicated that the year and season of kindling were the significant non-genetic influences at varying level on the reproductive performance of the does. Winter may be considered as the best season for breeding of Angora rabbits to have the ideal numbers of offspring with a moderate weight at birth and weaning. Pure breeding stock from other organized farm or fresh import of German Angora rabbits can be introduced to this farm to maintain superior genotypes and variability in the farm.

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