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Crossbreeding effects for litter and lactation traits in a Saudi project to develop new lines of rabbits suitable for hot climates

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Abstract

A five-years crossing scheme involving the Spanish V line (V) and Saudi Gabali (S) rabbits was practiced to produce 14 genetic groups: V, S, 1/2V1/2S, 1/2S1/2V, 3/4V1/4S, 3/4S1/4V, $(1/2V1/2S)^2$, $(1/2S1/2V)^2$, $(3/4V1/4S)^2$, $(3/4S1/4V)^2$, $((3/4V1/4S)^2)^2$, $((3/4S1/4V)^2)^2$, Saudi 2 (a new synthetic line) and Saudi 3 (another new synthetic line). A total of 3496 litters from 1022 dams were used to evaluate litter size at birth (LSB) and weaning (LSW), litter weight at birth (LWB), litter weight at 21 d (LW21) and litter weight at weaning (LWW), pre-weaning litter mortality (PLM), milk yield at lactation intervals of 0–7 d (MY07), 0–21 d (MY021), 0–28 d (TMY) and milk conversion ratio as g of litter gain per g of milk suckled during 21 d of lactation (MCR021). A generalized least squares procedure was used to estimate additive and heterotic effects (direct, maternal, and grand-maternal).

The comparison among V, S, Saudi 2 and Saudi 3 showed a complementarity between V and S. Line V was superior for LSB, LSW, LWB, PLM, MY07, MY021 and TMY, while line S was superior for the other traits (LW21, LWW and MCR021). Saudi 2 and Saudi 3 had the means equal to or higher than the founder lines (V or S) for all traits. Saudi 2 showed better values in litter size and pre-weaning litter mortality compared to Saudi 3 with no significant differences for the other traits. Concerning crossbreeding parameters, direct additive effects were significant for all traits, ranging between 12.3% and 31.8% relative to the average of the means of V and S. All estimates for direct heterosis except LWB and MCR021 were significant and ranged from 5.3% to 27.5%. No estimates for maternal additive effects and grand-maternal additive and heterotic effects were significant. Only estimates for maternal heterotic effects of LSB and LSW were significant (8.6% and 10.6%, respectively).

Keywords: Rabbits; Crossbreeding; Synthetic lines; Litter traits; Lactation; Additive effects; Heterosis

1. Introduction

In the last two decades, some developing countries have been interested in increasing their rabbit meat production through carrying out selection programs based on local breeds and exotic lines (Garreau et al.,

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2004). In hot-climate countries, such as Saudi Arabia and Egypt, selection programs for meat rabbits are currently active, addressing different issues under a broad perspective taking into account the adaptation to the heat (El-Raffa et al., 2005). The main point of these programs is dealing with the constitution and definition of the breeds and lines on which the selection and the production are to be based. Thus, the scheme followed in Saudi Arabia and Egypt has similar bases depending on the local breeds or using an exotic line selected for prolificacy that performs well under hot conditions (García and Baselga, 2002; Khalil et al., 2002) and synthetic lines between the local breeds and the exotic lines. The small-scale producers are the main beneficiaries of these new synthetics lines.

During the process of synthesizing new lines, it is common that several genetic types of animals, like the founders, F_1, F_2, backcrosses, other types of crossbreds and synthetics, perform contemporarily allowing a connection between all of them. This fact permits, if an adequate recording system is maintained along the process, a joint analysis of their records and estimates of many crossbreeding parameters between the founder breeds or lines of the synthetics (Dickerson, 1973), depending on the depth of the analysis for the number available in different types of animals. The knowledge of these parameters is useful to explain the differences between the founders and the synthetics and it also permits the prediction of the performance of other types of crosses among them. In Saudi Arabia, the procedure followed to create two new synthetic lines had three important requirements (Khalil et al., 2005): (1) connection among genetic groups, (2) adequate recording system, and (3) high number of genetic groups.

Traits related to productivity of the does, such as litter size, litter weight, milk production and longevity are considered the most important traits for efficient production and some of these traits are objectives of selection to develop maternal lines of rabbits (Estany et al., 1989; Gómez et al., 1996; de Rochambeau et al., 1998; Baselga, 2004). A deep knowledge involving crossbreeding parameters for these traits is lacking in temperate areas (Baselga et al., 2003; Brun and Baselga, 2005) and in hot climates (Khalil and Afifi, 2000; Khalil et al., 1995, 2004, 2005). Thus, the objectives of the present study were: (1) to evaluate the results of two new lines of rabbits, and (2) to estimate the crossbreeding parameters for litter and milk traits in terms of additive and heterotic effects (direct, maternal, and grand-maternal), recombination losses and cyto-plasmatic effects in a crossbreeding program involving one Saudi breed and one exotic line of rabbits, that are the founders of the new lines.

2. Materials and methods

2.1. Animals and crossbreeding program

A five-year crossbreeding project involving the desert Saudi Gabali breed (S) and the Spanish V line (V) was started in September 2000 in the experimental rabbitry, College of Agriculture and Veterinary Medicine, El-Qassim region to develop two new lines of rabbits in Saudi Arabia. Eighty pedigreed dams and sixteen pedigreed sires of V line rabbits were imported from Universidad Politécnica de Valencia, Spain, in September 2000. The V line is a maternal rabbit line selected for number of young weaned per litter (Estany et al., 1989) for 21 generations, while S line is a Saudi breed raised under desert conditions, especially in the Najd area. Rabbits of this breed are characterized by litter size of 6–8 young, mature body weight of 3200–3800 g and the ability to survive and adapt to produce and reproduce under hot environments. Before the starting of our program, no selection program was practiced in this breed and it has not originated from any crossbreeding program.

Two parallel crossbreeding schemes were carried out. The first scheme began by crossing S sires and V line dams to get the F_1 (1/2S1/2V), then dams and sires of this F_1 were mated to get the F_2 $(1/2S1/2V)^2$ and at the same time dams of F_1 were backcrossed with sires of V line to get 3/4V1/4S, then progeny of the backcross were mated to get $(3/4V1/4S)^2$, followed by one generation of *inter se* mating to get $((3/4V1/4S)^2)^2$ and finally three generations of inter se mating of the previous progeny was practiced to get a new synthetic maternal line named Saudi 2. The second scheme began by crossing V line sires with Saudi dams to get the F_1 cross (1/2V1/2S), then dams and sires of this F_1 were mated to get the F_2 $(1/2V1/2S)^2$ and at the same time dams of F_1 were backcrossed with Saudi sires to get 3/4S1/4V, then progeny of this backcross were mated to get $(3/4S1/4V)^2$, followed by one generation of *inter se* mating to get $((3/4S1/4V)^2)^2$ and finally three generations of inter se mating of the previous progeny was practiced to get a new synthetic line named Saudi 3. The breeding plan in the project permitted connected production of 14 genetic groups as shown in Table 1. The sires were randomly assigned to mate the dams naturally with the restriction to avoid the matings of animals with common grandparents. A total of 3496 litters of 1022 dams were used. These dams were obtained by crossing 419 dams and 151 sires. Numbers of litters born in V, S, 1/2V1/2S, 1/2S1/2V, 3/4V1/4S, 3/4S1/4V, $(1/2V1/2S)^2$, $(1/2S1/2V)^2$, $(3/4V1/4S)^2$, $(3/4S1/4V)^2$, $((3/4V1/4S)^2)^2$, $((3/4S1/4V)^2)^2$, Saudi 2, and Saudi 3 lines were 753, 571, 264, 280, 122, 277, 37, 77, 222, 164, 89, 187, 149 and 304, respectively.

2.2. Housing and feeding

Rabbits were raised in a semi-closed rabbitry. Breeding dams and sires were housed separately in individual wire cages. All cages were equipped with feeding hoppers and drinking nipples. In the rabbitry, the environmental conditions were monitored; temperature ranged from 20 °C to about