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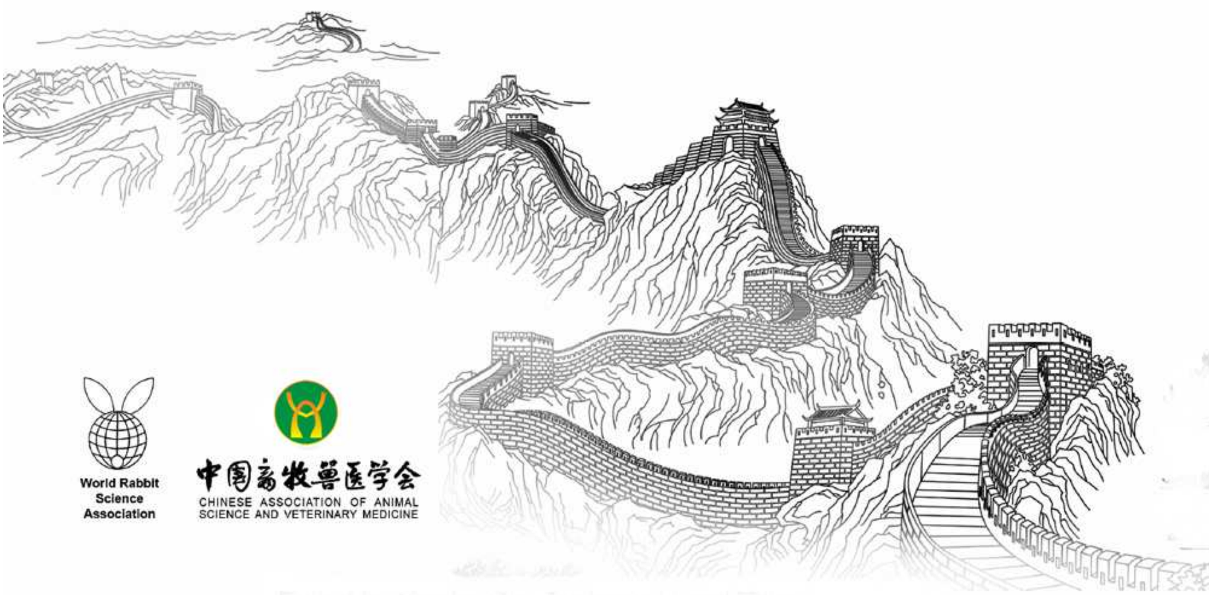

# VIABILITY AND PROLIFCACY TRAITS IN DIALLEL CROSSES OF FOUR RABBIT BREEDS

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## ABSTRACT

Three complete diallel crosses using purebred bucks and does of four rabbit breeds (Californian, C; Chinchilla, Ch; New Zealand White, N and Semigiant White, S) were realized in different periods (1968-1970 and 2003-2004), involving 6293 preweaning records. The traits studied were: total born (TBorn), born alive (BornA), viability at birth (ViabB), number weaned (NW), proportion of weaned litters (PWL) and viability at weaning (ViabW). A generalized linear mixed model using the *PROC GLMMIX* of *SAS* was applied, which considered the fixed effects of breed of the doe and the buck (4 classes each), experiment (3 trials), doble and triple interactions between all fixed effects, and the random effect of parity (5 levels).The does from breeds S and N excelled the others in viabilities and NW, while the bucks from N breed showed disadvantages in viabilities. The interaction effect between the doe and buck breeds identified the best crosses for NW, as SN, SCh and CS, over NCh, and C. The dam and sire breeds*experiment interactions were significant for ViabB, NW and ViabW. Differences between the breed of the doe were only found in experiment 1 and 2 with advantages for the N doe breed. The effect of buck breed was only significant in experiment 2, for ViabB, where C excelled N, and in ViabW the S breed excelled the rest. The triple interaction was significant in ViabW. It showed the best correspondence in merit order between experiment 1 and 3 with correlations of 0.5. The best three crosses across experiments were: SN, ChS, and ChN, which, along with the CS cross and the S and N dam breeds are recommended for commercial crossbreeding schemes.

**Key words**: rabbit breeds, diallel cross, prolificacy, viability

## INTRODUCTION

In tropical countries one of the most effective and rapid way for genetic improvement is crossbreeding. There is a coincidence among literature reports of crossbreeding experiments dealing with preweaning traits (Brun and Baselga, 2005) which demonstrate the benefits of this way of improvement in rabbits independently of the breeds involved.

In Cuba, among different crossbreeding experiments there are three diallel crossbreeding trials (Ponce de León, 1977; García, 2005) consisting of matings among bucks and dams from the same four breeds coming from different populations which were performed under different environmental conditions due to the different management practices and periods in which they were carried out. The objective of the present work is to determine viability and prolificacy performance resulting from those combinations of breeds involved in the mattings in order to identify the best genotypes for pre-weaning performance that could be recommended in a crossbreeding scheme for commercial units.

## MATERIALS AND METHODS

### Animals and experimental design

Three complete diallel crossbreeding trials involved bucks and does from four rabbit breeds: California (C), Chinchilla (Ch), New Zealand (N) and Semigiant White (S) leading to 16 different genetic types of progeny (4 purebreds and 12 crossbreds) with a total of 6293 preweaning records. The first two experiments were developed between July/1968 and November/1970 in the rabbitry "8 de octubre", while the third was realized between May/2003 and April/2004 in the rabbitry "26 de Julio", both located at San Jose de Las Lajas, Mayabeque province. The mating design accomplished the assumptions of a complete diallel cross (4*4) where all the reciprocal crosses were obtained. The animals were allocated in open sided buildings following a completely random design. Buck and dam breeders were selected from the genetic population and fulfilled the phenotypic characteristics of each breed.

**Management**
Natural mating were started three days after weaning (at 45days) in experiments 1 and 2 and after 11 days from parturition in experiment 3 with weaning at 35-40 days of age. For experiments 1 and 2 pelletized balanced diets were offered *ad libitum* containing 18% of crude protein supplemented with green forages of alfalfa (*Medicago sativa*) and ramie (*Bohemeria nivea*). For experiment 3 non pelletized concentrates containing 17-18% crude protein were offered at 70% of the requirements needed for each category (Lebas *et al*., 1996) mixed with 30% wheat bran and supplemented with grass forages.

**Statistical analysis**
The prolificacy traits studied were: total born (TBorn), born alive (BornA), viability at birth (ViabB=(BornA/TBorn)*100) in a set of 6293 records; number of weaners (NW), proportion of weaned litters (PWL, where: no animals weaned=0, one or more weaned=1), viability at weaning (ViabW= (NW/BornA)*100) in a set of 5915 records that excluded litters with zero born alive.

*Statistical Analysis System* (SAS), version 9.3 (2013) procedures were applied for the statistical analysis. SAS/INSIGHT procedure was used to study normality assumptions of the discrete variables. TBorn, BornA, NW responded to a Poisson distribution and , PWL, ViabB and ViabW to binomial distribution. The *PROC GLMMIX* of *SAS*(2013) was utilized to apply generalized linear models common to all variables, varying only for the link function attributed to each one. It considered the fixed effects of dam (MatB) and sire (PatB) breed, experiment (Exp), the interactions between: MatB*PatB breeds, PatB*Exp, MatB*Exp and PatB*MatB*Exp, and parity that was considered as a random effect in order to obtain REML solutions .The interactions with experiment considered the performance of breeds under different environmental conditions.

## RESULTS AND DISCUSSION

Information issued from diallel crosses allows the evaluation of different genetic aspects of the parental lines (Dickerson, 1969) that contribute to make objective decisions for the selection of the genetic material to be used in genetic improvement programs.

The analysis of variance identified the effect of experiment as the more consistent source of variation, as it affected all the traits. It was followed by the dam breed, the sire*dam breed, the dam breed*experiment and sire breed*experiment interactions, that influenced ViabB, NW and ViabW. The triple interaction affected only ViabW. Viability traits and NW were influenced by all effects, while prolificacy at birth only presented differences due to the experiment effect. In other Cuban reports, no significant effects of sire or dam breed were encountered for birth traits (Ponce de León 1977), but another situation is present at weaning, as García (2005).

**Breed effects.**
The dam breeds, Semigiant or New Zealand excelled California in weaning traits, while sire breed Semigiant present superiority over California and New Zealand in ViabW. However more attention should be paid to dam*sire interaction which is an indication of the specific combining ability. It permits the detection of specific crosses with relevant production levels and that could be interesting to introduce in commercial breeding schemes. Promising crosses were found for each trait, but significant differences were only found between extreme performances (table 1).

**Table 1**:Genotype effects[1] for viability and prolificacy traits in diallel crosses in rabbits.

| Sire breed | Dam breed | N. | ViabB (%) | | N. | NW (No.) | | ViabW (%) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Mean | ±SE | | Mean | ±SE | Mean | ±SE |
| C | C | 1644 | 90,3$^{ab}$ | 0,8 | 1564 | 2,72$^{cd}$ | 0,13 | 46,9$^{cd}$ | 1,7 |
| C | Ch | 92 | 87,2$^{abcdef}$ | 1,6 | 83 | 3,43$^{abc}$ | 0,24 | 55,5$^{abcd}$ | 3,5 |
| C | N | 98 | 92,5$^{a}$ | 1,1 | 94 | 2,89$^{abcd}$ | 0,18 | 48,2$^{bcd}$ | 2,5 |
| C | S | 116 | 90,4$^{abc}$ | 1,1 | 107 | 3,50$^{ab}$ | 0,19 | 54,0$^{abc}$ | 2,1 |
| Ch | C | 119 | 89,6$^{abcdef}$ | 1,2 | 111 | 3,18$^{abcd}$ | 0,19 | 53,1$^{abc}$ | 2,4 |
| Ch | Ch | 420 | 88,4$^{abcdef}$ | 1,0 | 394 | 2,74$^{bcd}$ | 0,16 | 44,5$^{cd}$ | 2,3 |
| Ch | N | 108 | 90,2$^{abcd}$ | 1,2 | 96 | 3,14$^{abcd}$ | 0,19 | 57,2$^{ab}$ | 2,3 |
| Ch | S | 115 | 83,3$^{ef}$ | 1,5 | 105 | 3,25$^{abcd}$ | 0,19 | 58,6$^{ab}$ | 2,3 |
| N | C | 91 | 83,1$^{def}$ | 1,8 | 81 | 2,97$^{abcd}$ | 0,20 | 53,1$^{abcd}$ | 2,8 |
| N | Ch | 93 | 84,2$^{cdef}$ | 1,6 | 83 | 2,49$^{d}$ | 0,18 | 41,1$^{d}$ | 2,4 |
| N | N | 1320 | 86,9$^{bcdef}$ | 0,9 | 1267 | 3,03$^{abcd}$ | 0,15 | 50,8$^{bcd}$ | 2,1 |
| N | S | 108 | 87,9$^{abcdef}$ | 1,3 | 101 | 3,31$^{abcd}$ | 0,20 | 53,9$^{abc}$ | 2,3 |
| S | C | 123 | 89,7$^{abcde}$ | 1,2 | 115 | 2,92$^{abcd}$ | 0,17 | 48,1$^{bcd}$ | 2,2 |
| S | Ch | 77 | 89,8$^{abcdef}$ | 1,8 | 75 | 3,62$^{a}$ | 0,27 | 65,4$^{abc}$ | 5,3 |
| S | N | 92 | 90,4$^{abc}$ | 1,2 | 91 | 3,57$^{a}$ | 0,21 | 64,4$^{a}$ | 2,3 |
| S | S | 1677 | 83,9$^{f}$ | 0,9 | 1548 | 3,27$^{abcd}$ | 0,15 | 53,3$^{bc}$ | 1,9 |

$^{abcdef}$ Parameters with different superscript in the same column differ at $P<0,05$ (Kramer 1956)

[1] Combined effects of sire, dam and interaction effects for each genotype

N. Number of meaning

For ViabB the best genetic types were CN, C, CS and SN over S and ChS. For NW the best combinations were SN, SCh, and CS with 3.6-3.5 weanlings, while the worst were NCh and C with less than 2.75 kids. A superior ViabW obtained by the SN cross (64%) followed by ChS and ChN with 6% less,while the poorest performance was attributed to the NCh cross, as well as the C and Ch purebreds. It should be considered that for ViabW the SCh cross, although it's high performance value, did not differ from the worst ones due to the high standard error which correspond to lower number of observations. It is convenient to continue a more profound study of this presumably high performing genetic type, which could be possible taking into account the triple interaction. These results are indicative S and N breeds where excelled in viabilities and NW as dam lines for initiating crossbreeding schemes. The sire breeds N expressed disadvantages in viabilities traits. Ponce de León (1977) too recommended the N and S breeds as dam lines by the advantages in preweaning performance.

The literature presents the different approaches of the crossbreeding results. On one hand, those which realize diallel crosses and are devoted to the estimation of genetic parameters of crossbreeding (Baselga *et al.*, 2003; Ragab, 2012), those which determine the merit order for the breed effects and of the involved genotypes in diallel crosses and a third line of work which consider genetic parameters and merit order of groups of crossbreeds not generated by diallel crosses, Iraqi *et al.* (2008) in Egypt and Al-Saef *et al.* (2008) in Saudi Arabia. These alternatives show that different ways of crossbreeding could be encountered which exceed pure native or exotic lines reaching the objective of crossbreeding in tropical and sub-optimal regions

**Interactions.**

Dam breed*experiment interaction influenced the same traits as the dam breeds. Differences appear mainly in experiment 1 for NW and ViabW, where N and S excelled the other breeds. In experiment 2 no differences appeared among breeds, while in experiment 3 it is was significant for viability traits, where N present higher values, the identification of N dam breed is reinforced as the best for viability traits and theS as a promising breed for NW. Sire breed*experiment interaction was also significant for NW, which was not significant for the main sire breed effect. Differences among breeds were only found in experiment 2, where C excelled N in Viabb. In ViabW S excelled the rest.

The triple interaction was only present for ViabW. An interesting result was the encountered stability in the performance of the 16 genotypes among the three diallel crosses. The best correspondence in merit order was between experiment 1 and 3 with correlations of 0.5, while the correlations between experiments 1 and2 were 0.05-0.08 respectively, despite the continuity in time for the first two experiments. Three crosses excelled in prolificacy performance across experiments. SN was the more robust with significant differences over the worst crooses in all three experiments. It is followed by ChS significantly superior in the experiment 1 and 2 that were the more divergent trials and finally ChN cross with superiority in experiment 1 and 3 and without differences from the rest in experiment 2.The worst performances were for NCh and the purebreds C, Ch and S.

The crosses with better performances and least variation in merit order among experiment were SN, ChS, and ChN. These crosses were identified as the best ones for viability at weaning in the sire*dam breed interaction and it was proved that they were poorly affected by environmental conditions and should be recommended for commercial production.

## CONCLUSIONS

This evaluation allowed to know the range of performance of these traits and the variations in the expression of the different breeds and crosses according to the environmental conditions. Semigiant White and New Zealand White were the best dam breeds. The most important effect was the dam*sire breed interaction, where the simple crosses SN, CS and ChS were the most promising for the preweaning stage. The best and more stable crosses across experiments were SN, ChS and ChN, derived from the triple interaction analysis and could be useful in commercial crossbreeding schemes.

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