CROSSBREEDING OF RHODE ISLAND RED AND WHITE LEGHORN CHICKENS MINIMIZES EMBRYONIC LOSSES DURING INCUBATION AND IMPROVES CHICK QUALITY

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ABSTRACT

A crossbreeding experiment involving reciprocal mating of Rhode Island Red (R) and White Leghorn (W) chickens was conducted to assess its influence on fertility and chick quality traits between purebred chickens and their hybrids. Result of the study revealed a poor clustering of genotypes based on fertility, hatchability, chicks quality and related traits. Eggs laid by R hens were heavier than those laid by W. Conversely, chicks hatched from W eggs were heavier ($P<0.05$) than those from R genotype, indicating higher chick yield and lower egg mass loss during incubation. Number of dead-in-shell chicks and weak chicks were higher ($P<0.05$) in the purebred chicks compared to hybrids, indicating a heterosis in the two traits. Crossbreeding therefore minimizes chick loss during incubation and improves chick quality.

Keywords: fertility, hatchability, chick quality, laying breeds

INTRODUCTION

Chick embryo growth and development are essential for poultry production because performance of the birds later in life depends heavily on the quality of chick after hatching (Chen et al., 2017). Chick quality depends on factors including the breed which provides the milieu for proper embryo development as well as incubation conditions. Chick yield and chick quality on the other hand determine the productivity of the birds and consequently, the farm efficiency in the form of profit margin for the farmer. In chicken breeding industry, crossbreeding leverages the breed complementarity and heterosis leading to increased productivity in egg laying efficiency and egg quality. In laying chickens, it remains to be uncovered whether or not the effect of crossbreeding starts early in life or is delayed. In this study, we examined the effect of crossbreeding elite egg laying breeds on fertility and hatchability of eggs as well as chick quality.

MATERIAL AND METHODS

Management of breeder birds

Two breeds, Rhode Island Red (R) and White Leghorn (W) chickens that were used for this study. The detail of the management of the breeder birds was reported in Isa et al. (2020). Briefly, the birds were raised at the poultry experimental station of the Institute of Animal Science, Chinese Academy of Agricultural Sciences located in Chagping District of Beijing. The breeder birds were of the same age and kept in individual cages under the same conditions including lighting regimes. They were fed breeder diet containing 19% CP and 11.91MJ/Kg. Reciprocal crossing was used to generate fertile eggs representing four populations: R, W, R × W (RW) and W × R (WR). Hens were artificially inseminated with freshly collected semen from sires of the parental lines. Hens in each line were inseminated with semen from cocks of the two populations. Semen was collected from 25 and 26 sires of R and W lines to inseminate the hens in 1:5 mating ratio. Insemination frequency was once every week for all breeder hens. F_1 hybrid eggs as well as chicks hatched from them were named with parental line first followed by maternal line. Number of eggs set for incubation were 422, 635, 665, and 597 respectively, for the R, W, RW and WR.

Incubation conditions and data collection

Generated eggs were set in a cabinet incubator for 21 days. Average weight of the eggs set were 60.01±1.14, 57.28±0.95, 59.26±2.97 and 0 for R, W, RW and WR respectively, which did not differ (P>0.05) significantly. The eggs were tagged and placed in egg setting crates for incubation. On the tenth day of incubation, all the eggs were candled, and the infertile eggs (clear eggs) recorded and remove from the incubator. Two days to the day of hatching (DOH), eggs from the same dam were tied in a heat resistant net containing between 2 to 12 eggs and place on the hatching tray. On the DOH, chicks were weighted and assessed for quality based on their appearance and alertness. Shell and residual yolk sack of the eggs were also weighted. Fertility was calculated as the ratio of fertile eggs to the total eggs set while hatchability was expressed as the percentage of chicks that hatched from the fertile. Chick yield which is a measure of egg weight loss during incubation was calculated as the ratio of the chick weight to the weight of the egg set for incubation (Iqbal et al., 2016).

Statistical analysis

All data generated including egg weight, fertility, hatchability, dead-in-shell chicks, weak chicks, chick weight, average shell weight after hatching and embryonic efficiency were subjected to principal component analysis (PCA) of the multivariate function in JMP statistical package. Traits that substantially contributed to the significant principal components of the PCA were further analyzed using ANOVA. Means were separated using Tukey-Kramer HSD method.

RESULTS AND DISCUSSION

Result of the PCA analysis indicated that the eight traits could be represented by the first four PCs (more than 79%) without loss of variability. Score plot revealed subtle clustering of the hybrids (RW and WR) away from the parental purebreds (R and W). Loading matrix of the PCA revealed that fertility, hatchability, dead-in-shell and weak chicks were the main contributors to the first two PCs.

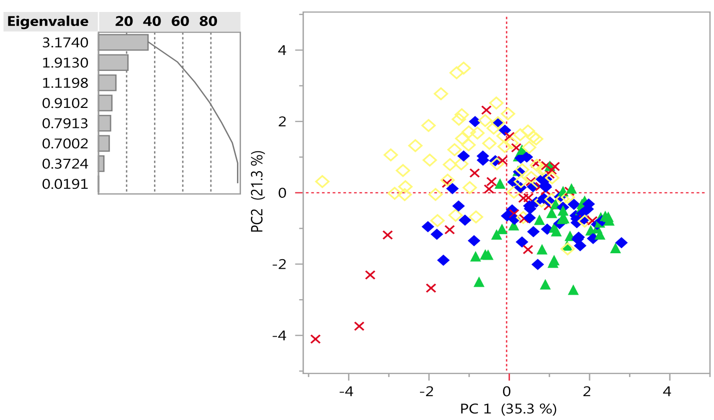

Figure 1: Eigenvalues and score plot for the first two principal components

Fertility and hatching traits

The fertility of eggs laid by W hens was above 92% while that from R hens was 87.27%. Reciprocal crossing of the two breeds improved the fertility of the hybrids (90.91-94.54%). Lower fertility rates were reported for R, RW and WR eggs by Zelleke et al. (2005) in a previous study. Although hatchability rate was not influenced by genotype in the current study, lower hatchability rates were reported for eggs laid by R and W hens in previous studies (Zelleke et al., 2005; Ewonetu and Kasaye, 2018).

Table 1: Fertility and hatchability traits of R and W purebred chickens, and their reciprocal hybrids

Genotype	Egg weight (g)	Fertility (%)	Hatchability (%)	Chick weight (g)	Chick yield (%)
R	60.01±1.14[a]	87.29±1.94[b]	91.60±1.72	38.86±0.52[b]	65.17±0.97[b]
W	57.28±0.95[b]	92.79±1.49[ab]	90.80±1.27	40.46±1.50[a]	72.41±0.75[a]
RW	59.26±2.97[b]	94.64±1.52[a]	95.41±1.29	39.66±0.40[ab]	68.97±0.74[ab]
WR	60.60±0.51[a]	90.91±1.79[b]	93.22±1.45	39.00±0.46[ab]	62.37±0.84[b]

R= Rhode Island Red, W= White Leghorn RW= Rhode Island Red (♂) x White Leghorn (♀) crossbred, WR= White Leghorn (♂) x Rhode Island Red (♀) crossbred.

The weight of eggs set for incubation differ (P<0.05) significantly between R and W, and was determined by the dam line. Generally, R hens laid heavier eggs compared to W hens (Table 2). Albumen and yolk are the major components and resources utilized during embryonic development, and its efficient utilization determines chick weight. In this study, chicks hatched from eggs laid by W were heavier (P = 0.014) than those hatched from heavier eggs laid by R hens, but not different from the hybrids. This is in contrast to several studies that reported higher chick weight from heavier eggs and lighter chicks from lighter eggs (Lourens et al., 2016; Iqbal, et al., 2017).

Chick yield and quality

Chick yield differed among the four groups (P < 0.05) and W parental line had significantly higher chick yield than other genotypes. High yield from W eggs indicated minimum weight loss of eggs during incubation which may be influenced by the shell thickness, a trait earlier reported to be higher in eggs laid by W hens compared to those laid by R hens (Isa et al., 2020). In contrast to the findings of the current study, lower egg weight loss ($P < 0.05$) and therefore high chick yield was recorded in large eggs of W during incubation (Eweonetu and Kasaye et al., 2018). In pigeons, egg weight loss of 27.22% was reported during incubation (Chen et al., 2018), suggesting higher chick yield than we observed in the current study.

Embryonic loss during incubation is represented by dead-in-shell chicks while chick quality is often assesses by chick weight and percent of weak chicks (Figure 2). Result of the analysis dichotomized the four genotypes in to pure lines and hybrids groups, and the hybrids had lower (P<0.05) percent of dead-in- shell and weak chicks compared to their parental pure breeds.

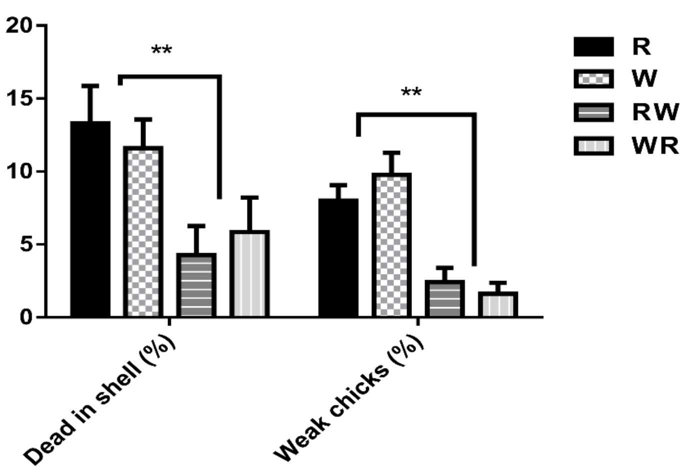

Figure 2: Effect of crossbreeding on dead-in-shell and weak chicks during incubation

CONCLUSIONS

For fertility and chick yield, the dam line plays more dominant role than the sire line. Crossbreeding improves chick quality and reduces embryonic mortality.

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