Genetic analysis of body weight in a selected line of Rhode Island Red grower chicken*

ANANTA KUMAR DAS1, SANJEEV KUMAR2, ABDUL RAHIM3 and LAXMIKANT SAMBHAJI KOKATE4

ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh 243 122 India

Received: 30 July 2018; Accepted: 12 December 2018

ABSTRACT

A total of 1207 pedigreed progenies of 50 sires and 177 dams of a selected line of Rhode Island Red chicken were investigated in two hatches at ICAR-Central Avian Research Institute for genetic analysis of their body weights. The genetic and non-genetic parameters of chick weight at day-old age and body weight at different ages were estimated using least squares analysis of variance. The heritability and correlation coefficients were estimated for different traits using paternal half-sibs. The mean sum of squares for sex component of variance was significant for body weights at third week of age onwards, males being heavier throughout the ages. Sire component of variance was also significant for chick weight and different body weights except the estimates at 6th and 16th week of age. Hatch component of variance was highly significant for chick weight and body weights up to 12th week of age. Regression effect of chick weight on subsequent body weights was found significant specifically for body weights from 1st week onwards to 20th week of age. The heritability estimates were 0.775±0.151 for chick weight, 0.303±0.09 to 0.44±0.142 for body weights from 1st week to 12th week of age, and 0.258 to 0.248 for body weights from 16th week to 20th week of age. The estimates at lower age could be used in selection programme based on the flock’s own performance to improve those traits. The genetic and phenotypic correlation coefficients were positive and highly significant in most of the cases. The corresponding estimates ranged from 0.044 to 0.990 and 0.020 to 0.788, and these coefficients could be combined in construct of standard selection indices for optimum growth in body weight that might be adopted in future breeding strategy for this RIR chicken genotype.

Key words: Body weight, Correlation, Genetic and non-genetic parameters, Heritability, RIR chicken

A selected line of Rhode Island Red (RIR) chicken is being maintained through genetic selection for egg production by the Central Avian Research Institute, Izatnagar (India) since its inception in 1979. Being carried out for over 33 generations, the selection could result in genetic change in the population which could be manifested by the change in heritability estimates. The estimates of genetic parameters could be used for prediction of response to selection, and also as a base for the future selection and breeding strategies. Breeders desire to obtain the estimates of genetic and phenotypic parameters afresh for each population in each generation, because the estimates vary from one population to another and at different times (Barot et al. 2008). Besides more egg production, optimum growth in body weight is also an important attribute to the farmers for promoting RIR in rural livelihood. Notably, the growth is an irreversible, correlated and coordinated increase in the mass of body in a definite interval of time (Kausar et al. 2016). It is necessary to have knowledge of factors influencing the growth of poultry birds because body growth is an important factor that contributes to the profitability in poultry production (Kausar et al. 2016). Therefore, the present study aimed for genetic analysis of grower body weights investigating the genetic and non-genetic parameters in a selected line of RIR chicken.

MATERIALS AND METHODS

A total of 1207 pedigreed progenies of RIR selected line chicken maintained at the experimental layer farm of ICAR-Central Avian Research Institute (CARI, Izatnagar) were investigated. Among these, 625 chicks were of 50 sires and 177 dams in first hatch and 582 chicks of 50 sires and 159 dams in second hatch. The day-old chicks were wing-banded and pedigreed by sire and dam in the hatchery itself. Standard litter brooding, housing and ad lib. feeding on the
The day-old chick weight and body weight at different ages were measured using digital weighing balance 5 mg used upto 8th week and 100 mg used 12th week onwards) during morning on empty stomach. Significant hatch-differences were also reported earlier in RIR chicken (Das et al. 2017, Debnath et al. 2015, Das 2013). The mean sum of squares of variance for regression effect of day-old chick weight on subsequent body weights were found significant (P<0.001), specially for body weights from 1st week onwards to 20th week of age (P<0.01 for 6th week; P<0.05 for 8th and 16th week), indicating significant chick weight effect on its subsequent growth in consistence to the earlier report (Das et al. 2017). It was interpreted that the body mass growth of the birds could be judged better by its day-old chick weights. Significant chick weight-regression effects on different body weights were also reported earlier when studied body weights data were pooled over different genotypes (Das et al. 2014a).

**RESULTS AND DISCUSSION**

The estimated least squares means±SE (no. of observations) of chick weight at day-old age in a selected line of RIR grower chicken was 37.55±0.24 g (1207), and grower body weights were 56.95±0.57 g (591), 91.08±0.77 g (1207), 37.55±0.24 g (1207), and White Leghorn chicken (Qadri et al. 2013, Chaudhary et al. 2009, Barot et al. 2008, Paleja et al. 2008). The lower magnitude of the present h² estimates indicated the presence of high environmental variances and its higher magnitude was indicative of greater role of additive genetic variance than the environmental component of variance (Rajkumar et al. 2011, Barot et al. 2008). The heritability of a trait is notably a population parameter which could be influenced by environmental circumstances (Falconer 1989). Thus, any change in the components of variance would lead to likely change in the heritability estimates and the fact might explain the attributed differences in the estimates by different workers. Moreover, the present estimates were in the expected range. The heritability estimates could vary considerably from study to study depending upon breed, strain, line, population sampled, environmental and management conditions, and random as well as systematic errors in the estimation procedures (Mia et al. 2013). The numbers of progeny per sire and the entire data set from which these estimates were obtained were relatively small, and could have sampling errors. However, the present heritability estimates could suggest for the breeders that the sire selection would be utilized for further genetic improvement in the body weight traits in RIR selected line chicken.

**Genetic and non-genetic factors:** The investigation evidenced that the male birds could demonstrate better estimates of body weights than the females almost throughout the ages. The mean sum of squares for sex component of variance were highly significant (P<0.001) for body weights at 3rd week of age (P<0.01) onwards indicating significant sex-differences and counter role of sex to control the growth of body mass as a whole a genetic factor (Das et al. 2017). The mean sum of squares for sire component of variance were also highly significant (P<0.001) for chick weight and body weights at different ages (P<0.001 for 20th week of age) indicating that body mass growth is influenced by a factor of sire-inheritance (Das et al. 2017, Das et al. 2015ab, Debnath et al. 2015, Das 2013). Hatch is considered as a non-genetic factor and the present results indicated highly significant (P<0.001) hatch-differences for different traits (P<0.01 for 4th week of age). Significant hatch-differences were also reported earlier in RIR chicken (Das et al. 2017, Debnath et al. 2015, Das 2013). The mean sum of squares of variance for regression effect of day-old chick weight on subsequent body weights were found significant (P<0.001), specially for body weights from 1st week onwards to 20th week of age (P<0.01 for 6th week; P<0.05 for 8th and 16th week), indicating significant chick weight effect on its subsequent growth in consistence to the earlier report (Das et al. 2017).

**Heritability estimates:** The heritability (h²)estimates from paternal half-sibs for the present chick weight and different body weights are presented in Table 1. The heritability estimates were 0.775±0.151 for chick weight, 0.303±0.09 to 0.44±0.142 for body weights from 1st week to 12th week of age, and 0.258 to 0.248 for body weights at 16th to 20th week of age, indicating that possibility of selection based on the flock’s own performance to improve these traits would take propagation of short generations for the concerned traits. The present estimates might be compared to the h²estimates from paternal half-sibs reported in RIR chicken (Das et al. 2017, Das et al. 2015ab) and White Leghorn chicken (Qadri et al. 2013, Chaudhary et al. 2009, Barot et al. 2008, Paleja et al. 2008). The lower magnitude of the present h²estimates indicated the presence of high environmental variances and its higher magnitude was indicative of greater role of additive genetic variance than the environmental component of variance (Rajkumar et al. 2011, Barot et al. 2008). The heritability of a trait is notably a population parameter which could be influenced by environmental circumstances (Falconer 1989). Thus, any change in the components of variance would lead to likely change in the heritability estimates and the fact might explain the attributed differences in the estimates by different workers. Moreover, the present estimates were in the expected range. The heritability estimates could vary considerably from study to study depending upon breed, strain, line, population sampled, environmental and management conditions, and random as well as systematic errors in the estimation procedures (Mia et al. 2013). The numbers of progeny per sire and the entire data set from which these estimates were obtained were relatively small, and could have sampling errors. However, the present heritability estimates could suggest for the breeders that the sire selection would be utilized for further genetic improvement in the body weight traits in RIR selected line chicken.

**Genetic and phenotypic correlations:** The genetic (rG)
Table 1. Estimated heritability (at diagonal), genotypic (above diagonal) and phenotypic (below diagonal) correlations of chick weight at day-old age and body weight at different ages in a selected line of RIR grower chicken.

| Traits | CW | BW1 | BW2 | BW3 | BW4 | BW6 | BW8 | BW12 | BW20 |
|--------|----|-----|-----|-----|-----|-----|-----|------|------|
| CW     | 0.775 ± 0.151 | 0.352 ± 0.208 | 0.176 | 0.174 | 0.136 | 0.120 | 0.169 | 0.119 | 0.199 |
| BW1    | 0.352 ± 0.208 | 0.85 ± 0.122 | 0.383 | 0.441 | 0.500 | 0.62 | 0.71 | 0.65 | 0.62 |
| BW2    | 0.176 | 0.383 | 0.788 | 0.644 | 0.604 | 0.500 | 0.404 | 0.327 | 0.548 |
| BW3    | 0.174 | 0.441 | 0.644 | 0.604 | 0.500 | 0.404 | 0.327 | 0.548 | 0.500 |
| BW4    | 0.136 | 0.500 | 0.604 | 0.500 | 0.404 | 0.327 | 0.548 | 0.500 | 0.404 |
| BW6    | 0.120 | 0.62 | 0.500 | 0.404 | 0.327 | 0.548 | 0.500 | 0.404 | 0.327 |
| BW8    | 0.169 | 0.71 | 0.404 | 0.327 | 0.548 | 0.500 | 0.404 | 0.327 | 0.548 |
| BW12   | 0.119 | 0.65 | 0.327 | 0.548 | 0.500 | 0.404 | 0.327 | 0.548 | 0.500 |
| BW20   | 0.199 | 0.62 | 0.548 | 0.500 | 0.404 | 0.327 | 0.548 | 0.500 | 0.404 |

Traits: CW, day-old chick weight in grams; BW, body weights in grams at different weeks of age; aP<0.05, bP<0.01, cP<0.001; ns, non-significant.

and phenotypic (rₚ) correlation coefficients estimated from paternal half-sibs for the present chick weight and different body weight traits were positive and significant (P<0.05, P<0.01 or P<0.001) for almost all the traits. The estimated r₉ and rₚ ranged from low to high in magnitude (Table 1). The ranges of the estimated r₉ and rₚ in different traits were 0.044 to 0.990 and 0.020 to 0.788, respectively, both with moderate to higher magnitudes for the most traits. The estimates <1 being beyond the absolute range are not under consideration. The present findings were in the line with earlier reports for different chicken genotypes (Das et al. 2017, Qadri et al. 2013, Rajkumar et al. 2011, Chaubhary et al. 2009, Barot et al. 2008, Paleja et al. 2008). In this context, few estimates were associated with higher standard errors (Qadri et al. 2013, Jayalaxmi et al. 2010, Barot et al. 2008) making them less precise which was due to less number of progeny per sire (Falconer 1989).

It was concluded that the estimated genetic and non-genetic parameters of chick weight and different body weights would serve as base information for academicians and in genetic improvement programme of the selected line of RIR chicken. The heritability estimates at lower age group could be used in selection programme based on the flock’s own performance to improve those traits. The genotypic and phenotypic correlation coefficients could be combined in construct of standard selection indices for optimum growth in body weights that might be adopted in future breeding strategy for this chicken genotype.

ACKNOWLEDGEMENTS

The IVRI fellowship to the first author for his Ph.D. programme is sincerely acknowledged. The authors are also thankful to the Director of Central Avian Research Institute and Head of its AGB Division for providing the necessary facilities for this work.

REFERENCES

Anonymous. 2011. Annual Report. ICAR-Central Avian Research Institute, Izatnagar, Uttar Pradesh, India. pp 32–33.

Barot V N, Savaliya P F, Hirani N D, Patel A B, Vataliyia P H, Khanaka K, Patel A M and Joshi R S. 2008. Genetic parameters of various economic traits in different generations of synthetic White Leghorn. Indian Journal of Poultry Science 43(1): 20–24.

Becker W A. 1975. Manual of Quantitative Genetics. 3rd ed. Washington State University, Pullaman, Washington, USA.

Chaubhary M L, Braih G S and Khurana S. 2009. Inheritance of body weight and body weight ratio and their relationship with economic traits in White Leghorn chicken. Indian Journal of Animal Sciences 43(2): 167–71.

Das A K, Kumar S, Mishra A K, Rahim A and Kokate L S. 2017. Genetics of body weights in a control line of Rhode Island Red grower chicken. Indian Journal of Animal Sciences 87(8): 1042–45.

Das A K, Kumar S, Mishra A K, Rahim A and Kokate L S. 2016. Evaluating body conformation and feed efficiency characteristics in CARI-Sonali grower chicken. Indian Journal of Animal Sciences 86(2): 192–96.
analysis of body conformation and feed efficiency characteristics in a selected line of Rhode Island Red chicken. *Asian Journal of Animal Sciences* 9(6): 434–40.

Das A K, Kumar S and Rahim A. 2015b. Genetics of body conformation and feed efficiency characteristics in a control line of Rhode Island Red chicken. *Iranian Journal of Applied Animal Science* 5(4): 965–73.

Das A K, Kumar S, Rahim A and Mishra A K. 2014a. Genetic variability in immunocompetence and performance status of Rhode Island Red chicken strains and its crosses. *International Journal of Bio-resource and Stress Management* 5(2): 246–54.

Das A K, Kumar S, Rahim A, Kokate L S and Mishra A K. 2014b. Assessment of body conformation, feed efficiency and morphological characteristics in Rhode Island Red-white strain chicken. *Indian Journal of Animal Sciences* 84(9): 984–91.

Das A K. 2013. ‘Microsatellite polymorphism, immunocompetence profile and performance evaluation in Rhode Island Red chicken and its crosses.’ PhD thesis, Indian Veterinary Research Institute, Izatnagar, Bareilly, U.P., India.

Debnath J, Kumar S, Bhanja S K, Rahim A and Yadav R. 2015. Factors influencing early layer economic traits in Rhode Island Red chicken. *Journal of Animal Research* 5(4): 915–19.

Falconer D S. 1989. *Introduction to Quantitative Genetics*. Longman Press, Essex, U.K.

Harvey W R. 1990. *User’s Guide for LSMLMW and MIXMDL*, *Mixed Model Least-squares and Maximum Likelihood Computer Program*. Ohio State University, Columbus, USA.

Jayalaxmi P, Gupta R B, Chatterjee R N, Sharma R P and Reddy R V. 2010. Genetic analysis of growth and production traits in IWK strain of White Leghorn. *Indian Journal of Poultry Science* 45(2): 123–26.

Kausar H, Verma M R, Kumar S, Sharma V B, Das A K and Dilliwar L. 2016. Modelling of Rhode Island Red chicken strains. *Indian Journal of Animal Sciences* 86(5): 612–15.

Mia M M, Khandoker M A M Y, Husain S S, Faruque M O and Notter D R. 2013. Estimation of genetic and phenotypic parameters of some reproductive traits of black Bengal does. *Iranian Journal of Applied Animal Science* 3(4): 829–37.

Paleja H I, Savaliya F P, Patel A B, Khanna K, Vataliya P H and Solanki J V. 2008. Genetic parameter in White Leghorn (IWN line) chicken. *Indian Journal of Poultry Science* 43(2): 151–54.

Qadri F S, Savaliya F P, Patel A B, Joshi R S, Hirani N D and Patil S S. 2013. Genetic study on important economic traits in two strains of White Leghorn chicken. *Indian Journal of Poultry Science* 48(2): 149–53.

Rajkumar U, Reddy B L N, Padhi M K, Haunshi S, Niranjan M, Bhattacharya T K and Chatterjee R N. 2011. Inheritance of growth and production traits in sex linked dwarf chicken in a laying cycle of 64 weeks. *Indian Journal of Poultry Science* 46(2): 143–47.