Genetic Parameters for Production Traits of Rhode Island Red and White Plymouth Rock Breeds Selected under Tropical Condition in Thailand

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ABSTRACT: Egg production data on Rhode Island Red and White Plymouth Rock hens selected for 11 generations under a tropical environment in Thailand were used to estimate genetic parameters for age at first eggs (AFE), body weight at first eggs (BFE), weight of first eggs (WFE), egg production from 1st day to 17 weeks of lay (EGG) and average egg weight at 17th week of lay (EWT). Estimated heritability for AFE, BFE, WFE, EGG and EWT of RIR hens were 0.46, 0.51, 0.28, 0.33 and 0.47 and for WPR hens these were 0.44, 0.41, 0.33, 0.30 and 0.43, respectively. AFE is positively correlated with BFE, WFE and EWT and negatively correlated with EGG in both breeds. EGG was negatively correlated with both WFE and EWT in both breeds. The estimated genetic parameters will be used in selection strategies to improve the productivity of both breeds.
Keywords: Layer chicken; Egg production; Genetic parameter

Introduction

The layer chicken industry is an important sector of livestock in Thailand. In the early 19th century, backyard poultry production systems were very popular among poultry farmers. Adapted local poultry breeds such as Bantum and Batong were used in these production systems. However, the productivity of these breeds was not adequate enough to sustain the household income in rural areas. Therefore, from 1924, exotic poultry breeds and strains were imported to Thailand to improve the egg production in commercial poultry farms. Crossbreeding programs were initiated in 1951. The local breeds were crossed with exotic breeds to produce crossbred chickens which could survive under harsh local environmental conditions and produced more eggs than the local breeds.

In 2003, in order to have a sustainable poultry genetic resource for the commercial as well as for the backyard poultry systems, the Department of Livestock Development in Thailand initiated a poultry improvement program. Rhode Island Red (RIR) and White Plymouth Rock (WPR) lines were established from the imported breeds and a commercial crossbreeding program was initiated (Sopha et al. (2012)). The day old chicks produced by crossing the RIR and WPR lines were issued to backyard farmers. The recent evaluation of the performance of these crossbred chickens under rural areas of Thailand suggested that the chickens could produce 260 eggs per year (71% rate of lay) while having high survivability (Sopha et al., (2012)). However, further genetic improvement is required to sustain this breeding program.

Knowledge of genetic parameters for economically important traits is a prerequisite for effective genetic improvement programs of the RIR and WPR breeds. Various authors have reported on heritability estimates for economically important traits for layer chicken (Dana et al. (2011); Lerner and Cruden (1948); McClung et al. (1976); Wei and van der Werf (1995)). However, almost all of these studies involved layer chickens managed under environmentally controlled houses in temperate climates. Very few studies have explored the genetic control for economically important traits for layer chicken under open houses in a tropical country. Genetic parameters specific to the selection environment is essential to optimize genetic gain through selection (Mulder and Bijma (2005)). The objective of this study was to estimate genetic parameters for five economically important traits in Rhode Island Red and White Plymouth Rock breeds, which were selected under the tropical environment in Thailand.

Materials and Methods

Data originating from a selection experiment conducted at Kabinburi Livestock Research and Breeding Center, Department of Livestock Development in Thailand was used in this study. It is located in the Eastern region of Thailand has an average annual rainfall of approximately 166 mm and the daily maximum temperature varies from 23 to 33°C. Selection for increased egg production of RIR and WPR breed for back yard farming under tropical climate was initiated in 2003. Approximately 500 hens and 100 cocks were maintained for each breed to produce crossbred day old chicks for backyard poultry keeping in Thailand. The purebred parent stock was raised in open houses. The parent stock was replaced once a year. Replacement day old chicks were kept on deep-litter housing from first day hatch until 16 weeks of age. At the onset of lay, the pullets were moved to individual battery cages. Age at first eggs (AFE), body weight at sexual maturity (BFE), weight of the first egg (WFE), daily egg production up to 17 weeks of age and weekly average egg weight were collected for 11 generations from 2003 to 2013. Traits considered in this study were the AFE, BFE, WFE, total egg production from 1st day of lay to 17 weeks of lay (EGG) and average egg weight at 17th week of lay (EWT).

Statistical analyses. Descriptive statistics of the five traits were carried out using the SAS package (SAS, (2010)). A univariate linear animal model was used in WOMBAT software (Meyer (2007)) to estimate genetic parameters for AFE, BFE, WFE, EGG and EWT of both breeds:

$$Y_{ijk} = y_i + h_j + a_k + e_{ijk}$$

where Y_{ijk} is one of the five traits measured on hen k, hatched in year i in hatch group j, a_k is the random additive genetic effect of animal k and e_{ijk} is the random error associated with this observation. Maternal and permanent environmental effects of hens were not fitted as they were not significant in the preliminary analysis. A series of bivariate analyses were performed to estimate the genetic correlations between the five traits in both breeds.

Results and Discussion

The data used in the estimation of genetic parameters for each of the five traits is presented in Table 1. Average AFE for pullets and the number of eggs laid during the seventeen weeks of production were very similar for both breeds. However, RIR pullets were slightly heavier (200 g) than the WPR and their egg weight was 5 g heavier. The phenotypic differences between the two breeds for the five traits suggest that the WPR breed could be identified as the dam line with higher emphasis on egg number (EGG), and RIR could serve as a male line with more emphasis on EWT. Monira et al. (2003) also observed that RIR hens laid more eggs with heavier egg weight than WPR.

Table 1. Descriptive statistics for age at first eggs (AFE), body weight at first eggs (BFE), weight of first egg (WFE) number of eggs (EGG) and average egg weight at 17th week of production (EWT) of Rhode Island Red and White Plymouth Rock breeds.

Traits	Rhode Island Red			White Plymouth Rock		
	Number	Mean	std	Number	Mean	Std
AFE,days	3958	175.5	12.1	3450	177.7	14.1
BFE,kg	3958	1.9	0.2	3450	1.7	0.2
WFE,g	3958	42.8	4.7	3282	37.3	4.2
EGG,total	3528	101.0	8.9	2440	98.0	9.5
EWT,g	3528	52.5	4.2	2437	49.7	4.0

Estimated heritabilities and genetic correlations for the five traits in RIR and WPR are given in Table 2. All five traits were moderately heritable in both breeds with the estimated heritabilities very similar in both breeds, except for BFE and EWT. Niknafs et al. (2012) also reported moderate heritability for the five traits of hens reared in arid climate in Iran. Estimated heritabilities of BFE and EWT were higher for RIR than WPR. Estimated heritability for the WFE was lower than the estimated heritability for EWT in both breeds. Estimated heritability for AFE in this study was in agreement with the estimate of 0.4 reported by Belsare et al. (2004) for hens managed under dry climate. In contrast, Sang et al. (2006) observed lower heritability of AFE than the estimates for RIR (0.46) and WPR (0.44). The estimated heritabilities for BWT of both breeds were within the range of estimates (0.38 to 0.57) reported by Sang et al. (2006). Hosseini and Tahmoorespur (2013) reported lower heritability for EGG (0.07) and WFE (0.10) for bird managed under dry climate. Estimated heritabilities for EWT of both breeds were similar to the range of heritabilities (0.5 to 0.8) reported by King and Henderson (1954) and Besbes and Gibson (1998) for birds managed and housed in controlled environment. These heritabilities estimates for all traits indicate that there is adequate scope to improve the traits in both breeds selection.

Genetic correlations

Moderately positive genetic correlations were estimated between BFE and WFE and EWT in both breeds (Table 2). Egg weights measured at sexual maturity were highly correlated with egg weights measured at 17th week of production in both breeds and the correlation ranged from 0.67 to 0.72. These estimates were within the range (0.56 to 0.73) published by Sang et al. (2006).The AFE was highly correlated with WFE than EWT in both breeds. Sang et al. (2006) also estimated highly positive correlations of 0.48 to 0.66 between AFE and WFE and 0.24 to 0.38 between AFE and EWT. In contrast, El-Labban et al. (2011) reported a low positive genetic correlation of 0.08 between AFE and WFE. Moderate negative genetic correlations were estimated between EGG and WFE and EWT in both breeds. These results were in agreement with Hosseini and Tahmoorespur (2013) who found a low negative correlation (-0.08) between EGG and WFE in native chicken under arid condition of Iran. Wolc et al. (2012) and Francesch et al. (1997) also reported moderately negative correlations between EGG and EWT. However, Besbes et al. (1992) (-0.04 to -0.18) and Sang et al. (2006) (0.06 to -0.12) reported slightly lower genetic correlations between EGG and EWT than the estimates from this study. Dana et al. (2011) also found a moderately correlation between BFE and EGG in a tropical climate of Ethiopia. The negative genetic correlations in both breeds between egg weight and egg number suggest that the traits need to be considered separately for selection.

Table 2. Heritability (on the diagonal) and the genetic correlations (above diagonal) for age at first eggs (AFE), body weight at first eggs (BFE), weight of first egg (WFE) number of eggs (EGG) and average egg weight at 17th week of production (EWT) of Rhode Island Red and White Plymouth Rock breeds (approximate standard error is in the parenthesis).

Traits	AFE	BFE	WFE	EGG	EWT
			Rhode Island Red		
AFE	0.46 (0.04)	0.36 (0.06)	0.38 (0.08)	-0.17 (0.08)	0.13 (0.07)
BFE		0.51 (0.04)	0.40 (0.07)	0.02 (0.08)	0.48 (0.06)
WFE			0.28 (0.04)	-0.25 (0.10)	0.72 (0.06)
EGG				0.33 (0.04)	-0.33 (0.08)
EWT					0.47 (0.04)
			White Plymouth Rock		
AFE	0.44 (0.05)	0.19 (0.08)	0.58 (0.06)	-0.35 (0.09)	0.18 (0.08)
BFE		0.41 (0.04)	0.33 (0.08)	-0.18 (0.10)	0.46 (0.08)
WFE			0.33 (0.04)	-0.28 (0.10)	0.67 (0.07)
EGG				0.30 (0.05)	-0.29 (0.10)
EWT					0.43 (0.05)

Conclusion

Estimated genetic parameters for AFE, BFE, WFE, EGG and EWT were moderately heritable, with very little difference between RIR and WPR. Hens that mature with higher body weight lay heavier eggs at the onset of lay and at 17th week of production. Genetic parameters estimated in this study were generally similar to those obtained in controlled temperate environments. Parameters estimated from this study will be used to develop selection strategies to improve the productivity of both breeds.

Acknowledgement

The authors would like to thank all of staff of Kabinburi Livestock Research and Breeding Center, Department of Livestock Development in Thailand for data collection. We also acknowledge the financial support provided by the Agricultural Research Development Agency (Public Organization), ARDA, of Thailand for the Master of Science degree of Miss S. Tongsiri.

Literature Cited

Belsare, R. M., Narayankhedkar, S. G. and Ahmed, M. (2004). J. Bombay Vet. Col. 12:64-65.

Besbes, B., Ducrocq, V., Foulley, J.L. et al. (1992). J. Genet. Sel. Evol. 24:539-552.

Besbes, B. and Gibson, J. P. (1998). Proc 6th WCGALP, 25:459-462.

El-Labban, A. M., Iraqi, M. M., Hanafi, M. S. et al. (2011). J. Live. Res. Rural Dev. 23:69-77.

Dana, N.,vander Waaij, E.H., and Arendonk, J. A. H. (2011). J. Trop. Anim. Heath Prod. 43:21-28.

Francesch, A., Estany, J., Alfonso, L. et al. (1997). J. Poult. Sci. 76:1627-1631.

Hosseini, S. A., and Tahmoorespur, M. (2013). Ind. J. Anim. Res. 47:205-211.

King, S. C. and Henderson, C. R. (1954). J. Poult. Sci. 33:155-169.

Lerner, I. M., and Cruden, D. M. (1948). J. Poult. Sci. 27:67-78.

McClung, M. R., Wang, A. B. S., and Jones, W. T. (1976). J. Poult. Sci. 55:160-171.

Meyer, K. (2007). J. Zhej Uni.Sci. 8:815-821.

Monira, K.N., Salahuddin, M., and Miah, G. (2003). J. Poult. Sci. 2:261-263.

Mulder, H.A. and Bijma, P. (2005). J. Anim. Sci. 83: 49-61.

Niknafs, S., Nejati-Javaremi, A., Mehrabani-Yeganeh, H. et al. (2012). J. Trop. Anim. Health Prod. 44:1437-1443.

Sang, B. D., Kong, H. S., Kim, H. K. et al. (2006). J. Anim. Sci. 19:319-323.

SAS. (2010). SAS Institute Inc., cary NC USA.

Sopha, D., Thummabood, S. and Srisuk, J. (2012). DLD layer chickens management. Department of Livestock Development in Thailand.

Wei, M. and van der Werf, J.H. (1995). J. Anim. Sci. 73:2220-2226.

Wolc, A., Arango, J., Settar, P. et al. (2012). J. Poult. Sci. 91:2011-2030.