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GENETIC PARAMETERS OF VARIOUS PERFORMANCE TRAITS IN DIFFERENT GENERATIONS OF SYNTHETIC WHITE LEGHORN STRAIN

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ABSTRACT
The data on body weights at 20 and 40 weeks of age, age at first egg, egg weight at 40 weeks of age and egg mass up to 40 weeks of age on pullets collected from records (2012-13 to 2016-17) of white leghorn strain maintained at the poultry farm of department of Animal Genetics and Breeding, LUVAS, Hisar; over five generations were analyzed by least squares analysis techniques. Larger magnitude of heritability estimates for body weights at 20 and body weights at 40 were observed in nearly all the generations under study. The heritability estimates were moderate for egg weight at 40 weeks of age and egg mass upto 40 weeks of age, whereas low estimate forage at first egg. The genetic correlations among body weight were strong and positive. The genetic and phenotypic correlations of age at first egg were negative with all other performance traits except egg weight at 40 weeks of age. Significant positive phenotypic and genetic correlation of body weight at 40 weeks of age with egg mass upto 40 weeks of age and with egg weight up to 40 weeks of age indicated that heavier birds will lay larger size eggs.

KEY WORDS: White leghorn, genetic parameters, 40 weeks.

INTRODUCTION

India ranks third in egg production with total population of approximately 729 million. Poultry is one of the fastest growing segments of agricultural sector in India with an average growth rate of 4.94%. Selective breeding is a well-known tool for increasing genetic potential as well as productivity. Selection changes the genetic structure of population by changing gene and genotypic frequencies and hence, the genetic parameters are also liable to change in the every generation (Falconer and Mackey, 1996). The main emphasis of commercial breeder largely depends on layer economic traits like body weight, age and weight at sexual maturity, egg production and egg weight *etc*. Knowledge of genetic parameters like heritability, genetic and phenotypic correlation is essential to evaluate the population under selection in every generation for these traits and is pre-requisite for deciding and formulating the effective breeding strategies.

MATERIALS & METHODS

Source of data

The relevant data for the present investigation were collected from synthetic White Leghorn population, maintained at the poultry farm of department of Animal Genetics and Breeding, LUVAS, Hisar. The data were collected over five generations (2012-13 to 2016-17). The birds have been maintained under uniform practices of feeding, housing and management during the period of data recording as far as possible. Following performance traits were taken for study i.e. Body weight at 20 week of age (BW_{20}), Body weight at 40 week of age (BW_{40}), Age at first egg in days (AFE), Egg weight (gm) at 40 weeks of age (EW_{40}), Egg mass upto 40 weeks of age (EM_{40}).

Statistical analysis

In order to overcome non-orthogonality of the data due to unequal subclass frequencies, least Squares and maximum likelihood computer programme of Harvey (1990) was used to estimate the effect of various tangible factors on different traits under study. Genetic parameters were estimated by the Henderson's method 3 using paternal half sib correlation. The following model was used to explain the underlying biology of the traits included in the study:

$$Y_{ijkl} = \mu + G_i + H_{ij} + S_{ik} + e_{ijkl}$$

Where,
Y_{ijkl}= observation on l^{th} progeny of k^{th} sire in j^{th} hatch of i^{th} generation,
μ= the overall mean,
G_i= the fixed effect of i^{th} generation (i = 1,2, ……….5)
H_{ij}= the fixed effect of j^{th} hatch in i^{th} generation (j = l………h)
S_{ik}= the random effect of k^{th} sire in i^{th} generation NID (0, σ^2e)
ande_{ijkl} is the random error associated with each observation and assumed to be NID (0, σ^2e).

For the estimation of genetic parameters in each generation, the following model was used

$$Y_{ijk}= \mu + H_i + S_j + e_{ijk}$$

Where,
$Y_{ijk=}$ observation on k^{th} progeny of j^{th} sire in i^{th} generation,
μ= the overall mean,
H_i =the fixed effect of i^{th} hatch (j = l………………h),
S_j=the random effect of j^{th} sire NID (0, σ^2e)
ande_{ijk} is the random error associated with each observation and assumed to be NID (0, σ^2e).

Heritability, phenotypic and genetic correlations

Heritability, phenotypic and genetic correlations for different economic traits were estimated as per standard procedure by paternal half-sib correlation method using sire component of variance and covariance.

RESULTS & DISCUSSION

Performance traits

Genetic (above diagonal) and phenotypic (below diagonal) correlations along with their standard errors among various performance traits (Pooled data)

Traits	BW_{20}	BW_{40}	AFE	EW_{40}	EM_{40}
BW_{20}		0.67±0.40	-0.46±0.17	0.09±0.18	0.01±0.19
BW_{40}	0.59^{**}±.02		-0.17±0.18	0.40±0.15	0.14±0.18
AFE	-0.31^{**}±.02	-0.26^{**}±.02		0.50±0.15	-0.28±0.19
EW_{40}	0.11*±.02	0.16**±.02	0.10±.02		0.04±0.20
EM_{40}	0.08±.02	0.21**±.02	-0.28**±.02	0.25**±.02	

Body weight at 20 weeks of age (BW_{20})

The results showed that heritability estimates for body weight at 20 weeks of age ranged from 0.35 ±0.10 (G_3) to 0.51 ±0.12 (G_4) in different generations. The pooled estimate of heritability for body weight at 20 weeks of was found to be 0.45 ±0.13. The trait was high heritable. The present results were in confirmation with the finding of Venugopal (2014) and Tomar (2014). The observed heritability estimates were lower than those reported by Ramesh *et al.* (2013) and Veermani *et al.* (2008) but higher than those reported by Nayak *et al*. (2015) and Kapishwar (2017).

Body weight at 40 weeks of age (BW_{40})

The heritability estimates for body weight at 40 weeks of age in various generations ranged from 0.17 ±0.07 (G_3) to 0.59 ±0.14 (G_5). The pooled estimate of heritability for this trait was 0.42 ±0.12. The present results were in confirmation with the finding of Venugopal (2014) and Tomar (2014). The observed heritability estimates were lower than those reported by Ramesh *et al.* (2013), Qadri *et al.* (2013), Savaliya *et al.* (2014) but higher than those reported by Savaliya *et al.* (2014) in IWP Strain.

Age at first egg (AFE)

Heritability estimates for age at first egg ranged from 0.23±0.09 (G_1) to 0.32±0.09 (G_4) in different generations. The pooled estimate of heritability for age at first egg was 0.28±0.08. This trait was found to be low heritable. The present results were in confirmation with the finding of Venugopal (2014). The observed heritability estimates were lower than those reported by Qadri*et al.,* (2013), Venugopal (2014) but higher than those reported by Savaliya *et al.,* (2014) , Nayak *et al.,* (2015), Rahim *et al.,* (2016) and Kapishwar (2017).

Egg weight at 40 weeks of age (EW_{40})

The heritability estimates of egg weight at 40 weeks of age ranged from 0.13±0.07 (G_5) to 0.70±0.15 (G_4). The pooled estimate of heritability for this trait was 0.43±0.12. The present results were in confirmation with the finding of Venugopal (2014). The observed heritability estimates were lower than those reported by Qadri *et al.,* (2013), Venugopal (2014) but higher than those reported by Savaliya *et al.,* (2014) , Nayak *et al.,* (2015), Rahim *et al.,* (2016) and Kapishwar (2017).

Egg mass upto 40 weeks of age (EM_{40})

The heritability estimates of egg mass upto 40 weeks of age ranged from 0.15±0.12 (G_2) to 0.50±0.13 (G_3). The pooled heritability estimate was 0.32±0.11.The result indicated that this trait was medium heritable. The heritability estimates were in close confinement with the estimates reported by Kapishwar (2017) and Qadri *et al.,* (2013) in IWN strain. On the contrary, Qadri *et al.* (2013) in IWP strain and Tomar (2014) reported lower estimates than those reported in the present study.

Correlation among various performance traits

On the basis of pooled estimates, the genetic and phenotypic correlations of body weight at 20 weeks of age (BW_{20}) with age at first egg (AFE) were found to be negative, -0.46 ±0.17 and -0.31 ±0.02, respectively. The results indicated that pullets with higher body weight attained sexual maturity earlier, confirming the fact that optimum body weight is quite essential in layer flock as well. Positive genetic correlations between body weight at 20 weeks of age and age at first egg was reported by Qadri *et al.* (2013). Negative genetic correlations between body weight at 20 weeks of age and age at first egg were reported by Tomar (2014), Rahim *et al.* (2016) and Kapishwar (2017). Positive phenotypic correlations between body weight at 20 weeks of age and age at first egg were reported by Qadri *et al.* (2013) in IWP strain and Rahim *et al.* (2016) and negative phenotypic correlations were reported by Qadri *et al.* (2013) in IWN strain and Tomar *et al.* (2014). The results indicated that pullets with higher body weight at 20 weeks of age attained sexual maturity earlier.

The genetic and phenotypic correlations of body weight at 20 weeks of age with body weight at 40 weeks of age (BW_{40}) were significant and high in magnitude (0.67 ±0.40 and 0.59^{**} ±.02, respectively). This high correlation might be due to pleiotropic gene action. Positive genetic correlation between body weight at 20 weeks of age and body weight at 40 weeks of age was also reported by Qadri *et al.* (2013) in IWN strain and Tomar (2014). The genetic and phenotypic correlations of body weight at 20 weeks of age with egg weight (EW_{40}) and egg mass (EM_{40}) upto 40 weeks of age were found to be positive with low in magnitude. Similar results were reported by Sreenivas *et al.* (2012) in IWI and IWK strain, Qadri *et al.* (2013), Tomar (2014) and Savaliya *et al.* (2014) while negative genetic correlations were reported by Veeramani *et al.* (2008) and Sreenivas *et al.* (2012) in IWH strain. The result revealed that heavier birds at 40 weeks of age laid larger eggs due to genetic as well as non-genetic causes. The positive correlations observed between body weights and egg weight indicated that it is possible to get heavier eggs from hens that were heavier during growing stage because body weight during growing and laying period bears a direct influence on production.

The genetic and phenotypic correlations of age at first egg were negative with all other performance traits except egg weight at 40 weeks of age which was 0.50 ±0.15 and 0.10 ±0.02, respectively. Positive genetic correlations of age at first egg with egg weight at 40 weeks of age were reported by Jayalaxmi *et al*. (2010), Sreenivas *et al*. (2012), Veeramani *et al*. (2012), Tomar (2014) while, Sreenivas *et al*. (2012) reported negative genetic correlation. Positive phenotypic correlations of age at first egg with egg weight at 40 weeks of age were reported by Jayalaxmi *et al*. (2010), Sreenivas *et al*. (2012), Veeramani *et al*. (2012), Tomar (2014) and negative phenotypic correlation were reported by Sreenivas *et al*. (2012) in control. The results indicated that late maturing birds laid larger eggs due to both genetic and non-genetic reasons.

On the basis of pooled data, there was significant positive phenotypic correlation of body weight at 40 weeks of age with egg mass upto 40 weeks of age (0.21** ±0.02) and with egg weight upto 40 weeks of age (0.16** ±0.02). Corresponding genetic correlations were also positive. Similar findings were reported by Qadri *et al.* (2013) in IWN strain and Tomar (2014). Genetic correlation of egg mass upto 40 weeks of age with egg weight upto 40 weeks of age was low positive whereas, corresponding phenotypic correlation was significant positive (0.25** ±.02). Qadri *et al.* (2013) reported negative genetic correlation between egg weight and egg mass. Kumar (2003) and Tomar (2014) reported low positive correlation between both these traits on both genetic and phenotypic scale. The results revealed that higher egg weight leads to higher egg mass.

In all the generations $G_{1,}$ $G_{2,}$ $G_{3,}$ G_4 and G_5 almost similar trend in genetic and phenotypic correlations between performance, part egg production and cumulative part egg production traits were observed.

Author contributions

All author equally contributed Author statement: All authors read, reviewed, agree and approved the final manuscript

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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