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Estimation of genetic parameters of important economic traits in Aseel chicken

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ABSTRACT

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The data pertaining to 529 Aseel birds across three generations (2018-19 to 2020-21), maintained at the Poultry Breeding Farm of the Department of Animal Genetics and Breeding at LUVAS, Hisar, were used to estimate genetic parameters of important traits. A mixed linear model was employed for the analysis, incorporating sire as a random effect and generation and hatch as fixed effects. The performance traits including age at first egg (AFE), body weight at 20 weeks of age(BW_{20}),body weight at 40 weeks of age(BW_{40}),egg number up to 40 weeks (EN_{40}),egg weight at 40 weeks(EW_{40})egg mass at 40 weeks of age(EM_{40}). Highly significant (P≤0.01) effect of generation was observed on all traits except $EM_{40.}$The least squares means for performance traits AFE, BW_{20}, BW_{40}, EN_{40}, EW_{40}, EM_{40} were 175.37±0.71 days, 1198.03±7.91 g, 1674.62±7.01g, 67.78±0.77 eggs, 46.71±0.14 g, and 2893.82±54.06 g, respectively. The heritability estimates were moderate to high for all the traits. The age at first egg (AFE) was negatively correlated with egg weight at 40 weeks(EW_{40}) of age and egg mass at 40 weeks of age (EM_{40}).Body weight at 20 weeks of age(BW_{20}) had strong association with EW_{40}. Moderate to high estimates of heritability for performance traits indicated that these traits can be improved through family selection.
Keywords: Aseel, Age at first egg, Egg mass, Egg weight, Body weight, Egg number, Heritability

INTRODUCTION

The Aseel breed, originated in Andhra Pradesh, is one of the prominent indigenous poultry breeds in India. These birds are known for their endurance, aggressive behavior, graceful stride, and fighting capabilities (Panda and Mahapatra, 1989). Over the years, Aseel chickens have been selectively bred for game purposes (Goli *et al.*, 2024) and is considered the oldest game fowl in Asia and primary ancestor of the Indian chicken. Notable features of the Aseel include its large size compared to other Indian native chickens, small wattles, a combative temperament, well-defined shoulders, upright stance, powerful muscular thighs, pea comb, strong legs, and meat that is both flavorful and tender (Dohner, 2001).In India, eight variants of the Aseel breed have been identified, with Aseel (Yellow) and Aseel (Black) being the most commonly found (Haunshi *et al.*, 2011). Despite of its distinct characteristics, the Aseel is under the threat of extinction because of its low production potential (Mohan *et al.,* 2008).

The annual egg production of the Aseel breed ranged to 64 eggs (Rajkumar *et al.,* 2017). So, there is a need for the improvement and conservation of Aseel breed. Understanding genetic parameters such as heritability, as well as genetic and phenotypic correlations, is crucial for evaluating populations under selection for various economically important traits in each generation. This knowledge serves as a foundation for developing and implementing effective breeding strategies. Genetic progress in the population under selection is determined by the response in primary and other correlated traits of economic importance (Rajkumar*et al.,* 2018). The aim of this study was to estimate heritability and genetic and phenotypic correlations for performance traits to understand inheritance pattern and relationships between key economic traits.

MATERIALS AND METHODS

All the relevant data for the present investigation was collected from the Aseel population, maintained at the poultry farm of the Department of Animal Genetics and Breeding, LUVAS, Hisar. The data spanned three generations (2018-19 to 2020-21), and a total of 529 birds were included in the analysis. The chicks were brooded and reared hatch-wise. The progenies were produced in separate hatches. All the chicks were bred through a pedigreed mating; wing banded at day old, and reared hatch wise using standard managemental practices. The chicks were vaccinated against Marek's, Ranikhet, Infectious Bursal Disease, and Fowl pox diseases.Age at first egg (AFE) was recorded in the flock. Bodyweight was measured at 20 (BW_{20}) and 40 weeks (BW_{40}) of age. Egg weight (EW_{40}) was measured to the nearest of 0.1g by taking the average weight of eggs laid for 3 consecutive days by each hen at 40 weeks of age.The weight of eggs was recorded using a digital balance (0.01 g accuracy). Egg mass (EM_{40}) was calculated by multiplying the average egg weight at 40 weeks and number of eggs produced up to 40 weeks (EN_{40}).

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Statistical analysis

Considering the non-orthogonality of the data resulting from unequal sub class frequencies, Least Squares Maximum Likelihood Computer Programme of Harvey (1990) was utilized to estimate the effect of various non- genetic factors on early performance traits as well as to estimate genotypic and phenotypic parameters. Sire and residual variance-covariance components for various performances traits were derived using least squares and maximum likelihood computer programme of Harvey (1990) applying the following mixed model:

$Y_{ijkl} = m + G_i + H_{ij} + S_{ik} + ei_{jk}$

Where, $Y_{ijkl,}$ l^{th} observation of k^{th}sire of j^{th} hatch of i^{th} generation; μ, overall mean; $G_{i\ ,}$ fixed effect due to i^{th} generation (i = 1, 2……g); $H_{ij,}$ fixed effect due to j^{th} hatch in i^{th} generation (j = 1, 2…..h); $S_{ik,}$ random effect due to k^{th} sire in i^{th} generation (k = 1, 2…….s) and $e_{ijkl,}$ random error associated with each and every observation and assumed to be normally distributed with mean zero and variance $\sigma^2_{e.}$ Generation means were compared using the modified version of Duncan's Multiple Range Test by Kramer (1957). Paternal half-sib correlation method was used to estimate heritability of the traits under study. The standard error of heritability was obtained from the formula given by Swiger *et al.*, 1964. The genetic correlations among different traits were estimated from sire component of variance and covariance. The standard errors of genetic correlations were obtained by using the formula of Robertson, 1959. The phenotypic correlations were obtained from sire and within sire components of variances and covariances. The standard errors of phenotypic correlations were calculated by the following formula given by Panse and Sukhatme, 1967.

RESULTS AND DISCUSSION

The least squares means along with standard errors for performance traits are given in Table 1.

Effect of non-genetic factors

The analysis of variance revealed that generation effect was highly significant (P≤0.01) on all performance traits viz., AFE, BW_{20}, BW_{40}, EN_{40}, EW_{40}, except for EM_{40}. Similarly, the effect of hatch within generations was highly significant (P≤0.01)on all the traits except for egg mass up to 40 weeks. The present findings are in accordance with Tomar (2014) and Kapishwar (2017) who observed significant effect of generation on BW_{20}, AFE, EW_{40}, EN_{40}, BW_{40} and EM_{40}. Manjeet (2018) also reported significant effect of generation on all performance in white leghorn strains. Results were also in accordance with Dalal *et al* (2019) who observed significant effect of the hatch on all the growth traits and age at first egg in Aseel chicken. Prevalence of highly significant effects due to generations on egg productions traits under study may be attributed to the outcome of selection, availability of feed ingredients as well as fluctuations in environment along with their interactions during the period of the investigation. The hatch effects observed did not show a clear trend, making it difficult to determine the optimal number of hatches for raising replacement progeny to minimize environmental impacts. It is plausible that reducing climatic and management variations together with the uniform nutritional and vaccination programmes could have reduced the variations in the performance of the hatches towards the completion of the investigation. Therefore, to reduce hatch effects, it is essential to provide more uniform conditions regarding floor space, feeder space, and feed. Additionally, maintaining consistent vaccination schedules, de-worming practices, and feed quality are critical environmental factors that should be standardized.

Least squares means

The overall least- squares means for AFE,BW20, BW40, EN40, EW40 and EM40 were 175.37±0.71 days, 1198.03±7.917 g, 1674.62±7.013g, 67.78±0.771 eggs 46.71±0.148g and 2893.82±54.06g respectively and presented in Table 1 and hatch wise least squares means was presented in Table 2. Decreasing trend of age at first egg was seen in Aseel over the generations.

The age at first egg was reported to be 175.37±0.71 days which was comparable with those reported in Aseel by Sarkar *et al.* (2012) and Satpathy *et al.* (2020) but lesser than the reports for the same breeds by Haunshi *et al.* (2011), Rajkumar *et al.* (2017), Dalal *et al.* (2019). Chatterjee *et al.* (2007) and Dalal *et al.* (2019) reported similar body weight at 20 weeks of age in Aseel as observed in this study. On the contrary, higher body weight was reported by Jha and Prasad (2013), and Satpathy *et al.* (2020). The difference in BW_{20} as observed in the present study and those reported in the literature could be due to genetic reasons and variation in the feeding and management of flocks. BW_{40} was in close conformity with the findings of Dalal *et al.*, (2019). The higher results of egg production might be due to increased response to selection performed over the generation and the loss of broodiness characteristics as a result of selection. Ahmad *et al.* (2014), Kumar *et al.* (2020) reported egg weight within the range reported in this study in Aseel while Usman *et al.* (2014), Premavalli *et al.* (2016) reported higher egg weight than observed in the study. Similar result for egg mass was reported by Haunshi *et al.* (2011).

Variation in egg production of Aseel and Kadaknath breed in different reports may be attributed to the differences in the genetic makeup of the different stocks, management and environmental conditions to which the birds are exposed. For the cumulative part egg production traits there is almost increase in number of eggs in successive generations. It shows that selection programme is effective in a right direction.

Heritability estimates of performance traits

Table 1: Generation-wise least squares mean along with standard error for performance traits of Aseel

TRAITSGEN	AFE (days)	BW_{20}(g)	BW_{40}(g)	EN_{40} (Number)	EW_{40}(g)	EM_{40}(g)
G 1	183.79^{b}±1.13(149)	1121.6 ^{b}±9.60(169)	1744.8 ^{c}6±11.67 (146)	67.30±1.22(146)	47.44^{b}±0.27(146)	3149.18^{b}±69.87(146)
G 2	172.28^{a}±10(201)	1353.48^{c}±9.33(201)	1605.26^{a}±9.04(190)	66.62±1.16(190) 66.62±1.16(192)	47.39^{b}±0.21(190)	2905.81^{b}±83.09(190)
G 3	169.17^{a}±1.31(150)	1065.22^{a}±9.62(160)	1697.2^{b}9±13.68(139)	70.26±1.72(130) 70.26±1.72(128)	44.76^{a}±0.21(139)	2604.52^{a}±122.85(139)
Pooled	175.37±0.71(500)	1198.03±7.91(530)	1674.62±7.01(475)	67.78±0.77(475)	46.71±0.14(475)	2893.82±54.06(475)

Table 2: Hatch-wise least-squares means along with standard error of performance traits in Aseel

Traits	Generation 1		Generation 2		Generation 3	
	Hatch 1	Hatch 2	Hatch 3	Hatch 4	Hatch 5	Hatch 6
AFE	182.56 ^{a}±1.16 (122)	189.37^{b}±3.16(27)	175.72^{a}±1.28(101)	168.42^{b}±1.47(90)	167.25^{a}±1.46(83)	175.79 ^{b}±2.58(24)
BW_{20}	1143.28^{a}±10.25(134)	1038.57^{b}±19.24(35)	1338.83^{a}±12.66(103)	1368.88 ^{b}±13.64(98)	1072.04±11.04(93)	1051.11±18.7(45)
BW_{40}	1754.62^{a}±12.71(119)	1701.85^{b}±28.05(27)	1587.76^{a}±12.42(98)	1623.91±12.97(92)	1706.59^{a}±15.49(91)	1675 ^{b}±27.96(45)
EN_{40}	67.87^{a}±1.38(119)	64.78^{b}±2.56(27)	64.54^{a}±1.64(97)	68.83^{b}±1.63(92)	71.90±1.93(83)	66.24±3.56(34)
EW_{40}	47.65±0.28(116)	46.56±0.79(27)	47.58^{a}±0.32(88)	47.21±0.28(91)	44.86±0.27(81)	44.5±0.33(34)
EM_{40}	3180.68±81.06(120)	3009.19±121.15(27)	2762.99^{a}±125.93(102)	3055.99±105.88(97)	2786.89 ^{a}±143.2(93)	2227.62^{b}±225.18(45)

Table 3: Genetic (above the diagonal) and phonotypic (below) correlation coefficients for performance traits

Traits	AFE	BW_{20}	BW_{40}	EN_{40}	EW_{40}	EM_{40}
AFE	0.28±0.17	-0.31±0.13	0.26±0.14	-0.46±0.13*	0.26±0.14	-0.40±0.14*
BW_{20}	0.52±0.09*	0.35±0.19	-0.6±0.1	-0.08±0.15	0.49±0.11*	0.15±0.15
BW_{40}	0.49±0.08*	-0.54±0.08*	0.45±0.15	0.17±0.15	-0.03±0.15	0.19±0.15
EN_{40}	0.02±0.09	-0.15±0.08	0.39±0.05	0.30±0.12	-0.07±0.15	0.87±0.04
EW_{40}	0.50±0.08*	0.58±0.08*	0.47±0.08*	0.59±0.08*	0.49±0.16	0.32±0.14
EM_{40}	0.13±0.09	0.10±0.08	-0.28±0.08	0.88±0.05*	0.15±0.08	0.30±0.12

* Significant at P≤0.05

The heritability estimate of AFE, BW20, BW40, EN40, EW40 and EM40 were as 0.28±0.17, 0.35±0.19, 0.45±0.15, 0.30±0.12, 0.49±0.16 and 0.30±0.12, respectively (Table 3). The heritability estimate of AFE were in confirmation with the finding of Dalal *et al.* (2019) but lower than those reported by Singh *et al.* (2018) and higher than those reported by Rajkumar *et al.* (2020).Heritability estimates of BW_{20} and BW_{40} were in close confirmation with Venugopal (2014) but higher than those reported by Singh *et al.* (2018) in Uttara chicken and Rajkumar *et al.* (2020) in Gramapriya female line. Singh *et al.* (2018) and Rajkumar *et al.* (2020) also reported higher heritability estimate for EW_{40} and EM_{40} than the present study. The pooled heritability estimates over three generations of the performance traits were in the range of moderate to high which indicate that enough scope exists for the improvement of these traits through selection.

Genetic and phenotypic correlations

On the basis of pooled estimates, the genetic and phenotypic correlations of body weight in Aseel at 20 weeks of age (BW_{20}) with age at first egg (AFE) were found to be,**-**0.31±0.13 and 0.521±0.09 respectively. These results suggest that pullets with higher body weight tend to reach sexual maturity earlier, highlighting the importance of achieving optimal body weight in layer flocks 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) in white leghorn strain. For phenotypic correlations, Qadri *et al.* (2013) and Rahim *et al.* (2016) found a positive correlation in the IWP strain, whereas negative phenotypic correlations were reported by Qadri *et al.* (2013) in the IWN strain. 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.* (2013) 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.* (2013) in IWH strain**.** It indicated that optimum body weight correlation is positive between egg production, egg weight and antagonistic when body weight is either less or more.

CONCLUSION

Moderate to high estimates of heritability for various performance traits indicated that enough scope exists for the improvement of these traits through selection. It indicated that optimum body weight correlation is positive between egg production, egg weight and antagonistic when body weight is either less or more. A positive selection response was observed in the population that maintained optimal levels for both egg production and egg weight, which are key traits for sustainable rural poultry farming.

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