



Inheritance of growth and production traits in Gramapriya male line chicken

T SREETEJA¹, D SREENIVAS¹, B SRIDEVI¹, R M V PRASAD¹ and U RAJ KUMAR^{2✉}

ICAR-Directorate of Poultry Research, Hyderabad, Telangana 500 030 India

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ABSTRACT

A comprehensive study was carried out in Gramapriya male line (PD-6) chicken with respect to growth, production and egg quality traits utilizing the data generated from 1995 chicks and 230 hens in S-8 generation at ICAR-Directorate of Poultry Research, Hyderabad, Telangana. Highly significant differences among hatches were observed for body weight, shank length, age at sexual maturity (ASM), egg production (EP), egg weight (EW) and egg mass (EM). The least squares mean of body weights (BW) at 2, 4, 6, 20 and 40 weeks of age were 187.03±0.97, 499.74±1.58, 838.67±5.69, 2074.93±9.82 and 2891.26±15.25 g, respectively. The least squares mean of shank lengths at 4 and 6 weeks of age were 70.19±0.09 and 87.48±0.12 mm respectively. The h^2 for body weight and shank length at six weeks of age was 0.31±0.06 and 0.23±0.05, respectively, which were moderate to high in magnitude. The ASM was 168.94±0.71 days. The EP40 was 69.87±1.24 eggs with an egg weight of 55.11±0.22 g. The EM40 was 3840.02±67.52 g. The heritability estimate was low for EP40 (0.09±0.11). The gradual improvement in primary trait (SL6) in parent line will improve the performance in terminal cross 'Gramapriya' which ultimately benefits the farmers.

Keywords: Correlation, Gramapriya, Growth, Heritability, Production

Poultry contributes substantially to animal husbandry sector and it was one of the fastest growing segments of agricultural sector in India with around 8% growth rate per annum. India is the third largest producer of eggs and fifth largest producer of poultry meat in the world, producing 129.60 billion eggs and about 4.78 million tons of poultry meat (BAHS 2022). Annual per capita availability of eggs is 95 and chicken meat is 3.55 kg against the ICMR recommended levels of 180 eggs and 11 kg of meat. Non-availability of poultry products and low purchasing power of rural people deprived them access to the highly nutritious egg and chicken meat, thereby, resulting in malnutrition and other health problems. To meet the growing demand, encouraging the backyard poultry farming in rural areas is one of the feasible alternatives. Backyard poultry has been a proven tool for alleviation of rural poverty, eradication of malnutrition and creation of gainful employment in rural areas (Rajkumar *et al.* 2021a).

Gramapriya is one of the popular egg type multi-coloured varieties developed by crossing between PD-6 × PD-3 lines and propagated by Directorate of Poultry Research, Hyderabad. Gramapriya significantly contributed to the rural poultry in terms of meat and eggs. Gramapriya male line (PD-6) is being improved for higher shank length, a

desirable trait in birds for fast movement to escape from the predators under free range conditions.

MATERIALS AND METHODS

Experimental population: A total of 1995 chicks for juvenile traits and 230 birds for production traits produced using 50 sires and 250 dams in a pedigreed full sib mating in three hatches during 8th generation were utilized for the study. PD-6 has been improved for higher shank length at 6 weeks of age over the last eight generations.

Rearing and Management: The chicks were reared under standard management conditions from birth to six weeks of age. The chicks were fed *ad lib.* with broiler starter (2900 cal: ME, 22% CP) and finisher (3000 cal: ME, 20% CP) diets based on maize-soyabean meal during 0-4 and 5-6 weeks of age, respectively. Hens (230) selected at 6 weeks of age were reared up to 40 weeks of age in individual cages with one and half square feet floor space with automated drinkers.

The birds were maintained on a broiler grower ration (2600, ME; 18% CP) up to 20 weeks of age and broiler breeder ration (2700, ME; 17% CP and calcium) from 21 weeks till the end of the production cycle. The birds were vaccinated against Marek's disease (day 1), Newcastle disease, Lasota (day 7 and 30), Infectious bursal disease (day 14 and 26), Fowl pox (6th week), ND R2B (9th week) and IB and ND inactivated (18th week).

Traits measured: Body weights at 2 (BW2), 4 (BW4), 6 (BW6), 20 (BW20) and 40 (BW40) weeks of age, shank

Present address: ¹College of Veterinary Science, Rajendranagar, Hyderabad, Telangana. ²ICAR-Directorate of Poultry Research, Hyderabad, Telangana. ✉Corresponding author email: ullengala@yahoo.com.

length at 4 (SL4) and 6 (SL6) weeks of age were measured. The production parameters such as age at sexual maturity (ASM), egg production up to 40 weeks of age (EP40), egg weights at 28 (EW28), 32 (EW32), 36 (EW36) and 40 (EW40) weeks of age, egg mass at EM40 weeks of age and egg quality parameters at 40 weeks of age were recorded. Heritability, genetic and phenotypic correlations were estimated for important economic traits.

Statistical analysis: Data were analyzed by least squares technique (Harvey 1990) and the hatch corrected data were utilized for estimating the heritability estimates by variance component analysis (Kings and Henderson 1954). Genetic and phenotypic correlations were estimated from (co) variance component analysis (Backers 1975). The egg quality traits were analyzed using standard protocols (Snedecor and Cochran 1994).

RESULTS AND DISCUSSION

Juvenile traits: The LSM for juvenile body weights are presented in Table 1. Hatch had significant effect on body weights and shank length ($P \leq 0.05$) with higher body weights and longer shanks in third hatch. Significant hatch effects similar to the present study in different chicken populations were reported by many authors (Prasad *et al.* 2016, Prince *et al.* 2020, Rajkumar *et al.* 2021b, c, d). The probable reason for the variations in body weights in different hatches might be due to the birth weight, environment, rolling reaction, etc. The body weights were in accordance with the reports of Kundu *et al.* (2015) in Vanaraja chicken. The BW6 was higher than the reports of Reddy *et al.* (2016) and Rajkumar *et al.* (2017) in different chicken populations. The mean shank length at 4 and 6 weeks of age (Table 1) were similar with the reports of Rajkumar *et al.* (2010) in Naked neck chicken. Healthy juvenile growth was important for optimum body weight at the time of laying for obtaining optimum production from the birds (Rajkumar *et al.* 2020a).

Table 1. Least squares means and heritability for juvenile traits of Gramapriya male line chicken

Traits	Mean	Heritability		
		h^2_s	h^2_D	h^2_{s+D}
<i>Body weight (g)</i>				
2 weeks	187.03±0.97	0.25±0.08	0.42±0.07	0.34±0.05
4 weeks	499.74±1.58	0.26±0.06	0.29±0.06	0.25±0.05
6 weeks	838.67±5.69	0.27±0.05	0.34±0.05	0.31±0.06
<i>Shank length (mm)</i>				
4 weeks	70.19±0.09	0.22±0.09	0.23±0.08	0.22±0.06
6 weeks	87.48±0.12	0.24±0.07	0.16±0.06	0.23±0.05

(h^2_s - heritability from sire component, h^2_D -heritability from dam component, h^2_{s+D} -heritability from sire + dam component)

Production traits: The least squares mean and heritability estimates of production traits are summarized in Table 2. All the production traits significantly varied among the hatches ($P \leq 0.05$) similar to the observations of many authors (Prince *et al.* 2020, Rajkumar *et al.* 2021b).

Table 2. Least squares means and heritability estimates for various production parameters of Gramapriya male line chicken

Parameter	Overall mean	Heritability		
		h^2_s	h^2_D	h^2_{s+D}
ASM (d)	168.94±0.71	0.19±0.11	0.34±0.11	0.24±0.09
<i>Body weight (g)</i>				
20 weeks	2074.93±9.82	0.09±0.12	0.64±0.33	0.39±0.27
40 weeks	2891.26±15.25	0.73±0.26	0.39±0.31	0.56±0.32
<i>Egg production (No)</i>				
40 weeks	69.87±1.24	0.09±0.11	0.17±0.18	0.13±0.24
<i>Egg weight (g)</i>				
28 weeks	50.88±0.25	0.33±0.11	0.42±0.14	0.37±0.08
32 weeks	53.75±0.20	0.28±0.13	-	-
36 weeks	54.61±0.24	-	-	-
40 weeks	55.11±0.22	0.38±0.12	0.34±0.24	0.36±0.21
<i>Egg mass (g)</i>				
40 weeks	3840.02±67.52	-	-	-

ASM, age at sexual maturity; d, days; No, number; h^2_{s-} heritability from sire component; h^2_D , heritability from dam component; h^2_{s+D} , heritability from sire + dam component.

Delayed maturity was observed by Singh *et al.* (2018) in Vanaraja chicken and Rajkumar *et al.* (2021b) in Gramapriya male line chicken. The body weight and egg production are the two important traits in chicken which needs attention of the breeders and farmers. The mean body weights at 20 and 40 weeks of age obtained in the present study were similar to the findings reported by Suresh (2018) in Vanaraja male line chicken and by Rajkumar *et al.* (2021b) in PD-6 line over the generations. However, the results in the present study were lower than the results obtained by Kalita *et al.* (2012), Sankhyan and Thakur (2016) in Vanaraja chicken. The mean egg production up to 40 weeks of age was similar to the reports of Padhi *et al.* (2015b) in a crossbred chicken, higher than the reports of Sankhyan and Thakur (2016) and Kalita *et al.* (2012) in Vanaraja chicken and lesser than the results of Rajkumar *et al.* (2021b) in PD-6 line in earlier generations. The variations in growth and production traits might be due to differences in genetic makeup, agro-climatic conditions, feeding and managerial practices, followed during the experimentation. The LSM for egg weights at different ages varied significantly ($P \leq 0.05$) among the hatches. Higher egg weights than the present findings were reported by Rajkumar *et al.* (2009) in Naked neck and Sankhyan and Thakur (2016) in Vanaraja chicken, whereas lower values were reported Haunshi *et al.* (2019) in PD-4 chicken. Higher egg weights in the present study might be due to better plane of nutrition and selection for egg mass which improves egg weight also (Rajkumar *et al.* 2020). The LSM for EM40 was 3840.02 ± 67.52 g which, was higher than the values obtained by Iraqi *et al.* (2012).

Genetic parameters: Heritability is the proportion of the variance that can be transferred to the next generation and it aids the breeder in identifying suitable method of selection. The heritability (h^2) estimates for juvenile and production parameters are presented in the Tables 1 and 2 respectively. The estimates of h^2 from dam component

were high for both BW6 and SL6 indicating the presence of maternal effect and non-additive gene action in early stages of growth. The presence and importance of maternal effects in early phase of growth were well documented in chicken by many authors (Rajkumar *et al.* 2011a, Prince *et al.* 2020, Rajkumar *et al.* 2021b). Rajkumar *et al.* (2012) reported higher h^2 estimates for sire component than the dam component which was contrary to the results of present study. Reddy *et al.* (2016) reported lower h^2 estimates for sire component than the dam component which was similar to present findings.

The h^2 estimate for ASM due to dam component was higher (0.34 ± 0.11) expressing the maternal influence on the trait. Rajkumar *et al.* (2011b) reported lower h^2 for sire component than dam and sire+dam component in Dwarf chicken, whereas Chatterjee *et al.* (2008) reported lower h^2 estimates for ASM than the present study. The h^2 estimate for body weights at 20 and 40 weeks of age ranged low to high (Table 2). The dam component of h^2 estimates was moderate and higher than h^2 estimate from sire and sire + dam component at 20 weeks of age and the heritability estimates at 40 weeks of age was moderate in magnitude. Results in the present study was comparable with the findings of (Rajkumar *et al.* 2012) for 20 weeks body weight. The h^2 estimates were moderate for egg weights at 28, 32, 36 and 40 weeks of age. The present results in the study was accordance with the results of Sreenivas *et al.* (2012). The h^2 estimate for egg production at 40 weeks of age was low to moderately heritable. The h^2 estimate from dam component was higher for egg production which may be due to the influence of maternal inheritance as the trait is expressed only in the females. The results were in agreement with the reports of Chatterjee *et al.* (2008) and Rajkumar *et al.* (2012). The present results were reasonably fair keeping in view the low heritable nature of the egg production traits.

Genetic and phenotypic correlations: Knowledge of correlations among economic traits is essential in any breeding experiment, as the direction and magnitude of these correlations would determine the genetic changes in the correlated traits. The estimated genetic correlations are almost high in magnitude and positive in direction indicating high degree of association between the traits (Table 3). Similar highly significant correlations were

Table 3. Genetic correlations from S+D component (above diagonal) and Phenotypic correlations (below diagonal) among juvenile body weights and shank length

Trait	BW2	BW4	BW6	SL4	SL6
BW2	-	0.82	0.61	0.75	0.55
BW4	0.60	-	0.77	0.89	0.86
BW6	0.49	0.77	-	0.66	0.83
SL4	0.63	0.91	0.77	-	0.89
SL6	0.51	0.78	0.87	0.79	-

S, sire; D, dam; BW, body weight; SL, shank length.

reported by Rajkumar *et al.* (2010) in Naked neck, Dana *et al.* (2011) in Horro chicken. The estimated phenotypic correlations were ranged from 0.49 (2BW and 6BW) to 0.77 (4BW and 6BW) in magnitude and positive direction with high degree of association between the two traits indicating that the same set of genes controlling the two traits and have positive epistatic effect on the traits. The genetic correlation between 4 BW \times 4SL and 6BW \times 6SL were 0.89 and 0.83, respectively, indicating the significant positive relationship between the traits. The higher genetic correlations between shank length and body weight at 6 weeks of age might be due to expression of the gene that increases the body weight considerably (Padhi *et al.* 2015a) from 6 weeks onwards. The phenotypic correlations were positive and high in magnitude between all the traits (Table 3).

The genetic correlations from sire + dam component between ASM and BW40 in the present study (Table 4) were positive and high which were in close agreement with the reports of Rajkumar *et al.* (2011b) and Sreenivas *et al.* (2012), whereas it has negative association with egg production, in line with the reports of Rajkumar *et al.* (2011b). The phenotypic correlations between ASM and body weights in the present study were negative and low in magnitude, whereas with egg weights were positive and high in magnitude, which were in agreement with the reports of Padhi and Chatterjee (2012). The correlation between ASM with EP40 was negative, which was similar to the findings of Rajkumar *et al.* (2011b). The genetic correlations from sire + dam component between body weights with egg weights in the present study were positive. Correlations between BW20 with EP40 were found to be positive, while that of BW40 with EP40 were

Table 4. Genetic correlations from S+D component (above diagonal) and phenotypic correlations (below diagonal) between various production traits of Gramapriya male line chicken upto 40 weeks of age

Trait	ASM	BW20	BW40	EW28	EW32	EW36	EW40	EP40
ASM	-	0.12	0.18	0.08	0.38	0.39	0.49	-0.62
BW20	-0.13	-	0.41	0.05	0.44	0.06	0.83	-0.41
BW40	0.07	0.35	-	0.13	0.28	0.12	0.27	-0.41
EW28	0.02	0.01	0.14	-	0.18	0.40	0.46	0.02
EW32	0.20	-0.70	0.11	0.35	-	0.47	0.78	-0.78
EW36	0.23	-0.11	0.14	0.34	0.44	-	0.78	-0.84
EW40	0.24	0.65	0.21	0.32	0.42	0.55	-	-0.16
EP40	-0.23	-0.25	-0.18	-0.03	-0.08	-0.42	-0.61	-

S, sire; D, dam; BW, body weight; ASM, age at sexual maturity; EW, egg weight; EP, egg production; EM, egg mass.

found to be negative similar to the reports of Padhi and Chatterjee (2012), Rajkumar *et al.* (2021b; c; d). The phenotypic correlations of body weights with egg weights in the present study were positive and low in magnitude whereas those of egg production with BW20 and BW40 were negative, which were in line with the reports of Padhi and Chatterjee (2012). The genetic correlations among egg weights at different ages in the present study were positive and low to high magnitude. The phenotypic correlations among egg weights at different ages were positive whereas between egg weight and egg production were negative similar to the findings of many authors (Sreenivas *et al.* 2012, Padhi and Chatterjee 2012, Rajkumar *et al.* 2020b, c).

Egg quality traits: In the present study, the mean egg weight was found to be 55.22 ± 0.22 g in PD-6 line at 40 weeks of age. Lower egg weights were reported by Niranjana *et al.* (2008) and Rajkumar *et al.* (2020a) than the present study. The variations in egg weights may be due to the breed variations, type of birds and body weights of birds utilized in the study. The mean shape index in the present investigation was found to be 74.72 ± 0.55 , which was comparable to the values reported by Padhi *et al.* (2014) in crossbred chicken and Rajkumar *et al.* (2020a) in PD-2 line. The higher shape index indicates the more uniformity in size of the eggs. The mean Haugh unit value in the present study was found to be 82.22 ± 0.21 , which indicate the high quality of albumin in the egg. Lower Haugh unit values were reported by Rajkumar *et al.* (2020a) in PD-2 line and Rajkumar *et al.* (2014) in Aseel chicken. The mean yolk colour in the present study was 8.42 ± 0.21 indicating the dense concentration of carotenoid pigments which was in accordance with the findings of Niranjana *et al.* (2008). However, low yolk colour values were observed in PD-4 (Rajkumar *et al.* 2014, Haunshi *et al.* 2015, Rajkumar *et al.* 2020a). The variation in yolk colour may be because of type of feed offered during laying period and varied deposition of pigments during the egg formation.

The mean shell weight recorded in the present study was 5.47 ± 0.01 g which was comparable with the values reported by Niranjana *et al.* (2008) in crosses. These differences are expected as shell weight depends on egg weight which in turn depends on genotype and nutritional background of their stock. The mean shell thickness was 0.41 ± 0.001 mm, which was comparable with the values reported by Niranjana *et al.* (2008) in crosses and Rajkumar *et al.* (2020a) in PD-2 line, whereas Kundu *et al.* (2015) reported slightly higher shell thickness values in crosses. The higher shell thickness helps in preventing the damage during handling and also improves the keeping quality of the eggs.

The study concluded that PD-6 parent line has the genetic variability in both juvenile and production traits studied with reasonable additive genetic variance offering scope for improvement in economic traits. The improvement in primary traits will lead to increased performance in terminal crosses, which would be beneficial to the farmers.

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