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Dissecting the performance of Indian White Leghorn chicken lines through short-term selection experiment

ANEET KOUR[1], K S RAJARAVINDRA[1], L LESLIE LEO PRINCE[1], S K BHANJA[1] and U RAJKUMAR[✉1]

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

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ABSTRACT

Selection and breeding have resulted in huge genetic gains in White Leghorns over the years. Therefore, it is very important to quantify the rate of genetic progress from time to time. This study was conducted in three selected lines (IWH, IWI and IWK) and one control population (LC) of Indian White Leghorn to understand the short-term effects of selection in the improvement of performance traits. Phenotypic data included production, reproduction and growth traits recorded for five generations starting from 2016 to 2021-22. Using Analysis of Variance, it was revealed that genotype was significantly influencing the generation-wise performance of almost all the traits. IWH was the best performing line for the primary selection trait i.e. egg production at 64 weeks (EP64) over the generations. Genetic response to selection for EP64 was positive in IWH and IWK lines and negative in IWI line. Variance and heritability estimates were also calculated for the egg production (EP) traits from 24 to 72 weeks at four weeks interval in IWH line. Heritability was comparatively higher for the traits at the start of laying cycle (0.191±0.054 for EP24) and decreased considerably towards the end of the laying cycle (0.074±0.06 for EP72). Based on our findings, it is recommended to collate data for few more generations and if negative trend persists in IWI, we can go for either line crossing or introduction of outside variability. Also, genetic parameters can be estimated on a larger dataset in all the lines after few generations for greater precision and accuracy.

Keywords: Egg production, Layer lines, Selection, White leghorn

Selection and breeding are two tools in the hands of poultry breeder for genetic improvement of the populations. It helps in improving the performance of desired traits while at the same time, continuous selection of a trait also considerably reduces the additive genetic variability in a population (Rajkumar *et al*. 2021a). Therefore, quantifying the rate of progress in the populations subjected to selection from time-to-time helps in deciding the future breeding strategy for the flock (Sosa-Madrid *et al*. 2023).

In layers, female lines are generally selected for higher egg production and egg quality parameters (Kour *et al.* 2024). Under All India Coordinated Research Project (AICRP) on Poultry Breeding, selection and genetic improvement has been extensively carried out for White Leghorn lines. ICAR-Directorate of Poultry Research (ICAR-DPR), being the coordinating unit of AICRP, is maintaining seven lines of White Leghorn *viz.*, IWH, IWI, IWK, IWD, IWF, IWN and IWP and one layer control (LC) population. In order to assess the rate of genetic progress in the primary selection trait i.e. egg production, these lines are generally evaluated for their performance at definite intervals (Rajkumar *et al*. 2020). Comparative performance of selected lines vis-à-vis control population over the years highlights the genetic trend and efficacy of selection (Rajkumar *et al*. 2016, Saxena and Kolluri 2018). Performance data obtained from different generations of selection can also be utilized to obtain genetic (co)variance and heritability estimates for the traits from time to time (Chandan *et al*. 2019a,b). Estimation of these genetic parameters enables the breeders to understand the existing genetic variability in the population and scope for further improvement (Rajkumar *et al.* 2021b).

This study was conducted in the three selected lines of Indian White Leghorn *viz*., IWH, IWI and IWK and one layer control population (LC) over five generations to evaluate their performance. Further, genetic parameters including variance and heritability were also estimated for egg production traits in IWH.

MATERIALS AND METHODS

Experimental population: This study was performed at the experimental poultry farm of ICAR-Directorate of Poultry Research, Hyderabad. The farm is located in the Deccan plateau region in the southern part of India and experiences tropical environmental conditions. It involved three White Leghorn lines *viz.*, IWH, IWI and IWK with the first two lines having undergone eight and the third line completing sixteen generations of selection till 2021-22. IWH and IWI lines were selected for higher egg production

Present address: [1]ICAR-Directorate of Poultry Research, Hyderabad, Telangana. ✉Corresponding author email: ullengala@yahoo.com

up to 64 weeks using Osborne index whereas IWK line was selected for higher egg production up to 64 weeks along with higher egg weight at 28 weeks of age. A random bred pedigreed layer control (LC) population maintained for sixteen generations (till 2021-22) without any intentional selection was also simultaneously recorded. The data was available for five generations starting from the year 2016 to 2021-22. Sufficient data could not be obtained for the year 2020-21 due to pandemic induced lockdown and related issues and hence, was not considered for this study.

Rearing and Management practices: Regeneration plan for three selection lines (IWH, IWI and IWK) involved pedigreed mating of 50 sires with 250 dams in the ratio of 1:5 whereas the control population (LC) was reproduced by pedigreed mating of 50 sires with 200 dams in the ratio of 1:4. Chicks were wing banded at the time of hatch and were reared in deep litter system till 16 weeks of age. Accordingly, feeding schedule was planned and layer starter diet (2600 kcal/kg ME and 18% CP) was given up to 16 weeks. After 16 weeks, the birds were shifted to individual cages and were provided with layer breeder ration containing 2650 kcal/kg ME and 16.5% CP along with 3.5% calcium. Daily allowance of 16 hours of light including natural light was also provided to the birds. Similar rearing and management conditions were provided to all the birds in this study. Layer vaccination schedule was strictly adhered to starting from Marek's disease vaccine on the day of hatch. Thereafter, birds were vaccinated against New Castle disease, Infectious Bursal Disease, Fowl Pox and Infectious Bronchitis following the standard vaccination program.

Traits recorded: Egg production was daily recorded for individual birds and traits were generated by summing up the total production up to a certain age. On the other hand, egg weight at a particular age was determined by taking the average of egg weight measurements for five consecutive days.

Traits considered in this study were reproduction traits like age at sexual maturity (ASM), overall fertility (%), overall hatchability on fertile egg basis (%), egg production traits like egg production up to 40 (EP40), 52 (EP52), 64 (EP64) and 72 (EP72) weeks of age and egg weight traits like egg weight at 28 (EW28), 40 (EW40), 52 (EW52) and 64 (EW64) weeks of age. Growth traits like body weight at day 0 (BW0), body weight at 4 (BW4), 8 (BW8), 16 (BW16), 20 (BW20), 40 (BW40) and 52 (BW52) weeks of age were also considered for the study.

EP72 data was not available for 1st generation; EW64 data was unavailable for 2nd and 4th generation while EW52 and ASM data was missing for 3rd generation. Similarly, BW0 data for 5th generation and BW52 for 1st and 2nd generation was unavailable.

Effect of genotype on performance: The phenotypic data for different years was normalized to remove outliers and fitted into Mean±3.S.D. to be used for further analysis. In order to determine the effect of different genotypes on the traits, analysis of variance (ANOVA) was performed using SPSS 16.0 software (SPSS Inc. 2007). Post hoc analysis was also done to identify significant differences between different genotypes with respect to the traits.

Genetic parameter estimation: Genetic parameter estimation was performed for the White Leghorn line showing the best performance for the primary selection trait (EP64) over the generations. Egg production traits recorded at monthly intervals starting from 24 to 72 weeks of age were generated for analysis. Fixed non-genetic

Table 1. Effect of different genotypes on reproduction traits over the generations (Values in parenthesis indicate no. of observations)

	1st	2nd	3rd	4th	5th
		ASM			
IWI	138.79±0.46[a] (456)	142.60±1.08[a] (150)	-	150.26±0.60[a] (286)	141.24±0.71[a] (205)
IWH	138.90±0.46[a] (458)	149.93±1.07[bc] (152)	-	139.18±0.52[b] (390)	135.83±0.55[b] (342)
IWK	136.26±0.39[b] (614)	146.93±0.70[b] (354)	-	153.49±0.87[c] (137)	143.14±0.71[a] (202)
LC	149.81±0.49[c] (400)	150.74±0.88[c] (225)	-	157.35±0.69[d] (212)	148.84±0.59[c] (286)
		Overall fertility (%)			
IWI	76.70	69.62	90.12	76.88	73.57
IWH	75.39	55.45	86.48	83.85	78.85
IWK	78.47	74.67	92.03	84.57	84.01
LC	62.02	61.47	83.86	80.70	78.04
		Overall hatchability based on FES (%)			
IWI	79.43	78.79	90.69	91.09	93.24
IWH	74.69	48.34	90.70	88.38	88.47
IWK	84.55	83.18	95.51	89.52	92.15
LC	84.98	80.73	93.77	96.50	79.60

Same superscript indicates no significant difference between the performance of genotypes while different superscripts indicate significant difference between the performance of genotypes factors included generation (N = 3) and hatch (N = 5) while animal was the random genetic effect considered for the analysis. Variance and heritability for egg production traits i.e. EP24, EP28, EP32, EP36, EP40, EP44, EP48, EP52, EP56, EP60, EP64, EP68 and EP72 were estimated by employing AIREML approach using WOMBAT software (Meyer, 2007).

The linear mixed model for the analysis was:

$$Y_{ijkl} = \mu + H_i + G_j + A_k + e_{ijkl}$$

Where, Y_{ijkl}, is the phenotype of k[th] animal in i[th] hatch and j[th] generation; H_i, i[th] hatch;
G_j, j[th] generation; A_k, k[th] animal; e_{ijkl}, random residual.

RESULTS AND DISCUSSION

Genotype significantly influenced all the traits across the generations except EW28 in 2[nd] and 5[th], EW40 in 4[th] and BW8 in 5[th] generations.

Effect of genotype on reproductive performance: The effect of genotype on the reproductive performance has been outlined in Table 1. In the last two generations, ASM was significantly lower for IWH as compared to rest of the lines. This finding is a reiteration of the fact that egg production is negatively correlated with age at sexual maturity and early maturity results in higher production (Prince *et al*. 2020). This observation is also in line with the findings of Haunshi and co-workers (2016) who also reported lowest ASM in IWH line as compared to IWI, IWK and LC populations. As compared to the initial generations, the overall fertility (%) and hatchability based on fertile eggs set (%) has also improved in all the lines.

Effect of genotype on growth performance: Birth weight (BW0) was significantly higher for IWK as compared to other lines which may be attributed to the fact that this line has been selected for higher egg weight and egg size is reported to have positive influence on hatch size in chickens (Fathi *et al.* 2022). Body weight at sexual maturity (BW16 and BW20) was usually higher for IWH line vis-à-vis other selection lines. This finding concurs with the widely accepted hypothesis that higher body weight leads to early sexual maturity in chickens (Akbas and Takma 2005, Jambui *et al*. 2017, Rajkumar *et al*. 2020). For the trait BW52, IWK line showed superior performance in two out of last three recorded generations. This is in agreement with the already reported literature that a highly positive genetic correlation exists between body weight and egg weights at different ages (Lin *et al*. 2016, Chomchuen *et al*. 2022). The body weight performance at different ages in the three selection lines has been outlined in Table 2.

Table 2. Effect of different genotypes on body weight traits over the generations (Values in parenthesis indicate no. of observations)

	1st	2nd	3rd	4th	5th
			BW0 (g)		
IWI	33.07±0.59[a] (467)	33.28±0.25[a] (158)	34.81±0.14[a] (548)	35.83±0.18[a] (297)	-
IWH	31.30±0.23[b] (447)	32.09±0.27[b] (151)	35.33±0.23[b] (219)	34.79±0.17[b] (404)	-
IWK	35.82±0.13[c] (625)	34.08±0.16[c] (359)	37.25±0.14[c] (565)	38.17±0.22[c] (223)	-
LC	36.23±0.18[c] (429)	34.29±0.19[c] (246)	-	-	-
			BW4 (g)		
IWI	277.23±4.19 (448)	157.69±2.56[a] (156)	170.96±1.78[a] (357)	181.28±2.19[a] (295)	194.43±3.34[a] (99)
IWH	-	137.28±2.14[b] (150)	146.69±1.85[b] (254)	-	188.00±3.47[a] (123)
IWK	-	141.76±1.33[b] (369)	151.59±1.88[b] (270)	200.76±2.80[b] (213)	-
LC	-	150.36±1.83[c] (248)	-	-	160.84±2.84[b] (135)
			BW8 (g)		
IWI	549.43±5.79[a] (314)	358.20±5.28[a] (157)	429.73±4.96[a] (293)	340.54±4.17[a] (295)	410.83±6.39 (98)
IWH	451.57±3.65[b] (417)	388.21±5.85[b] (151)	409.52±4.84[b] (256)	-	410.85±4.02 (302)
IWK	-	407.59±3.89[c] (359)	399.51±5.45[b] (278)	435.26±5.94[b] (204)	409.05±5.89 (137)
LC	453.78±4.39[b] (414)	367.98±5.42[a] (249)	-	-	426.07±6.14 (195)
			BW16 (g)		
IWI	985.36±6.54[a] (438)	903.47±7.54[a] (153)	859.08±4.51[a] (412)	862.26±9.31[a] (92)	916.86±5.97[a] (200)
IWH	902.75±5.46[b] (422)	867.99±7.85[b] (150)	937.54±9.36[b] (185)	950.66±6.01[b] (371)	1034.58±5.34[b] (342)
IWK	-	848.07±5.22[bc] (367)	932.48±5.40[b] (488)	1036.27±19.75[c] (49)	935.96±6.35[a] (194)
LC	-	838.47±6.82[c] (237)	-	1118.01±16.71[d] (124)	983.23±5.86[c] (285)

Table 2 continued ...

Table 2. *Concluded*

	1st	2nd	3rd	4th	5th
			BW20 (g)		
IWI	1156.40±5.63^{a} (438)	1111.85±9.01^{a} (158)	1119.22±5.36^{a} (557)	1006.17±6.76^{a} (289)	1139.68±6.74^{a} (203)
IWH	-	1177.50±8.91^{b} (151)	1263.47±8.99^{b} (273)	1153.31±5.76^{b} (389)	1257.00±6.63^{b} (288)
IWK	-	1099.49±6.34^{a} (359)	1146.05±6.24^{c} (518)	1050.32±17.17^{c} (74)	1162.97±7.44^{c} (200)
LC	1190.13±7.06^{b} (359)	1183.46±8.48^{b} (249)	1149.14±7.55^{c} (300)	1184.19±17.57^{b} (62)	1228.16±7.07^{d} (284)
			BW40 (g)		
IWI	1346.48±7.92^{a} (429)	1305.81±12.14^{a} (147)	1467.26±7.92^{a} (505)	1434.91±8.48^{a} (268)	1397.58±9.99^{a} (202)
IWH	1418.52±7.66^{b} (451)	1400.28±14.52^{b} (148)	1521.14±10.84^{b} (247)	1423.99±9.34^{a} (361)	1519.06±10.21^{b} (346)
IWK	1388.81±7.10^{c} (586)	1319.75±7.65^{a} (334)	1474.48±9.49^{a} (414)	1544.22±20.58^{b} (65)	1379.66±11.15^{a} (194)
LC	1547.53±8.00^{d} (443)	1480.73±15.15^{c} (140)	1623.92±14.70^{c} (155)	1573.06±13.39^{b} (54)	1501.87±10.91^{b} (281)
			BW52 (g)		
IWI	-	-	1625.12±9.25^{a} (357)	1484.23±10.34^{a} (254)	1365.21±11.42^{a} (200)
IWH	-	-	1605.43±11.73^{a} (238)	1497.19±10.37^{a} (336)	1531.79±9.86^{b} (342)
IWK	-	-	1622.49±10.02^{a} (495)	1607.16±22.59^{b} (64)	1386.99±11.89^{a} (198)
LC	-	-	1680.34±12.25^{b} (273)	1689.58±25.43^{c} (50)	1503.15±11.57^{b} (282)

Same superscript indicates no significant difference between the performance of genotypes while different superscripts indicate significant difference between the performance of genotypes

Effect of genotype on egg production performance: Effect of genotype on the egg production performance of different traits over the generations has been presented in Table 3. Overall, IWH line showed the best estimates with respect to egg production at different ages and across different generations. Although in the 1st generation, IWI had slightly higher production at 64 weeks than IWH line, there was no significant difference in the performance of two

Table 3. Effect of different genotypes on egg production traits over the generations (Values in parenthesis indicate no. of observations)

	1st	2nd	3rd	4th	5th
			EP40		
IWI	120.34±0.85^{a} (432)	125.74±1.47^{a} (148)	89.92±0.97^{a} (503)	111.81±1.07^{a} (272)	115.00±1.20^{a} (198)
IWH	117.77±0.83^{a} (447)	130.65±1.46^{b} (151)	116.88±1.41^{b} (239)	120.51±0.91^{b} (371)	115.97±0.92^{a} (339)
IWK	107.41±0.72^{b} (590)	112.13±0.99^{c} (328)	83.54±0.95^{c} (530)	95.52±1.25^{c} (198)	105.64±1.19^{b} (200)
LC	100.51±0.83^{c} (444)	97.71±1.41^{d} (161)	95.26±1.29^{d} (287)	83.61±1.22^{d} (206)	99.14±1.02^{c} (275)
			EP52		
IWI	192.28±1.09^{a} (410)	198.44±2.08^{a} (133)	148.07±1.48^{a} (509)	174.26±1.79^{a} (264)	179.37±1.53^{a} (197)
IWH	190.30±1.06^{a} (432)	203.86±1.96^{a} (150)	183.22±2.13^{b} (246)	187.17±1.54^{b} (358)	185.37±1.20^{b} (318)
IWK	169.43±0.94^{b} (559)	170.13±1.33^{b} (326)	142.99±1.46^{a} (523)	147.89±2.08^{c} (196)	173.28±1.58^{c} (185)
LC	163.62±1.06^{c} (439)	165.29±2.03^{b} (140)	156.14±2.00^{c} (279)	131.48±2.03^{d} (206)	161.91±1.30^{d} (271)

Table 3 continued ...

Table 3. *Concluded*

	1st	2nd	3rd	4th	5th
			EP64		
IWI	258.36±1.47^{a} (403)	257.17±3.14^{a} (132)	206.85±2.04^{a} (485)	227.45±2.45^{a} (263)	235.97±1.89^{a} (192)
IWH	256.89±1.44^{a} (418)	264.58±2.97^{a} (148)	182.69±2.67^{b} (248)	241.63±2.14^{b} (347)	254.40±1.51^{b} (300)
IWK	223.23±1.25^{b} (556)	216.65±2.01^{b} (324)	202.55±2.00^{a} (503)	188.27±2.81^{c} (200)	231.09±1.90^{a} (189)
LC	224.35±1.42^{b} (432)	218.15±3.21^{b} (127)	208.70±2.68^{a} (281)	173.81±2.83^{d} (197)	221.57±1.60^{c} (267)
			EP72		
IWI	-	294.39±3.79^{a} (131)	232.12±2.36^{a} (489)	250.29±2.79^{a} (259)	267.66±2.22^{a} (192)
IWH	-	302.46±3.70^{a} (144)	268.95±3.21^{b} (264)	263.56±2.44^{b} (341)	285.79±1.77^{b} (302)
IWK	-	240.55±2.50^{b} (315)	234.60±2.34^{a} (499)	204.21±3.19^{c} (198)	267.81±2.25^{a} (188)
LC	-	250.05±3.96^{b} (125)	240.08±3.13^{a} (279)	178.85±3.22^{d} (195)	255.53±1.89^{c} (266)

Same superscript indicates no significant difference between the performance of genotypes while different superscripts indicate significant difference between the performance of genotypes

lines. Also, similar pattern was observed in 3rd generation when EP64 for IWI was higher than IWH. However, EP72 for the same generation was significantly higher for the latter than the former. Since EP64 and EP72 show highly positive genetic correlation, the dip in EP64 performance of IWH line can be attributed to some temporary or specialized environmental effects (Falconer and Mackay 1989). Interestingly, IWH line also showed highest egg production at 52 weeks (EP52) for all the generations. This is attributable to the positive genetic correlation between egg production at different ages (Lin *et al*. 2016) and hints at the possibility of going for early selection at 52 weeks as an indicator of the overall egg production or EP72 (Chandan *et al.* 2019b).

Effect of genotype on egg weight performance: IWK outperformed the other two selection lines with respect to the egg weight performance traits. Since the line has been selected for higher EW28 (along with higher EP64), it consistently performed better as compared to IWH and IWI for EW28, EW40 and EW52. Although IWI reported a slightly higher estimate than IWK line for EW40 in 2nd generation, the difference between two lines was not significant. As far as EW64 weeks was concerned, IWK line reported highest estimate for almost all the generations. This is obvious given the fact that this line has been selected for higher EW28 and that egg weight measurements at different ages show highly positive genetic correlation amongst them (Chandan *et al*. 2019b, Ni *et al*. 2023). The details of egg weight measurements in different genotypes have been reported in Table 4.

Table 4. Effect of different genotypes on egg weight traits over the generations (Values in parenthesis indicate no. of observations)

	1st	2nd	3rd	4th	5th
			EW28 (g)		
IWI	44.85±0.17^{a} (424)	46.90±0.26 (152)	48.36±0.18^{ab} (380)	49.37±0.16^{a} (277)	47.95±0.20 (198)
IWH	44.82±0.16^{a} (446)	47.56±0.26 (150)	48.77±0.23^{b} (239)	47.52±0.13^{b} (373)	47.96±0.15 (334)
IWK	45.77±0.14^{b} (576)	47.75±0.17 (344)	48.88±0.17^{b} (417)	51.12±0.33^{c} (62)	47.46±0.20 (199)
LC	46.09±0.17^{b} (435)	47.72±0.27 (139)	47.77±0.35^{a} (101)	47.54±0.36^{b} (51)	48.06±0.17 (274)
			EW40 (g)		
IWI	50.64±0.18^{a} (421)	52.14±0.31^{a} (145)	49.96±0.19^{a} (442)	52.59±0.17 (268)	49.93±0.23^{a} (193)
IWH	50.79±0.18^{a} (438)	49.19±0.31^{b} (148)	50.03±0.27^{a} (219)	52.16±0.15 (350)	50.45±0.18^{ab} (325)
IWK	52.29±0.16^{b} (563)	52.11±0.21^{a} (307)	55.57±0.19^{b} (455)	55.88±0.38 (56)	51.07±0.23^{b} (187)
LC	52.94±0.18^{c} (430)	51.19±0.32^{a} (135)	52.44±0.25^{c} (269)	55.66±0.38 (55)	51.13±0.19^{b} (272)

Table 4 continued ...

Table 4. *Concluded*

	1st	2nd	3rd	4th	5th
			EW52 (g)		
IWI	53.84±0.20[a] (403)	52.23±0.34[a] (131)	-	54.83±0.23[a] (254)	54.39±0.29[a] (174)
IWH	54.24±0.23[a] (409)	-	-	53.35±0.19[b] (335)	55.01±0.22[a] (303)
IWK	54.89±0.18[b] (518)	52.34±0.23[a] (273)	-	58.49±0.48[c] (56)	56.29±0.29[b] (167)
LC	55.65±0.19[c] (416)	56.86±0.42[b] (83)	-	55.34±0.52[a] (48)	54.48±0.24[a] (248)
			EW64 (g)		
IWI	55.39±0.22[a] (364)	-	55.21±0.21[a] (372)	-	54.17±0.30[a] (164)
IWH	56.05±0.20[b] (319)	-	56.66±0.28[b] (208)	-	54.57±0.28[a] (199)
IWK	57.46±0.19[c] (474)	-	-	-	55.86±0.29[b] (180)
LC	57.44±0.21[c] (395)	-	56.75±0.28[b] (204)	-	54.90±0.24[a] (255)

Same superscript indicates no significant difference between the performance of genotypes while different superscripts indicate significant difference between the performance of genotypes

Response in primary trait: Phenotypic and genetic response was also plotted for the primary selection trait EP64 over the generations in the three selection lines and it was observed that the genetic trend was positive for IWH and IWK lines and negative for IWI line (Figures 1-3). This essentially means that IWI line needs to be observed for few more generations and if negative trend persists, outside variability needs to be introduced in the population in order to improve the selection response. Line crossing can be another viable alternative to introduce new genetic variability in the line.

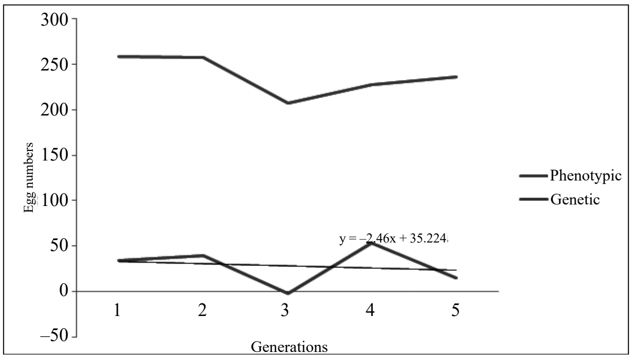

Fig. 1. Phenotypic and genetic response for EP64 over the generations in IWI line

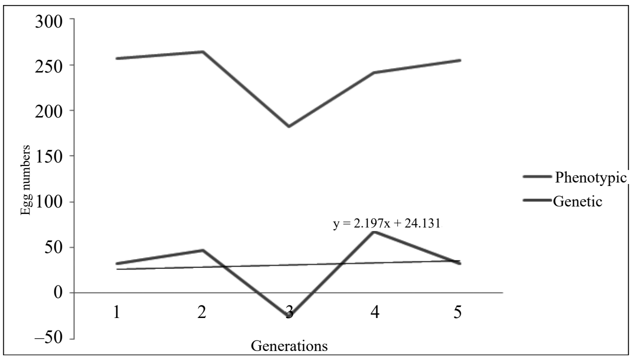

Fig. 2. Phenotypic and genetic response for EP64 over the generations in IWH line

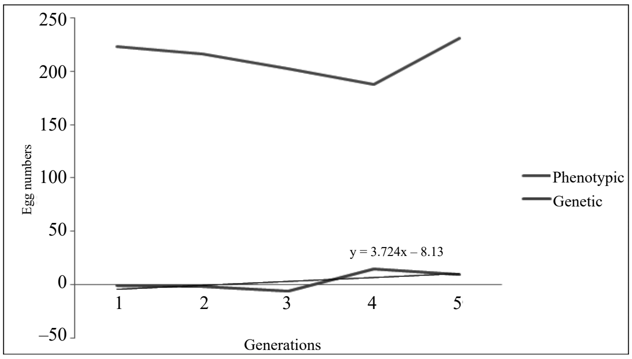

Fig. 3. Phenotypic and genetic response for EP64 over the generations in IWK line

Genetic parameter estimation: For genetic parameter estimation, egg production traits starting from 24 to 72 weeks of age i.e. EP24, EP28, EP32, EP36, EP40, EP44, EP48, EP52, EP56, EP60, EP64, EP68 and EP72 were recorded for the recent years (2020-23) in IWH line. Genetic variance and heritability estimates for the traits have been presented in Table 5. Overall, an almost linearly decreasing trend was observed across the laying cycle. This finding is in agreement with the earlier reports that heritability is comparatively higher at the start of the laying cycle and subsequently, goes on decreasing (Venturini *et al.* 2012). Heritability of the primary selection trait EP64 (0.061±0.06) was less due to obvious reasons i.e. continuous selection pressure over the generations has considerably reduced the additive genetic variability in the population (Hallsson

Table 5: Heritability of egg production traits in IWH line

Trait	N	σ^2_a	σ^2_e	h^2±S.E.
EP24	1051	9.76	41.41	0.191±0.054
EP28	1049	18.71	89.95	0.172±0.05
EP32	1046	30.78	135.53	0.185±0.05
EP36	1021	43.79	162.28	0.213±0.05
EP40	1021	65.75	268.72	0.197±0.06
EP44	923	36.23	236.82	0.133±0.05
EP48	687	53.49	311.73	0.146±0.06
EP52	669	49.98	345.46	0.126±0.06
EP56	636	56.05	347.74	0.139±0.06
EP60	626	49.79	488.46	0.093±0.06
EP64	603	39.49	608.06	0.061±0.06
EP68	546	17.79	820.32	0.021±0.06
EP72	546	59.49	747.51	0.074±0.06

and Björklund 2012). However, standard error associated with the h^2 estimate is also high which may be either due to the reason that sample size considered for the estimate was small or that the partitioning of trait variance was not appropriate (Rajkumar *et al*. 2021c). In the same population, comparatively higher estimates for egg production traits were reported by Haunshi *et al.* (2016) and Chandan and co-workers (2019b) as compared to our findings. This can be attributable to the decreasing variability resulting from continuous selection over the generations (Bulmer 1971). Genetic parameters were estimated by Haunshi *et al.* (2016) and Chandan *et al.* (2019b) after three and four generations of selection respectively. In this study, genetic parameters were estimated after the population had already undergone nine rounds of selection.

Nonetheless, this population could be monitored for another three to four generations to obtain more precise genetic estimates. Additionally, the primary selection criteria for IWH line could be modified depending on the additive genetic variability of the trait and its genetic correlations with the total egg production in a laying cycle.

This study concluded that IWH was the best performer amongst other selected lines of Indian White Leghorn for the primary selection trait *viz*., egg production up to 64 weeks. As far as the genetic variability in this population was concerned, sample size needs to be increased in order to further improve the estimates. At the same time, any alternative trait with higher additive genetic variability and highly positive genetic correlations with the later traits needs to be identified. In order to improve selection response in IWI line, genetic variability can be created either through line crossing or outside germplasm introduction.

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