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Genetic characterization of layer germplasm evolved by AICRP on poultry breeding

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ABSTRACT

The study was carried out to evaluate White Leghorn lines (IWH, IWI, IWK and layer control-LC) and to genetically characterize IWH and LC lines for production traits. Body weight at 20 weeks was significantly higher in LC, IWH and IWK lines as compared to IWI. Similarly, body weight at 40 weeks of age was also significantly higher in LC as compared to IWK, IWH and IWI. Among selected lines, it was significantly higher in IWK than that in IWH and IWI. The ASM was significantly lesser in IWH followed by IWI, IWK and LC. Egg weight at 28 weeks was significantly higher in LC followed by IWK, IWI and IWH. However, egg weight at 40 weeks was significantly higher in IWK followed by LC, IWI and IWH. Similarly, egg weight at 52 weeks of age was significantly higher in IWK followed by LC, IWH and IWI. Egg mass at 40 weeks of age was significantly higher in IWH, IWI and IWK as compared to LC. Egg mass at 52 weeks of age was also significantly higher in IWH as compared to IWK, IWI and LC. However, this trait was significantly higher in IWK and IWI as compared to LC. Heritability estimates on sire component of variance were high for all the traits except for ASM (moderate) in IWH while, they were high for all the traits except for body weight at 40 weeks of age (moderate) in LC.The study concluded that despite the continuous selection, these lines differ for many of the production traits and considerable genetic variation exists for many of the traits in IWH and LC, and IWH line could continue to be improved for production traits.

Key words: AICRP, Characterization, Layer lines, Production traits, Selection

AICRP on poultry breeding played a significant role in development of egg type chicken germplasm (White Leghorn) in the country. IWH, IWI, IWK and layer control (LC) lines evolved under AICRP on poultry breeding are being maintained at ICAR-Directorate of Poultry Research, Hyderabad. IWH and IWI lines were subjected to selection for higher egg production and being used for production of commercial layer cross named 'Krishilayer' while IWI line in combination with PD–3 line is being used for production of another egg type cross named 'Swetasree' for backyard poultry production. IWK line is being subjected to selection for improvement of both egg weight and egg production traits. Pedigreed random bred layer control (LC) population is being maintained to serve as reference population to monitor the genetic progress being made in the selected lines at ICAR-DPR and its AICRP centres. These lines need to be periodically evaluated simultaneously to understand the effect of selection on the production traits among selected lines in comparison to unselected LC line. Earlier study reported the inheritance of economic traits up to 40 weeks of age (Chatterjee *et al*. 2008). However, these lines need to be evaluated for higher part period egg production to reflect their true genetic potential as very high genetic correlation between long part record and whole record compared to early part record with whole record were reported (Fairfull and Gowe 1990). Therefore, the present study was carried out to evaluate IWH, IWI and IWK selected lines for production traits up to 52 weeks of age in comparison with LC population. Further, to genetically characterize IWK and LC lines for the economic traits.

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MATERIALS AND METHODS

Experimental lines: The study involved birds belonging to IWH, IWI, IWK and LC lines of White Leghorn breed. IWH and IWI lines were undergoing IDS index selection for higher egg production up to 64 weeks of age during last three generations at ICAR-DPR and were previously subjected to selection for higher egg production for several generations at ICAR-CARI, Izatnagar. On the other hand, IWK line is being subjected to selection for higher egg production up to 64 weeks of age as well as for higher egg weight at 28 weeks of age since last 11 generations at the institute. The pedigreed random bred layer control (LC) population is being maintained at the institute since last 11 generations without any intentional selection.

Management practices: Chicks of 3 selected pure (IWH, IWI and IWK) lines were reproduced by pedigree mating of 50 sires with 250 dams in 1:5 ratio while those of LC population were reproduced by pedigreed mating of 50 sires with 200 dams in 1:4 ratio. Chicks were sexed and wing banded on the day of hatch and reared in open sided house on deep litter up to 16 weeks of age. They were provided with layer chick starter ration [2,600 kcal/kg metabolizable energy (ME) and 18% crude protein (CP)] up to 8 weeks of age and grower ration (2,500 kcal/kg ME and 16% CP) from 9 to 16 weeks of age in *ad lib.* quantity. After 16 weeks of age, birds were housed in individual cages and provided with layer ration (2,600 kcal/kg ME and 16% CP) from the onset of egg production till the completion of the experiment. Light for 16 h (including natural day light) was provided during laying period. Management and rearing conditions during the period of experiment were similar for all four genetic groups. On the day of hatch chicks were vaccinated against Marek's disease and subsequently birds were protected against important diseases like RD, IBD and fowl pox using standard vaccination program.

Growth and production traits: Body weights of individual birds were recorded at 20 and 40 weeks of age to the nearest of 1g accuracy. Egg production was calculated by averaging egg produced by each surviving hen up to 52 weeks of age, while egg weight was recorded to the nearest of 0.1g accuracy by taking average weight of eggs laid by each hen during 28th, 40th and 52nd week of age. Egg mass at 40 and 52 weeks of age was calculated by multiplying the average egg production up to respective age with average egg weight recorded at corresponding age.

Statistical analysis: Means and standard errors of various traits were calculated using standard statistical methods and significant differences among four genetic lines for various economic traits were tested with one way ANOVA (Snedecor and Cochran 1994). The heritability estimates were calculated using hatch-corrected data by variance component analysis (King and Henderson 1954). Genetic and phenotypic correlations among various economic traits were estimated using variance component analysis (Becker 1992) using LSM LMW mixed model computer program (Harvey 1990).

RESULTS AND DISCUSSION

Economic traits such as body weight and egg production are influenced by various factors such as genotype, environment, genotype environment interactions, selection etc. In this study birds of 3 different selected lines were evaluated at same time at same location in comparison with control population to investigate how the lines differ with respect to the various body weight and production traits.

Growth performance: Mean value of body weight at 20 and 40 weeks of age of all 4 lines are presented in Table 1. Body weight at 20 weeks was significantly higher in layer control (LC), IWH and IWK lines as compared to IWI line. Similarly, body weight at 40 weeks of age was significantly higher in LC as compared to IWK, IWH and IWI lines. Among selected lines, it was significantly higher in IWK line than that in IWH and IWI lines although no significant difference was observed among IWH and IWI lines. Finding of significantly higher body weight both at 20 and 40 weeks of age in LC as compared to selected lines could be explained from the fact that LC was evolved from synthetic base population and higher body weight of synthetic base population remained stable over generations primarily due to not being subjecting this line for selection. Since IWK line is being improved for higher egg weight at 28 weeks of age besides egg production over last 11 generations and egg weight and body weights are positively correlated and that might have helped in maintaining the higher body weight (40 weeks) in this line as compared to IWH and IWI lines. Similar results were reported by Chatterjee *et al*. (2008).

Production performance: Production performance up to 52 weeks of age of three selected layer lines (IWH, IWI and IWK) and LC population is presented in Table 1. Among

Table 1. Production performance of selected lines and layer control population

Trait	IWH	IWI	IWK	Control	P value
No. of observations	367	526	433	375	
Body weight (g)					
20 weeks	1060±6.1 [a]	1043±12.9 [b]	1055±6.1 [a]	1081±7.3 [a]	0.036
40 weeks	1326±7.9 [c]	1308±6.8 [c]	1372±8.3 [b]	1496±9.8 [a]	0.000
ASM (d)	140.7±0.47[d]	145.3±0.46[c]	147.8±0.54[b]	156.4±0.74[a]	0.000
Egg weights (g)					
28 weeks	43.95±0.16 [d]	44.60±0.12 [c]	45.43±0.15 [b]	46.17±0.17 [a]	0.000
40 weeks	48.08±0.17 [d]	48.83±0.13 [c]	53.02±0.18 [a]	51.28±0.22 [b]	0.000
52 weeks	51.38±0.23 [c]	51.91±0.17 [c]	55.33±0.18 [a]	52.99±0.22 [b]	0.000
EP (No.)					
40 weeks	117.9±0.86 [a]	114.4±0.65 [b]	104.9±0.84 [c]	94.9±1.21 [d]	0.000
52 weeks	188.8±1.12 [a]	176.0±1.12 [b]	167.4±1.24 [c]	156.8±1.88 [d]	0.000
Egg mass (g)					
40 weeks	5672±44.4[a]	5656±37.1[a]	5587±43.6[a]	5029±37.1[b]	0.000
52 weeks	9743±65.5[a]	9279±65.8[b]	9386±67.5[b]	8546±65.8[c]	0.000

Means with at least one common superscript within the row do not differ significantly (P<0.01); ASM, age at sexual maturity; EP, egg production.

4 pure lines, significant differences were observed for age at sexual maturity (ASM), egg weight at 28, 40 and 52 weeks of age, egg production up to 40 and 52 weeks of age, egg mass at 40 and 52 weeks of age. The ASM was significantly lesser in IWH followed by IWI and IWK lines as compared to LC line. Selection for higher egg production in selected lines has affected the ASM negatively as compared to LC population as egg production and ASM are negatively correlated (Akbas and Takma 2005). Egg production up to 40 weeks of age was significantly higher in IWH followed by IWI, IWK and LC line. Similar trend was observed in egg production up to 52 weeks of age. It may be noticed that IWH line appears to be responding better for selection followed by IWI and IWK line. Egg production up to 40 weeks was higher than those reported by Reddy *et al.* (2004) for IWH and IWI lines. Egg mass and egg production up to 40 weeks were higher than those reported by Chatterjee *et al.* (2008) for all lines.

Egg weight at 28 weeks of age was significantly higher in LC population followed by IWK, IWI and IWH line. However, egg weight at 40 weeks of age was significantly higher in IWK followed by LC, IWI and IWH lines. Egg weights recorded at 40 weeks in IWK and LC were comparable to those reported by Sreenivas *et al.* (2013) and Vasu *et al.* (2004) in control line and slightly lesser in IWH and IWI lines as compared to those reported by Chatterjee *et al*. (2008) in respective lines. Similarly, egg weight at 52 weeks of age was significantly higher in IWK followed by LC, IWH and IWI lines although there was no significant difference between IWH and IWI lines. Selection for higher egg weight helped in maintaining the higher egg weight in IWK line. Significantly lesser egg weight in IWH and IWI lines as compared to LC at all ages tested could be explained from the fact that LC has higher body weight, and egg weights and body weights are positively correlated. Further, negatively correlation between egg production and egg weight explains the reasons for lesser egg weight observed in the IWH and IWI lines. Chatterjee *et al*. (2008) and Sreenivas *et al*. (2013) also reported similar trend for egg weight at 40 weeks of age in these lines.

Egg mass at 40 weeks of age was significantly higher in IWH, IWI and IWK lines as compared to LC but no significant difference was evident among selected lines for this trait. Compared to the findings of Chatterjee *et al.* (2008) higher 40 weeks' egg mass was observed in this study. However, egg mass at 52 weeks of age was significantly higher in IWH line as compared to IWK, IWI and LC. This trait was significantly higher in IWK and IWI lines as compared to LC although no significant difference was observed among IWK and IWI lines. Higher egg production observed in IWH and IWI lines was responsible for higher egg mass recorded in these lines as compared to LC while higher egg weight in combination with higher egg production was responsible for higher egg mass in IWK line as compared to LC.

Genetic parameters of production traits: The genetic parameters such as heritability, and genetic and phenotypic correlations on sire component of variance were estimated for different traits in IWH line and control population.

Heritability estimates

IWH line: Heritability estimates on sire component of variance (Table 2) were high for all the traits except for body weight at 20 weeks of age and moderate for ASM in IWH line. This line is being selected for higher egg production up to 64 weeks of age at ICAR-DPR since last three generations and previously also it was subject for selection for higher egg production for several generations under AICRP on poultry breeding at ICAR-CARI, Izatnagar (Anonymous 2012) and showed significant improvement in egg production. Higher estimates of heritability on sire component of variance for egg production, egg weight and egg mass traits observed in IWH line indicates that there is still a large additive genetic variation in this line and hence this line could continue to be improved for egg production, egg weight or egg mass traits. By and large, present findings were in agreement with those reported by Chatterjee *et al*. (2008) who observed higher heritability estimates for body weight at 20 weeks and egg weight at 28 and 40 weeks and moderate for ASM and body weight at 40 weeks and low for egg production and egg mass at 40 weeks of age in IWK line on sire component of variance. On the contrary, Sethi *et al.* (2003) Reddy *et al.* (2004) and Jayalaxmi *et al*. (2010) reported lower heritability estimates for most of the production traits in IWH line as compared to the present findings.

LC line: Heritability estimates in this line were high for ASM, body weight at 20 weeks of age, egg weights, egg production and egg mass traits and moderate for body weight at 40 weeks of age. This LC is being maintained as pedigreed random bred population since last 11 generation in order to use it as reference population for determining the genetic response in selected lines maintained under AICRP on poultry breeding for eggs. Presence of higher

Table 2. Heritability estimates for some of the important traits in selected and control populations on sire component of variance

Trait	IWH line	Layer control
Body weight		
20 weeks	0.13±0.16	0.39±0.19
40 weeks	0.51±0.25	0.16±0.18
ASM	0.28±0.15	0.45±0.21
Egg production		
40 weeks	0.45±0.19	0.44±0.21
52 weeks	0.39±0.18	0.41±0.19
Egg weight		
28 weeks	0.53±0.21	0.67±0.28
40 weeks	0.85±0.27	0.69±0.26
52 weeks	0.85±0.26	0.53±0.25
Egg mass		
40 weeks	0.50±0.20	0.40±0.19
52 weeks	0.42±0.18	0.34±0.19

genetic variation in control population indicates that this line could be used as a baseline/resource population in future for selection or to introduce genetic variation in unresponsive selected population as and when the need arises. Similar to the present findings, Chatterjee *et al*. (2008) reported higher estimates for body weight at 20 and 40 weeks, egg weight at 28 and 40 weeks, egg production and egg mass at 40 weeks of age and moderate for ASM in LC line on sire component of variance. However, Vasu *et al*. (2004) reported low to moderate estimates of heritability for production traits in control line.

Genetic correlations

IWH line: Genetic correlation of 20 weeks body weight (BW) with 40 weeks body weight, egg weight at 28, 36, 40 and 52 weeks, egg production (EP) to 40 and 52 weeks and egg mass (EM) at 40 and 52 weeks was positive in direction and high in magnitude (Table 3). Similarly, genetic correlation of BW40 was positive in direction and low to moderate in magnitude with EW28, EW40 and EW52, EM40 and EM52. Genetic correlation of ASM with BW20, BW40, EW28, EW40, EW52, EP40, EP52, EM40 and EM52 was moderate to high in magnitude and negative in direction. Genetic correlation of EW28 with EW40, EW52, EM40 and EM52 was positive in direction and high in magnitude. Genetic correlation of EW40 with EW52 and EM52 was positive and high while that with EM40 was positive and moderate. Similarly, EW52 was positively correlated with EM40 and EM52. EP40 was positively correlated with EP52, EM40 and EM52. Similarly, EP52 was positively correlated with EM40 and EM52. Finally, EM40 was highly correlated with EM52 (0.99±0.10).

LC line: Genetic correlation of BW20 was positive and high with BW40, EP40, EP52, EM40 and EM52 (Table 4). BW40 was positively correlated with EW28, EW40, EW52, EP52 and EM52. ASM was negatively correlated with EP40, EP52, EM40, EM52 and BW20. EW28 was positively correlated with EW40, EW52, EM40 and EM52. Similarly, EW40 was positively correlated with EW52 and negatively correlated with EP40 and EP52. EW52 was negatively correlated with EP40 and EP52. EP40 was positively correlated with EP52, EM40 and EM52. EM40 was positively correlated with EP52 and EM52. EP52 was positively correlated with EM52.

Phenotypic correlations among various traits in both lines were lesser in magnitude but followed almost similar trend as that of genetic correlations (Tables 3, 4). One of the important observations in this study was the finding of positive correlation of body weight at 20 weeks of age with egg production up to 40 and 52 weeks of age. This can be explained from the fact that better body weight at sexual maturity (16–20 weeks) helps in increasing the egg production by advancing the age at sexual maturity (Reddy *et al.* 2004, Vasu *et al.* 2004). Similar observations were

Table 3. Genetic (above diagonal) and phenotypic (below diagonal) correlations on sire component of variance in IWH line

Trait	ASM	BW20	BW40	EW28	EW40	EW52	EP40	EP52	EM40	EM52
ASM		-0.50±0.38	-0.57±0.48	-0.48±0.41	-0.61±0.55	-0.62±0.44	-0.75±0.28	-0.53±0.39	-0.92±0.34	-0.97±0.43
BW20	-0.28		0.73±0.19	0.70±0.22	0.67±0.26	0.63±0.21	0.33±0.24	0.24±0.31	0.56±0.20	0.74±0.22
BW40	-0.05	0.54		0.41±0.23	0.42±0.28	0.40±0.23	0.09±0.28*	-0.02±0.36*	0.20±0.27	0.29±0.32
EW28	0.12	0.18	0.23		0.84±0.15	0.76±0.12	0.17±0.22*	-0.03±0.27*	0.51±0.19	0.66±0.22
EW40	0.12	0.26	0.32	0.51		1.0±-0.11	0.07±0.28*	-0.30±0.33	0.47±0.23	0.68±0.27
EW52	0.04	0.30	0.29	0.51	0.67		0.12±0.23*	-0.30±0.27	0.58±0.19	0.63±0.19
EP40	-0.48	0.34	0.09	-0.06	-0.11	-0.08		0.99±0.07	0.91±0.05	0.96±0.11
EP52	-0.37	0.28	0.09	-0.02	-0.15	-0.16	0.86		0.78±0.13	0.54±0.23
EM40	-0.39	0.44	0.24	0.20	0.38	0.25	0.87	0.73		0.99±0.10
EM52	-0.30	0.44	0.27	0.30	0.29	0.49	0.70	0.78	0.80	

ASM, age at sexual maturity; BW, body weight; EW, egg weight; EP, egg production; EM, egg mass, *; non-significant.

Table 4. Genetic (above diagonal) and phenotypic (below diagonal) correlations on sire component of variance in layer control

Trait	ASM	BW20	BW40	EW28	EW40	EW52	EP40	EP52	EM40	EM52
ASM		-0.92±0.52	-0.10±0.49*	-0.23±0.30	0.21±0.29	0.22±0.32	-0.77±0.14	-0.60±0.21	-0.73±0.16	-0.58±0.24
BW20	-0.46		0.89±0.12	0.29±0.30	-0.21±0.30*	-0.29±0.31*	0.73±0.15	0.65±0.20	0.66±0.20	0.54±0.27
BW40	0.07	0.32		0.99±-0.10	0.81±0.15	0.58±0.33	0.27±0.48	0.31±0.46	0.71±0.25	0.63±0.32
EW28	0.07	0.15	0.23		0.72±0.13	0.80±0.11	0.05±0.31*	-0.06±0.31*	0.41±0.26	0.31±0.30
EW40	0.10	0.11	0.25	0.43		0.91±0.48	-0.42±0.25	-0.34±0.27	0.05±0.30*	0.08±0.32*
EW52	0.06	0.12	0.31	0.40	0.63		-0.46±0.30	-0.39±0.29	0.02±0.34*	0.06±0.36*
EP40	-0.54	0.47	0.01	-0.03	-0.16	-0.10		0.94±0.04	0.88±0.07	0.81±0.12
EP52	-0.35	0.34	0.02	-0.02	-0.16	-0.09	0.89		0.86±0.09	0.89±0.01
EM40	-0.49	0.50	0.17	0.14	0.22	0.15	0.92	0.81		0.96±0.03
EM52	-0.32	0.38	0.15	0.14	0.09	0.28	0.82	0.92	0.84	

ASM, age at sexual maturity; BW, body weight; EW, egg weight; EP, egg production; EM, egg mass, *; non-significant.

made by Bais *et al.* (1997) and Chatterjee *et al*. (2008) in IWH and control lines.

The present study concluded that despite the continuous selection for production traits, these lines differ for most of the production traits. Considerable additive genetic variation exists for many of the traits in IWH and LC lines and therefore IWH line could continue to be improved for production traits.

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