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INHERITANCE OF CHICK WEIGHT AND EGG PRODUCTION IN WHITE LEGHORN BIRDS

By

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "INHERITANCE OF CHICK WEIGHT AND EGG PRODUCTION IN WHITE LEGHORN BIRDS" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship, or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this thesis, entitled "INHERITANCE OF CHICK WEIGHT AND EGG PRODUCTION IN WHITE LEGHORN BIRDS" is a record of research work done independently by Smt. Rose Jobe,T. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to her.

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Dedicated

to

My Husband

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Rose. Jobe. T

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INTRODUCTION

India ranks eighth in the World in egg production. Poultry keeping as an organised industry or as one confined to the backyard has gained popularity due to its quick return in terms of production of eggs and meat as compared to other animal products.

The quality of the genetic material mainly decides the success of the industry. Selection is considered to be the best tool for genetic improvement and heritability an important factor for predicting the outcome. The knowledge of correlations among various traits is very essential in any breeding programme for obtaining the desired progress in the earliest possible time. Genetic correlation helps in the estimation of magnitude and direction of change likely to take place in a correlated trait or traits.

The ultimate aim of selective breeding of White Leghorn birds is improving egg production. Now-a-days selection for annual production based on part-period production is practised in order to reduce generation interval.

A positive relationship between egg production and chick weight if any, - as reported by certain workers - will be an aid in early selection of birds. Moreover, selection of males based on chick weight if possible, is also likely to improve the egg production potential. With this in view, to ascertain the genetic relationship between chick weight and egg production upto 280 days of age and also to estimate the inheritance of these traits the present study was undertaken.

Review of Literature

REVIEW OF LITERATURE

Heritability Estimates

The knowledge of heritability is important in the effective breeding plan for improving the economic traits through selection. The most important function of heritability in the genetic study is its predictive role, expressing the reliability of phenotypic value as a guide to the breeding value (Falconer, 1960).

Six-week body weight

Many investigators have estimated the heritability of body weight in chickens. But only a few reports are available on six-week body weight and the available ones also are mostly in breeds other than White Leghorns. Information available are given in Table-1. Most of the estimates found are around 0.3.

Eight-week body weight

Heritability estimates in different breeds are given in Table-2. The estimates are found to range between 0.06 and 0.94.

Hazel and Lamoreux (1947) found that five per cent of the variation in body weight was due to maternal effects. No evidence was found that sex-linked genes influenced body weight in White Leghorns.

Table - 1

Heritability estimates of six-week body weight

Investigator	Material	Amount of data	Method	Heritability estimate
Martin *et al.* (1953)	Rhode Island Red	24 sires 71 dams 1,238 chicks	S+D	0.29
Godfrey and Goodman (1955)	Silver Oklabar fowls	715 chicks	Realised heritability	0.26
Thomas *et al.* (1958)	New Hampshire	56 sires 218 dams 1,196 chicks	S D	0.50 (Male) 0.65 (Female) 0.83 (Male 1.02 (Female)
Ipe (1972)	Forsgate strain of White Leghorn	45 sires 303 dams 1026 chicks	b_{OD}	0.256 ± 0.086
Kumar and Acharya (1979)	Desi chicks	46 sires 2370 chicks	S + D	0.447
Chaudhary and Dev (1980)	Broiler type	88 sires 245 dams 2009 chicks	Average estimate	0.294

S = Paternal half-sib correlation

D = Maternal half-sib correlation

S+D = Full-sib correlation

b_{OD} = Intra-sire regression of offspring on dam.

Table - 2

Heritability estimates of eight-week body weight

Investigator	Material	Amount of data	Method	Heritability estimate
Dillard *et al.* (1953)	New Hampshire	5000 chicks	S + D	0.34
			bo_D	0.32
Hurry and Nordskog (1953)	New Hampshire Barred Rocks		S + D	0.33
Wyatt (1954)	9 breeds	159 sires 609 dams	b_{OD}	0.40 ± 0.15
		1960 chicks	S + D	0.46
Thomas *et al.* (1958)	New Hampshire	56 sires 218 dams	S	0.55 (Male 0.86 (Female)
		1196 chicks	D	0.86 (Male) 0.69 (Female)
Rico (1962)	Three strains of White Plymouth Rock			0.31
King *et al.* (1963)	White Leghorn	50 sires 250 dams 900 progeny per year 6 years data	S	0.29
VanVleck *et al.* (1963)	White Leghorn		S	0.22
			D	0.35

(contd......)

Table - 2 continued.

Investigator	Material	Amount of data	Method	Heritability estimate
Kinney and Shoffner (1967)	Broiler type	1,086 males 1,275 females	bo_D	0.37 (Male) 0.35 (Female)
Kinney *et al.* (1968)	White Leghorn		Average estimate	0.45
Enfield and Comstock (1969)		16,557 birds	S	0.27±0.09 (Male) 0.29±0.04 (Female)
Dev *et al.* (1969)	Three population of broiler stocks	35 sires 45 dams 400 chicks in each generation of five stocks	Realised heritability	0.29 0.21 0.26
Lien (1973)	White Plymouth Rock	1699 male chicks 2358 female chicks	D	0.39 (Male 0.31 (Female)
Han and Ohh (1975)	Three strains of White Leghorn	3121 chicks		0.64 0.24 0.59
Ali and Haque (1976)	New Hampshire		S D S + D	0.46 0.60 0.53
	Rhode Island Red		S D S + D	0.27 0.94 0.60

(contd.....)

Table 2 contd.....

Investigator	Material	Amount of data	Method	Heritability estimate
Gonzalez *et al.* (1978)	Broilers	12 - 27 broiler sire families each comprising of 300 - 945 progeny		0.20 - 0.59
Kumar *et al.* (1979)	White Plymouth Rock	30 sires 195 dams 751 chicks	S D	0.34 ± 0.14 0.30 ± 0.12
Patel and Rathnasabapathy (1979)	Meyer strain of White Leghorn	723 chicks	bo_D	0.06 ± 0.13
Kumar and Acharya (1979)	Desi chicks	46 sires 2370 chicks	S + D	0.465
Chaudhary and Dev (1980)	Broilers	2009 birds	Average estimate	0.276
Ayoub *et al.* (1980)	White Plymouth Rock, Light Sussex and their reciprocal crosses		S + D	0.42 (Male) 0.45 (Female)

(contd......)

Table 2 contd ....

Investigator	Material	Amount of data	Method	Heritability estimate
		First year		
Ahlawat *et al.* (1982)	Babcock strain of White Leghorn	20 sires 209 dams 566 birds		0.31 ± 0.15
		Second year		
		20 sires 207 dams 635 birds		0.19 ± 0.08

Kruegar (1952) found that both additive and non-additive gene effects influenced ten-week body weight. Garber and Godbey (1952) found that heritability of sire differences in gain was greatest from nine to twelve weeks of age and heritability of dam differences in gain was greatest from hatching to three weeks of age in White Leghorns.

Yao _et al_. (1959) reported that ten-week body weight showed a highly significant dominance effects in White Leghorns.

Non-additive gene effects were found to be very low in eight week body weight by Goodman and Jaap (1960) in New Hampshires.

Wersels (1963) reported that the presence of the dominant factor 'S' gene improved eight-week body weight in pullet chicks. Maternal effects were reported in eight-week body weight by King _et al_. (1963).

Orozco and Lobo (1964) could find that maternal and environmental effects accounted for 17 per cent and 59 per cent of the total variation in body weight at eight-week.

Abd - El - Gawad (1970) estimated 10.4 per cent maternal effects in male and 8.6 per cent sex-linked effects in females for eight-week body weight and found that additive genes were mainly responsible for the genetic variance in eight-week and twelve-week body weight.

Maternal effects on body weight were found until 16 weeks of age in a randombred flock of White Leghorns by Krishna and Chaudhary (1972).

Panda _et al_. (1976) expressed the view that the higher estimate from dam component indicated the presence of maternal effects and some amount of non-additive genetic variance.

Chaudhary and Dev (1980) reported that non-additive and sex-linked effects were important for body weight gain till eight weeks of age.

In almost all reports heritability estimate from dam component were found to be higher than from sire component. This indicates the possible importance of maternal effects and/or non-additive gene effects on early chick weight.

Part - period egg production

Many workers have reported estimates of heritability of part-period production in different breeds. In White Leghorns the estimates were found to be varying between 0.02 and 0.70 (Table - 3).

King and Henderson (1954) could find 2 to 8 per cent

Table - 3

Heritability estimates of part-period egg production

Investigator	Material	Amount of data	Method	Heritability estimate
Kinney *et al.* (1968)	White Leghorn		Literature summary	0.18
Jackunas and Stankevicene (1969)	White Leghorns 3 S lines			0.269 0.237 0.260
	3 K lines			0.303 0.381 0.302
Ipe (1972)	Forsgate strain of White Leghorns	40 sires 267 dams 912 pullets		0.278 ± 0.105
Chaudhary *et al.* (1975)	White Leghorn	39 sires 158 dams 330 pullets	S	0.304
Manickavel *et al.* (1975)	Meyer strain of White Leghorn	20 sires 100 dams 291 pullets		0.14 ± 0.16
Sivasamy *et al.* (1976)	Meyer strain of White Leghorn	20 sires 114 dams 232 pullets	S bo_D	0.11 ± 0.17 0.22 ± 0.11

(contd.......)

Table 3 contd.....

Investigator	Material	Amount of data	Method	Heritability estimate
Lal (1976)	White Leghorn	30 sires 6-7 dams 1359 pullets	Half-sib correlation	0.169 ± 0.03
Shukla *et al.* (1977)	White Leghorn	213 pullets		0.49
Liansawia (1977)	Mychix strain of White Leghorn	36 sires 270 dams 1562 pullets	S D S + D	0.40 ± 0.12 0.28 ± 0.07 0.34 ± 0.08
Johari *et al.* (1977)	White Leghorn	276 pullets		0.02 ± 0.06
Reddy (1977)	Four White Leghorn strains			0.36-0.76
Azimov (1978)	Three lines of White Leghorn		S	0.163 0.15 0.093
Mehta *et al.* (1978)	Two lines of White Leghorn	86 sires 2088 pullets	S	First year 0.34 0.38 Second year 0.32 0.38
Poggenpoel and Erasmus (1978)	White Leghorn		Realised heritability	0.14

(contd....)

Table 3 contd...

Investigator	Material	Amount of data	Method	Heritability estimate
Thangaraju *et al.* (1978)	Meyer strain of White Leghorn	19 cocks 317 pullets		0.56 ± 0.23
Balachandran *et al.* (1979)	Meyer strain of White Leghorn	19 cocks 115 dams 327 pullets	S D S + D	0.28 ± 0.17 0.34 ± 0.25 0.31 ± 0.14
Gill *et al.* (1979)	Two lines of White Leghorn			0.217 0.268
Patel and Rathnasabapathy (1979)	Meyer strain of White Leghorn	583 birds 12 sires, 87 dams 84 birds 7 sires, 47 dams		0.05
Cabaner and Abplanalp (1979)	UCD - 126 line of White Leghorn		b_{OD}	0.216
Kotaiah and Renganathan (1980)	White Leghorn	1137 birds	S	0.51
Singh (1980)	White Leghorn	28 sires 240 pullets	S	0.268
Ahlawat *et al.* (1982)	White Leghorn	First year 20 sires 209 dams 566 pullets		0.21 ± 0.11
		Second year 20 sires 207 dams 635 pullets		0.27 ± 0.09

of maternal effects for the production traits. Jerome *et al.* (1956) opined that an exceptionally high production of dominance variance existed in the trait of total egg production.

Yao *et al.* (1959) reported that egg production showed highly significant dominance effect and moderately significant additive effect.

Goodman and Jaap (1961) found that sex-linked genetic effects were important for egg production. King (1961) reported dominance effects and maternal effects (0.12) for per cent production upto 72 weeks.

VanVleck and Doolittle (1964) stressed the importance of maternal effects for egg production. Orozco and Lobo (1964) reported that maternal effects and environmental effects accounted for 10 per cent and 78 per cent respectively of the total variation in number of eggs produced by nine months of age.

Liannawia (1977) found sex-linked gene effects for egg production.

A maternal effect of 1.49 per cent was found in the trait of egg number by Balachandran *et al.* (1979).

Genetic, phenotypic and Environmental correlations among chick weights and with egg production

Panda *et al.* (1976) could observe a high genetic relationship between six and eight-week body weight (0.810 ± 0.073) and environmental correlation was found to be higher than genetic correlation. The phenotypic correlation was found to be 0.764 ± 0.015 in White Cornish. Chaudhary and Dev (1980) also reported that body weight at six-week was highly genetically correlated with eight-week body weight (0.991).

The genetic correlation of six-week body weight with egg production was found to be 0.595 ± 0.163 by Ipe (1972) in White Leghorn birds, and phenotypic correlation 0.307 and environmental correlation 0.252.

Dillard *et al.* (1953) reported a genetic correlation of -0.17 to -0.20 between egg production and eight-week body weight in broilers. Siegel (1963) obtained a phenotypic correlation of -0.12 to 0.16 and a genetic correlation of -0.01 to -0.71 between eight-week body weight and egg production to January 1st in White Plymouth Rocks. Orozco and Lobo (1964) found a genetic correlation of -1.33, 0.04 and -0.23 between eight-week and nine months egg production on the basis of sire, dam and sire + dam components of variance respectively in White Rocks. Orozco and Rabanal (1970) found the genetic correlation between eight-week body weight and nine months egg production as 0.18 and -0.09 in the lines WR_7 and WR_8 in a strain of White Plymouth Rock. Doornenbal _et al._ (1970) could find a significant decrease in body weight when selection for increased part record egg production was carried out. Kaats (1972) found that the genetic correlation between body weight at eight-weeks of age and egg production to 350 and 450 days of age was very low in broilers. Singh _et al._ (1979) reported that egg production at 40 weeks of age and sexual dimorphism at eight-week of age are genetically correlated by -0.23 ± 0.04. Ahlawat _et al._ (1980) observed that 90-day egg production was significantly correlated genetically with body weight at twelve weeks of age (0.44) in White Leghorns.

In general, it could be seen that chick weights at six-week and eight-week had high genetic correlation. Correlation between chick weight and egg production was found to be low in meat type birds and medium in White Leghorns.

Materials and Methods

MATERIALS AND METHODS

The data were collected from All India Co-ordinated Research Project (A.I.C.R.P.) on Poultry for Eggs attached to the College of Veterinary and Animal Sciences, Mannuthy. Two strains of White Leghorn birds viz., N and P brought from A.I.C.R.P. on Poultry for Eggs, Hyderabad are maintained in this centre.

The selection of birds is done using Osborne's index taking into account the number of eggs produced upto 280 days of age. To a certain extent egg weight is also considered for selection. For selection of cockrels, dam and sire family averages are taken. In every generation 1500 pullets and 480 cockrels of each strain reproduced out of 40 selected sires and 240 selected dams are maintained. Hens are allotted at the rate of six per cock. Six female and two male chicks are kept from each hen for the next generation.

The chicks are pedigree-hatched. They are transferred from the brooder house to the grower by five to six weeks of age and from there to individual cages at 16 weeks of age. The birds are provided with optimum feeding and managemental conditions.

The observations were made on body weight at six weeks of age, eight weeks of age and egg production upto 280 days of age. Body weights were taken on the day of completion of that age. Data used in this study belonged to three generations consisting of 14 hatches of N strain and 13 hatches of P strain. Number of sires, dams and progenies in N and P strains used for the analysis is given in Table - 4.

Mean, Standard error and coefficient of variation were obtained for the three characters, for the two strains separately by methods given by Snedecor and Cochran (1967). Generation and hatch effects were studied by Least squares analysis for non-orthogonal data using the technique described by Harvey (1966).

The model used was

$$Y_{ijk} = \mu + G_i + h_{ij} + e_{ijk}$$

where Y_{ijk} = Observation on the k^{th} individual of the j^{th} hatch of i^{th} generation.

μ - Population mean when each sub-class members exist.

G_i - Effect of the i^{th} generation.

h_{ij} - Effect of the j^{th} hatch within i^{th} generation.

e_{ijk} - Random error N $(0, \sigma_e^2)$.

The restriction $\sum_i G_i = \sum_j h_{ij} = 0$ was imposed and Least Squares constants for generation and within generation hatch effects were estimated. The significance of the generation

Table - 4

Distribution of sires, dams and progenies of White Leghorns included in the study.

	N Strain			P Strain		
Characters	Sires	Dams	Progenies	Sires	Dams	Progenies
Six-week body weight	120	500	1930	80	360	1423
Eight-week body weight	121	573	2303	96	418	1577
Egg production upto 280 days of age	81	352	1596	79	298	1184

effects and hatch effects were tested by 'F' test. Least Squares constants developed were used to adjust the data.

$$Y'_{ijk} = Y_{ijk} - G_i - h_{ij}$$

where Y'_{ijk} = The adjusted observation.

Estimation of heritability

The model used for the estimation of heritability (Becker, 1975) was $Y_{ijk} = \mu + S_i + d_{ij} + e_{ijk}$

where Y_{ijk} = Observation of the k^{th} progeny of the j^{th} dam mated to the i^{th} sire.

μ = Common mean.

S_i = Effect of the i^{th} sire

d_{ij} = Effect of the j^{th} dam mated to the i^{th} sire.

e_{ijk} = Uncontrolled environmental and genetic deviations attributed to the individual.

All effects are random, normal and independent with expectations equal to zero.

Analysis of variance

Source	d.f.	S.S.	M.S.S.	E.M.S.
Between sires	S-1	SS_S	MS_S	$\sigma^2_W + K_2\sigma^2_D + K_3\sigma^2_S$
Between dams within sires	D-S	SS_D	MS_D	$\sigma^2_W + K_1\sigma^2_D$
Between progeny within dams	$n_{..}$-S	SS_W	MS_W	σ^2_W

S = Number of sires
D = Total number of Dams

$n_{..}$ = Total number of progeny

SS_S, SS_D, SS_W are the sum of squares due to sire, dam and progeny respectively and MS_S, MS_D, MS_W are the concerned mean sum of squares.

K_1 = Number of dams per sire

$$= \left\{ \left(n_{..} - \Sigma_i \frac{\Sigma_j \; ni^2 j}{n_i.} \right) \right\} / \text{d.f. (dams)}$$

K_2 = Number of progeny per dam

$$= \left\{ \Sigma_i \frac{\Sigma_j \; ni^2 j}{ni.} - \frac{\Sigma_i \; \Sigma_j \; ni^2 j}{n_{..}} \right\} / \text{d.f. (sire)}$$

K_3 = Number of progeny per sire

$$= \left\{ n_{..} - \frac{\Sigma_i \; ni.^2}{n_{..}} \right\} / \text{d.f. (sire)}$$

where

n_{ij} = Number of progeny per dam

$ni.$ = Number of progeny per sire

σ^2_W = Variance among progeny, within dams within sires.

= MS_W

σ^2_D = Dam component of variance

$$= \frac{MS_D - MS_W}{K_1}$$

σ^2_S = Sire component of variance

$$= \frac{MS_S - MS_W - K_2 \sigma^2_D}{K_3}$$

The heritabilities were then estimated by the formulae

$$h^2_S = \frac{4 \sigma^2_S}{\sigma^2_S + \sigma^2_D + \sigma^2_W}$$

$$h^2_D = \frac{4\,\sigma^2_D}{\sigma^2_S + \sigma^2_D + \sigma^2_W}$$

$$h^2_{S+D} = \frac{2\left\{\sigma^2_S + \sigma^2_D\right\}}{\sigma^2_S + \sigma^2_D + \sigma^2_W}$$

The standard errors of heritabilities were estimated from sire and dam components of variance.

$$\mathrm{Var}\,(\sigma^2 S) = \frac{2}{K_3^2}\left\{\frac{MS_S^2}{d.f_{(s)} + 2} + \frac{MS_D^2}{d.f_{(D)} + 2}\right\}$$

$$S.E.\,(\sigma^2_S) = \sqrt{\widehat{\mathrm{Var}}\,(\sigma^2 S)}$$

$$S.E.\,(h^2_s) = \frac{4 \times S.E.\,(\sigma^2 S)}{\sigma^2 S + \sigma^2 D + \sigma^2 W}$$

$$\mathrm{Var}\,(\sigma^2 D) = \frac{2}{K_2^2}\left\{\frac{MS_D^2}{d.f_{(D)} + 2} + \frac{MS^2_W}{d.f_{(W)} + 2}\right\}$$

$$S.E.\,(\sigma^2_D) = \sqrt{\widehat{\mathrm{Var}}\,(\sigma^2 D)}$$

$$S.E\,(h^2 D) = \frac{4 \times S.E\,(\sigma^2 D)}{\sigma^2 S + \sigma^2 D + \sigma^2 W}$$

$$\mathrm{Var}\,(\sigma^2 W) = \frac{2\,(MS_W)^2}{d.f_{(W)} + 2}$$

$$\mathrm{Cov}\,(\sigma^2 S\,\sigma^2 D) = \mathrm{Var}(\sigma^2 W) - \frac{K_1^2\,\mathrm{Var}\,(\sigma^2 D)}{K_1 K_3}$$

$$S.E\,(h^2_{S+D}) = \frac{2\sqrt{\mathrm{Var}\,(\sigma^2 S) + \mathrm{Var}\,(\sigma^2 D) + 2\,\mathrm{Cov}\,(\sigma^2 S\,\sigma^2 D)}}{\sigma^2_S + \sigma^2_D + \sigma^2_W}$$

Estimation of correlations

The analysis of variance models and procedures for X and Y (two characters considered at one time) are the same as given for the estimation of heritability. The variance components $\sigma^2_{S(X)}$, $\sigma^2_{S(Y)}$, $\sigma^2_{D(X)}$, $\sigma^2_{D(Y)}$, $\sigma^2_{W(X)}$ and $\sigma^2_{W(Y)}$ are obtained as before.

Analysis of Co-variance

Source	d.f.	S.C.P.	M.S.C.P.	E.M.C.P.
Between sires	S-1	SCP_S	MCP_S	$Cov_W+K_2Cov_D+K_3Cov_S$
Between dams within sires	D-S	SCP_D	MCP_D	$Cov_W+K_1Cov_D$
Between progeny within dams	$n_{..}$ - D	SCP_W	MCP_W	Cov_W

K_1, K_2 and K_3 are estimated as in the case of analysis of variance.

Genetic correlations were estimated by the formulae:

1. $$r_{GS} = \frac{4\,Cov_S}{\sqrt{4\sigma^2_{S(X)}\;4\sigma^2_{S(Y)}}}$$

2. $$r_{GD} = \frac{4\,Cov_D}{\sqrt{4\sigma^2_{D(X)}\;4\sigma^2_{D(Y)}}}$$

3. $$r_{G(S+D)} = \frac{Cov_S + Cov_D}{\sqrt{\sigma^2_{S(X)} + \sigma^2_{D(X)}}\;\sqrt{\sigma^2_{S(Y)} + \sigma^2_{D(Y)}}}$$

Environmental correlations

$$1.\ r_{ES} = \frac{Cov_W - 2\ Cov_S}{\sqrt{\sigma^2_{W(X)} - 2\ \sigma^2_{S(X)}}\ \sqrt{\sigma^2_{W(Y)} - 2\ \sigma^2_{S(Y)}}}$$

$$2.\ r_{ED} = \frac{Cov_W - 2\ Cov_D}{\sqrt{\sigma^2_{W(X)} - 2\ \sigma^2_{D(X)}}\ \sqrt{\sigma^2_{W(Y)} - 2\ \sigma^2_{D(Y)}}}$$

$$3.\ r_{E(S+D)} = \frac{Cov_W - Cov_S - Cov_D}{\sqrt{\sigma^2_{W(X)} - \sigma^2_{S(X)} - \sigma^2_{D(X)}(\sigma^2_{W(Y)} - \sigma^2_{S(Y)} - \sigma^2_{D(Y)}}}$$

Phenotypic correlation

$$r_P = \frac{Cov_W + Cov_S + Cov_D}{\sqrt{\sigma^2_{W(X)} + \sigma^2_{S(X)} + \sigma^2_{D(X)}}\ \sqrt{\sigma^2_{W(Y)} + \sigma^2_{S(Y)} + \sigma^2_{D(Y)}}}$$

Cov_S	=	Sire component of covariance.
Cov_D	=	Dam component of covariance.
Cov_W	=	Covariance among progeny within dams within sires.

Results

RESULTS

The mean, standard error and coefficient of variation of six-week body weight, eight-week body weight and egg production upto 280 days of age in N and P strains are presented in Table-5. The mean values for six-week body weight (g), eight-week body weight (g) and egg production upto 280 days of age (number) were found to be 319.4 ± 1.4, 452.9 ± 1.8, 71.5 ± 0.4 for N strain and 351.2 ± 1.7, 513.7 ± 2.2, 80.6 ± 0.5 for P strain.

Least squares analysis of variance for generation effect and effect of hatches within generation in N and P strains are given in Tables-6, 7 and 8.

For six-week body weight, generation effect was significant. Hatches within generation were found to be significant for first and third generation and non-significant for second generation. Same was the case with P strain also, except that first generation had only one hatch and hence no hatch effect was worked out.

For eight-week body weight, generations had significant effects. Hatches within generation were found to be significant for all the three generations in N strain and two generations in P strain. In P strain first generation had only one hatch and hence no hatch effect was worked out.

Table - 5

Mean, Standard error and Coefficient of variation of Six-week body weight, Eight-week body weight and Egg production upto 280 days of age in White Leghorns.

	N strain		P strain	
Character	Mean	C.V.	Mean	C.V.
Six-week body weight (g)	319.4 ± 1.4	19.4	351.2 ± 1.7	19.4
Eight-week body weight (g)	452.9 ± 1.8	20.0	513.7 ± 2.2	17.5
Egg production upto 280 days of age	71.5 ± 0.4	18.2	80.6 ± 0.5	17.8

Table - 6

Least squares analysis of variance for Six-week body weight in White Leghorns.

	N strain			P strain		
Source	d.f.	S.S.	M.S.	d.f.	S.S.	M.S.
Between generations	2	1212115.3	606057.7**	2	1747161.5	873580.7**
Between hatches within first generation	2	255287.6	127543.8**	-	-	-
Between hatches within second generation	1	7542.9	7542.9	1	16857.6	16857.6
Between hatches within third generation	3	804213.6	268071.2**	3	1287116.2	429038.7**
Error	2067	10680300.5	5167.1	1605	12006623.4	7480.8

** Significant $P < 0.01$.

Table -7

Least squares analysis of variance for Eight-week body weight in White Leghorns.

	N strain			P strain		
Source	d.f.	S.S.	M.S.	d.f.	S.S.	M.S.
Between generations	2	5608209.2	280414.6**	2	3127676.1	1563838.1**
Between hatches within first generation	2	198568.7	99284.3**	-	-	-
Between hatches within second generation	3	798697.7	266232.6**	2	279712.9	139856.4**
Between hatches within third generation	3	1298594.3	432864.8**	3	3212824.6	1070941.5**
Error	2406	11920706.6	4954.6	1717	8404664.9	4895

Table - 8

Least squares analysis of variance for Egg production upto 280 days of age in White Leghorns.

Source	N strain d.f.	N strain S.S.	N strain M.S.	P strain d.f.	P strain S.S.	P strain M.S.
Between generations	1	82608.2	82608.2**	1	50801.2	50801.2**
Between hatches within first generation	3	1823.7	607.9	2	11892.5	5946.3**
Between hatches within second generation	5	26209.0	5241.8**	5	40734.3	8146.9**
Error	1804	466578.7	258.6	1284	307063.1	239.1

** Significant P $\angle$ 0.01.

For egg production upto 280 days of age also, generations had significant effects. In the first generation, hatches were found to be significant for P strain and non-significant for N strain. In the second generation, hatches were significant in both the strains.

Least squares constants for generations are presented in Table-9 for six-week body weight, eight-week body weight and egg production upto 280 days of age in N and P strains.

For six-week body weight, Least squares constants for generations were -38.38, 1.95 and 36.43 in N strain. The constants for P strain were -67.10, 3.87 and 63.23. For eight-week body weight, the constants were -47.70, -18.32 and 66.02 for N strain and -59.63, -10.41 and 70.04 for P strain. The constants obtained for egg production were -8.4 and 8.4 for N strain and -8.57 and 8.57 for P strain.

The Least squares constants for hatches within generations are presented in Tables-10, 11 and 12. In N strain for six-week body weight, the constants obtained for hatches in first generation were 35.08, 13.44 and -48.52. In P strain, generation one had only one hatch and hence no constant. The constants in N strain for eight-week body weight were 19.69, 3.67 and -23.36. In P strain, generation

Table - 9

Least squares constants for Six-week body weight, Eight-week body weight and Egg production upto 280 days of age for generations in White Leghorns.

	N strain				P strain			
Character	μ	G1	G2	G3	μ	G1	G2	G3
Six-week body weight	310.47	-38.38	1.95	36.43	316.03	-67.10	3.87	63.23
Eight-week body weight	444.10	-47.70	-18.32	66.02	485.78	-59.63	-10.41	70.04
Egg production upto 280 days of age	68.21	-8.4	8.4	-	75.47	-8.57	8.57	-

Table - 10

Least squares constants for six-week body weight, Eight-week body weight and Egg production upto 280 days of age for first generation hatches in White Leghorns.

	N strain				P strain		
Character	H_1	H_2	H_3	H_4	H_1	H_2	H_3
Six-week body weight	35.08	13.44	-	-48.52	-	-	-
Eight-week body weight	19.69	3.67	-23.36	-	-	-	-
Egg production upto 280 days of age	-2.35	-0.04	2.25	0.14	7.70	-6.14	-1.56

Table - 11

Least squares constants for six-week body weight, Eight-week body weight and Egg production upto 280 days of age for second generation hatches in White Leghorns

	N strain						P strain					
	H_5	H_6	H_7	H_8	H_9	H_{10}	H_4	H_5	H_6	H_7	H_8	H_9
Six-week body weight	-	-2.75	2.75	-	-	-	-7.2	7.2	-	-	-	-
Eight-week body weight	-33.66	26.81	35.17	-28.32	-	-	0.22	34.45	-34.67	-	-	-
Egg production upto 280 days of age	-2.30	2.25	4.50	3.71	0.24	-8.40	8.00	6.03	3.85	0.82	-3.66	-15.04

Table - 12

Least squares constants for Six-week body weight and Eight week body weight for third generation hatches in White Leghorns.

	N strain				P strain			
Character	H_{11}	H_{12}	H_{13}	H_{14}	H_{10}	H_{11}	H_{12}	H_{13}
Six-week body weight	37.62	-0.17	0.14	-37.59	37.26	21.57	-5.85	-52.98
Eight-week body weight	36.71	3.20	20.24	-60.15	55.97	33.30	-4.93	-84.34

one had only one hatch as in the case of six-week body weight and hence no constant. For egg production the constants were -2.35, -0.04, 2.25 and 0.14 for N strain and 7.70, -6.14 and -1.56 for P strain. For six-week body weight in second generation the constants for hatches were -2.75 and 2.75 for N strain and -7.2 and 7.2 for P strain. The constants for eight-week body weight were -33.66, 26.81, 35.17 and -28.32 in N strain and 0.22, 34.45 and -34.67 in P strain. For egg production the constants obtained were -2.30, 2.25, 4.50, 3.71, 0.24 and -8.40 for N strain and 8.0, 6.03, 3.85, 0.82, -3.66 and -15.04 for P strain.

For hatches in third generation, the constants obtained for six-week body weight were 37.62, -0.17, 0.14 and -37.59 for N strain and 37.26, 21.57, -5.85 and -52.98 for P strain. The constants obtained for eight-week body weight were 36.71, 3.20, 20.24 and -60.15 for N strain and 55.97, 33.30, -4.93 and -84.34 for P strain. For egg production, data were not available for third generation in both the strains.

The data were adjusted for generation effect and hatches within generation effect. The mean, standard error and coefficient of variation of six-week body weight,

eight-week body weight and egg production upto 280 days of age in N and P strains based on the adjusted data are presented in Table-13. The adjusted mean value for six-week body weight (g), eight-week body weight (g) and egg production (number) were found to be 309.4 ± 1.1, 444.1 ± 1.4, 68.2 ± 0.4 for N strain and 314.8 ± 1.4, 485.8 ± 1.7, 75.5 ± 0.4 for P strain.

Heritability estimates

The analysis of variance in the heritability estimates for six-week body weight, eight-week body weight and egg production upto 280 days of age in N and P strains are presented in tables 14, 15 and 16.

The heritability estimates for six-week body weight were 0.223 ± 0.112, 0.642 ± 0.078 and 0.433 ± 0.099 for N strain and 0.405 ± 0.110, 0.341 ± 0.103 and 0.373 ± 0.101 for P strain based on sire, dam and sire + dam components of variance respectively. The estimates for eight-week body weight were 0.278 ± 0.108, 0.372 ± 0.068 and 0.325 ± 0.095 for N strain and 0.354 ± 0.110, 0.443 ± 0.094, 0.398 ± 0.118 for P strain based on sire, dam and sire + dam components of variance. For egg production upto 280 days of age, the estimates were 0.219 ± 0.095, 0.379 ± 0.077 and 0.298 ±0.104 for N strain and 0.530 ± 0.102, 0.230 ± 0.130 and 0.380±0.131

Table - 13

Adjusted mean, standard error and Coefficient of variation of Six-week body weight, Eight-week body weight and Egg production upto 280 days of age in White Leghorns

	N strain		P strain	
Character	Mean	C.V.	Mean	C.V.
Six-week body weight (g)	309.4±1.1	16.9	314.8±1.4	17.2
Eight-week body weight (g)	444.1±1.4	15.9	485.8±1.7	14.4
Egg production upto 280 days of age (number)	68.2±0.4	23.5	75.5±0.4	20.4

Table - 14

Analysis of variance in the heritability estimates for Six-week body weight in White Leghorns.

	N strain			P strain		
Source	d.f.	S.S.	M.S.	d.f.	S.S.	M.S.
Between sires	119	754965	6344.2	79	688905	8720.3
Between dams within sires	345	1330893	3857.7	235	807727	3437.1
Between progeny within dams	1465	3160982	2157.7	1108	2686043	2424.2
h^2_S		0.223 ± 0.112			0.405 ± 0.110	
h^2_D		0.642 ± 0.078			0.341 ± 0.103	
$h^2_{(S+D)}$		0.433 ± 0.099			0.373 ± 0.101	

Table 15

Analysis of variance in the heritability estimates for Eight-week body weight in White Leghorns

	N strain			P strain		
Source	d.f.	S.S.	M.S.	d.f.	S.S.	M.S.
Between sires	120	1538566	12821.4	95	1230954	12957.4
Between dams within sires	393	2336896	5946.3	271	1609068	5937.5
Between progeny within dams	1789	7438807	4158.1	1210	4719713	3900.6
h^2_S		0.278 ± 0.108			0.354 ± 0.110	
h^2_D		0.372 ± 0.068			0.443 ± 0.094	
$h^2_{S+D)}$		0.325 ± 0.095			0.398 ± 0.118	

Table - 16

Analysis of variance in the heritability estimates for Egg production upto 280 days of age in White Leghorns.

Source	N strain d.f.	N strain S.S.	N strain M.S.	P strain d.f.	P strain S.S.	P strain M.S.
Between sires	80	51837	648	78	55007	705.2
Between dams within sires	224	75365	336.5	211	50740	240.5
Between progeny within dams	1421	312352	219.8	894	168534	188.5
h^2_S		0.219 ± 0.095			0.530 ± 0.102	
h^2_D		0.379 ± 0.077			0.230 ± 0.130	
$h^2_{(S+D)}$		0.298 ± 0.104			0.380 ± 0.131	

for P strain based on sire, dam and sire + dam components of variance respectively.

Correlation estimates

Analysis of covariance in the estimation of correlations between six-week body weight and eight-week body weight, six-week body weight and egg production, eight-week body weight and egg prodution in N and P strains are presented in Tables-17, 18 and 19.

The genetic correlation estimates between six-week body weight and eight-week body weight were found to be 1.105, 0.997 and 1.016 for N strain and 1.005, 0.995 and 0.995 for P strain based on sire, dam and sire + dam components of variance. The environmental correlation estimates were 0.597, 0.633 and 0.615 for N strain and 0.612, 0.615 and 0.613 for P strain based on sire, dam and sire + dam components of variance. The phenotypic correlation estimates were found to be 0.762 and 0.760 for N and P strains respectively.

The genetic correlation estimates between six-week body weight and egg production upto 280 days of age were -0.096, 0.377 and 0.230 for N strain and 0.468, -0.462 and 0.116 for P strain based on sire, dam and sire + dam components of variance. The environmental correlation estimates were 0.142,

Table - 17

Analysis of covariance in the estimation of correlations between Six-week body weight and Eight-week body weight in White Leghorns.

	N strain			P strain		
Source	d.f.	S.C.P.	M.S.C.P.	d.f.	S.C.P.	M.S.C.P.
Between sires	117	811820	6938.6	70	704230	10060.4
Between dams within sires	301	1091911	3627.6	228	812813	3565.0
Between progeny within dams	1101	2325161	2111.9	980	2122768	2166.1
r_{GS}	1.105			1.005		
r_{GD}	0.997			0.995		
$r_{G(S+D)}$	1.016			0.995		
r_{ES}	0.597			0.612		
r_{ED}	0.633			0.615		
$r_{E(S+D)}$	0.615			0.613		
r_P	0.762			0.760		

Table - 18

Analysis of covariance in the estimation of correlation between Six-week body weight and Egg production upto 280 days of age in White Leghorns.

	N strain			P strain		
Source	d.f.	S.C.P.	M.S.C.P.	d.f.	S.C.P.	M.S.C.P.
Between sires	68	10722	157.7	32	9545	298.3
Between dams within sires	127	23628	186.0	54	-1329	-24.6
Between progeny within dams	379	28689	75.7	150	7458	49.7
r_{GS}	-0.096			0.468		
r_{GD}	0.377			-0.462		
$r_{G(S+D)}$	0.230			0.116		
r_{ES}	0.142			-0.085		
r_{ED}	-0.006			0.186		
$r_{E(S+D)}$	0.077			0.061		
r_P	0.131			0.082		

Table - 19

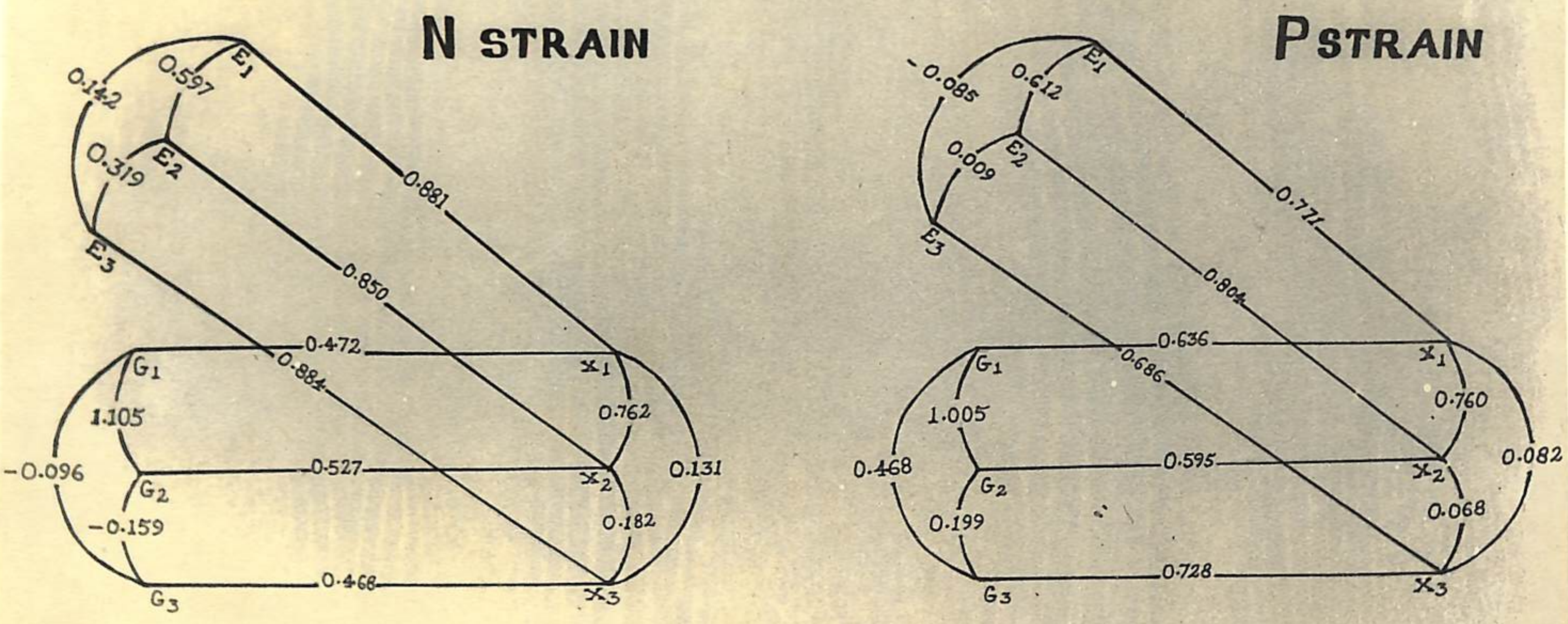
Analysis of covariance in the estimation of correlations between Eight-week body weight and Egg production upto 280 days of age in White Leghorns.

	N strain			P strain		
Source	d.f.	S.C.P.	M.S.C.P.	d.f.	S.C.P.	M.S.C.P.
Between sires	76	2834	37.3	50	11214	224.3
Between dams within sires	208	41994	201.9	89	4081	45.9
Between progeny within dams	759	170522	224.7	259	13493	52.1
r_{GS}	-0.159			0.199		
r_{GD}	-0.059			-0.026		
$r_{G(S+D)}$	-0.099			0.100		
r_{ES}	0.319			0.009		
r_{ED}	0.303			0.084		
$r_{E(S+D)}$	0.311			0.048		
r_P	0.182			0.068		

-0.006 and 0.077 for N strain and -0.085, 0.186 and 0.061 for P strain based on sire, dam and sire + dam components of variance. The phenotypic correlation estimates were found to be 0.131 and 0.082 for N and P strains respectively.

The genetic correlation estimates between eight-week body weight and egg production upto 280 days of age were -0.159, -0.059 and -0.099, in N strain and 0.199, -0.026 and 0.100 for P strain respectively. The environmental correlation estimates were 0.319, 0.303 and 0.311 for N strain and 0.009, 0.084 and 0.048 for P strain based on sire, dam and sire + dam components of variance respectively. The phenotypic correlation estimates were found to be 0.182 and 0.068 for N and P strains respectively.

PATH COEFFICIENT DIAGRAM



X_1 - SIX-WEEK BODY WEIGHT

X_2 - EIGHT-WEEK BODY WEIGHT

X_3 - EGG PRODUCTION UPTO 280 DAYS OF AGE

Discussion

DISCUSSION

Mean values for six-week body weight, eight-week body weight and egg production upto 280 days of age were found to be higher in P strain compared to N strain. 't' test revealed that the differences between strains were significant ($P < .01$) for all the three characters. The average age at first egg of these N and P strains of birds were reported to be 162 and 166 days by Joseph (1982), the difference between strains being four days. In the case of egg production the difference in egg number was 9.1. Hence only a portion of the superiority of the P strain in egg production can be attributed to early maturity and the major difference in egg production should be thought to be due to difference in persistency. Coefficient of variation was found to be same in both the strains for six-week body weight. For egg production upto 280 days of age, only a small difference was seen between the two strains. In the case of eight-week body weight, coefficient of variation was considerably more in N strain ie. 20 per cent as against 17.5.

Least Squares analysis of variance revealed significant generation effect for all the three characters in both the strains. The generation differences can be thought to be due to environmental changes, viz., in weather and also due to management. Eventhough every efforts have been taken to keep the management constant over generations, differences in availability of various feed ingredients and other managemental factors might be responsible for this variation.

For six-week body weight, hatches within first generation and third generation had significant effects for N strain. Second generation which had only two hatches did not show any significant hatch effects. In P strain, third generation hatches had significant effects and second generation did not have any significant effect as in N strain. First generation had only one hatch and hence no hatch effect was estimated in P strain.

For eight-week body weight, hatches showed significant effects in all the three generations in N strain. In the same strain for six-week body weight, hatches in the second generation had not shown significant effects. In the second generation, number of hatches for six-week body weight had been only two (H_6 and H_7) and for eight-week body weight, the number had been four (H_5, H_6, H_7 and H_8). The inclusion of hatches of H_5 and H_8 for eight-week body weight, might have resulted in the significance of hatch effects in the second generation. In P strain third generation had significant effects. First generation had only one hatch and no effect could be estimated. Second generation showed significant hatch effects in N strain. In the same P strain, six-week body weight did not have significant hatch effects for second generation. The difference can be attributed to the difference in the number of hatches for the two characters. For eight-week body weight, a third hatch with one week difference was also available for the study.

In N strain, egg production upto 280 days of age had significant hatch effect for second generation. Hatch effects were not significant for first generation. In P strain, both the generations had significant hatch effects. The first generation hatch number in N strain had been four (H_1, H_2, H_3 and H_4) and in P strain, the number of hatches had been three (H_1, H_2 and H_3). The hatches in both the strains had not been simultaneous. That may be the reason for the different hatch effects.

The hatch effects whenever significant can possibly be attributed to the environmental difference for the different hatches ie. incubator conditions, weather changes and the micro-environmental differences between hatches. Significant hatch effects had been reported for production traits by Babu *et al.* (1974) in White Leghorns, for eight-week body weight by Singh and Singh (1979) in White Cornish, and by Ahlawat and Chaudhary (1981) for production traits and body weight in White Leghorns.

A close look on the Least squares constants showed that first generation had negative constants for six-week body weight, eight-week body weight, and egg production upto 280 days of age for both the strains. Second generation had constants positive for six-week body weight and egg production upto 280 days of age and higher constant though negative for eight-week body weight also in N strain. Same was the case with P strain, though the magnitude of the constants had been slightly different. Third generation constants for six-week body weight and eight-week body weight had been positive for both the strains and for egg production, third generation data were not available for the study.

For six-week body weight, the constants for hatches ranged from -48.52 to + 37.62 in N strain and -52.98 to + 47.26 in P strain. For eight-week body weight in N strain, the range had been from -60.15 to + 36.71 and in P strain -84.34 to + 55.97. For egg production, -8.40 to 4.50 in N strain and -15.04 to + 8.0 in P strain. The variation between constants for hatches within generation had been more compared to that between constants for generations.

The data were then adjusted using the Least Squares constants derived. Adjusted means when compared with raw means were lower in both the strains for all the three characters. For six-week body weight in third generation, the number of observations had been 1231 and 1212 out of 2077 and 1612 for N and P strains respectively. Constants for third generation had been positive and high compared to first and second generations. In the case of eight-week body weight the adjusted and raw mean differences had been more in P strain compared to N strain. The third generation constants had been positive for this character in both the strains. But for N strain the distribution of the number of observations had been more uniform over generations compared to P strain, which had about 68 per cent observations in third generation. For egg production, of the data available for two generations, second generation had more number of observations and positive constants in both the strains, bringing in a reduction of the adjusted mean. The lowering of the means by adjustment is due to the higher proportion of the number of observation and also the high and positive constants for six-week and eight-week body weight in the third generation and for egg production in the second generation.

Heritability estimates

Six-week body weight

In N strain, heritability estimate by dam component of

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variance 0.642 had been much higher than the estimate of 0.223 by sire component of variance. But in P strain, heritability by sire component (0.405) had been slightly higher than that by dam component (0.341). In N strain the higher heritability by dam component compared to that by sire component could be thought to be due to maternal influence and/or non-additive gene effects. But in P strain, this does not hold good as the difference in estimates of heritability by sire and dam components did not show much difference. The effects of the residual environmental variation including variation due to dominance and epistasis had been reported by Kruegar (1952) from six to nine weeks of age and maternal effects on body weight until 16 weeks of age by Krishna and Chaudhary (1972) in White Leghorns. Comparison of heritability in the strains revealed a higher estimate in P strain by sire component. Reverse was true for the estimate by dam component. So naturally heritability by sire + dam component did not show any much difference.

The heritability estimate 0.223 by sire component of variance in N strain was found similar to 0.256 reported by Ipe (1972) in White Leghorns but other estimates in this study were higher.

Eight-week body weight

In N strain, eight week body weight had higher estimate of heritability by sire component, as in six-week body weight. But in the case of eight-week body weight the difference between the two had been lesser . In this strain heritability by sire component for eight week body weight had been higher compared to six-week body weight. But heritability by dam component was less for this character compared to six-week body weight. It gives an indication that probably maternal influence is less on eight-week body weight compared to six-week body weight. Maternal effects on eight-week body weight had been reported by King et al. (1963) in White Leghorns, Orozco and Lobo (1964) in White Rock and by Abd-El-Gawad (1970). In P strain heritability by dam component increased slightly and that by sire component decreased to a small extent compared to six-week body weight. In P strain eight-week body weight had the sire component of heritability higher compared to N strain, similar to the finding in six-week body weight even though the strain differences appeared to be less for eight-week body weight. The heritability estimates for the two strains by the different methods were somewhat in accordance with the estimates of 0.29 by King et al. (1963) by sire component of variance, 0.35 by VanVleck et al. (1963) by dam component of variance, 0.45 average estimate reported by Kinney et al. (1968), 0.31

by Ahlawat *et al.* (1982) in White Leghorns. But much higher than the estimate of 0.06 estimated by regression of daughter on dam by Patel and Rathnasabapathy (1979) in White Leghorns.

Egg production upto 280 days of age

In N strain, egg production had higher estimate of heritability by dam component which may be due to the maternal influence and/or non-additive gene effects. Maternal effects on egg production have been reported by King and Henderson (1954), King (1961), VanVleck and Doolittle (1964), Orozco and Lobo (1964) and by Balachandran *et al.* (1979). Non-additive gene effects on egg production have been reported by Jerome *et al.* (1956), Yao *et al.* (1959) and King (1961).

In P strain, heritability by sire component had been higher. It is possible that sex-linked variance plays a part in the inheritance of egg production in P strain. Sex-linked genetic effects on egg production had been reported by Goodman and Jaap (1961) and Lianmawia (1977). Compared to N strain, heritability by dam component had been lower and by sire component much higher in P strain.

The estimates obtained in the present study are somewhat similar to those of 0.237, 0.303 and 0.381 reported by Jackunas and Stankeviceno (1969), 0.278 by Ipe (1972), 0.22 by Sivasamy et al. (1976) by regression of offspring on dam method, 0.34 by Lianmawia (1977) by full-sib correlation method, 0.31 by full-sib correlation method reported by Balachandran et al. (1979), 0.216 by Cabaner and Abplanalp (1979) by regression of daughter on dam method and 0.51 by Kotaiah and Renganathan (1980) by sire component of variance.

Lower estimates had been reported for egg production, 0.14 by Manickavel et al. (1955), 0.11 by Sivasamy et al. (1976), 0.093 by Azimov (1978) by sire-component of variance and 0.05 by Patel and Rathnasabapathy (1979).

In N strain, heritability by sire component had been moderate for all the three characters. The estimates by dam component had been higher indicating maternal effect and/or non-additive gene effects. In P strain, the heritability by sire component had been more for six-week body weight and egg production.

Paternal half-sib correlation is considered to be the most reliable method, since it is free from maternal and non-additive gene effects. When the estimates by sire component for the three characters are examined, P strain was found to have higher heritability compared to N strain.

Correlation estimates

Body weights at six-week and eight-week

The genetic correlation was found to be positive and high between six-week body weight and eight-week body weight in both the strains, by sire, dam and sire + dam components of variance. Similar correlations were reported by Panda et al. (1976) and Chaudhary and Dev (1980). The high correlation might be due to pleiotropy or linkage. The phenotypic correlation was found to be positive but lower compared to genetic correlation and similar in both the strains. The environmental correlation had also been positive though it was of still lesser magnitude in both the strains. The positive environmental correlation between these indicated that environment which caused a higher six-week body weight would result in a higher eight-week body weight.

Six-week body weight and egg production

Genetic correlation by sire component of variance was found to be low and negative (-0.096) compared to positive genetic correlation by dam component in N strain (0.377). In case of P strain, it was found to be positive (0.468) by sire component and negative (-0.462) by dam component. This difference may be due to the effect of maternal influence and/or non-additive gene effects. In the case of N strain, genetic correlation between six-week body weight and egg production was found to be very low and negative but in P strain, it was medium and positive (0.468). In N strain both six-week weight and egg production had higher estimates of heritability by maternal half-sib correlation method. The genetic correlation between the two characters is also higher by dam component. In P strain, these two characters had lower heritability by dam component and their correlation by dam component is also lower. The correlation by sire component is much higher compared to dam component. So it can be assumed that in N strain maternal and/or non-additive gene effects and in P strain sex-linked effects may be responsible for this situation.

The phenotypic and environmental correlation were found to be of low magnitude for both the strains.

However, higher correlation estimates were reported by Ipe (1972) between six-week body weight and egg production in White Leghorns.

Eight-week body weight and egg production

Low values were obtained for the correlation estimates between eight-week body weight and egg production in both the strains by sire, dam and sire + dam components. Environmental correlation was more in N strain (0.319) than in P strain (0.009). Phenotypic correlation also was found to be more in N strain. In case of N strain environmental correlation was found to be more than genetic and phenotypic correlation estimates. This gave the indication that the environment which caused higher eight-week body weight resulted in higher egg production in N strain. But this was not observed in P strain.

The correlation estimates found between eight-week body weight and egg production are similar to the reports by Dillard _et al._ (1953), Orozco and Rabanal (1970) and Kaatz (1972).

Conclusions

Results of the study which can be seen from the Path. coefficient diagrams were not suggestive of any strong relationship in N and P strains between chick weights at six or eight-weeks and egg production. Hence only egg production deserves consideration in the selection as chick weight in White Leghorns is not an economic character.

Heritability estimates of 0.219 by sire component of variance for egg production in N strain could be used for predicting the response to selection. Heritability by sire component is believed to be more reliable in the absence of sex-linked variance as dam component is likely to have maternal and/or non-additive gene effects. For P strain, heritability by sire component had been much higher compared to that by dam component which indicated a possible sex-linked variance. Heritability by dam component was not high and did not show any evidence of maternal or non-additive gene effects. Hence heritability by dam component could be thought to be more reliable.

For predictions based on heritability, the estimate likely to be free of non-additive gene effects would be better as it would avoid overestimations and also would bring in confidence about the predictions.

A selection proportion of about 8.5 per cent for males and 16 per cent for females gives intensities of 1.87 and 1.53. Considering the heritability of 0.219 and a standard deviation of 16.04 in N strain it was seen that there could be an improvement of 7.57 eggs per generation when Osborne's index is used. In P strain also for the same selection intensity, a heritability of 0.230 and standard deviation 15.41, the improvement could be expected to be the same ie. 7.57 eggs per generation.

SUMMARY

Summary

Data on White Leghorn birds of S and I strains maintained at the poultry farm under All India Co-ordinated Research Project on Poultry for Eggs during the period from 1979 - 1981 were analysed. The characters considered for the study were six-week body weight, eight-week body weight and egg production upto 280 days of age. Observations on [illegible] progenies of [illegible] sires and [illegible] dams in S strain and [illegible] progenies of [illegible] sires and [illegible] dams in I strain were used for the analysis.

The mean values for six-week body weight (g), eight-week body weight (g), and egg production upto 280 days of age (number) were [illegible] ± [illegible], [illegible] ± [illegible] and [illegible] ± [illegible] for S strain and [illegible] ± [illegible], [illegible] ± [illegible], and [illegible] ± [illegible] for I strain. Mean values for the three characters in S strain were found to be significantly higher compared to I strain.

Least squares analyses for effect of generations and between [illegible] within generations were carried out. Generation effects were significant for all three characters in both the strains. Effect of between [illegible] within generations were also found to be significant sources for egg production in first generation and six-week body weight in [illegible] generation also [illegible] in S strain. The least squares [illegible]

SUMMARY

Data on White Leghorn birds of N and P strains maintained at the poultry farm under All India Co-ordinated Research Project on Poultry for Eggs Mannuthy during the period from 1979 - 1981 were analysed. The characters considered for the study were six-week body weight, eight-week body weight and egg production upto 280 days of age. Observations on 2303 progenies of 121 sires and 573 dams in N strain and 1577 progenies of 96 sires and 418 dams in P strain were used for the analysis.

The mean values for six-week body weight (g), eight-week body weight (g), and egg production upto 280 days of age (number) were 319.4 ± 1.4, 452.9 ± 1.8 and 71.5 ± 0.4 for N strain and 351.2 ± 1.7, 513.7 ± 2.2. and 80.6 ± 0.5 for P strain. Mean values for the three characters in P strain were found to be significantly higher compared to N strain.

Least squares analysis for effect of generations and hatches within generations were carried out. Generation effects were significant for the three characters in both the strains. Effect of hatches within generations were also found to be significant except for egg production in first generation and six-week body weight in second generation hatches in N strain. The Least squares constants were

estimated and data were adjusted with those constants. Adjusted data were used for further analysis.

Heritability of the three characters were estimated using paternal half-sib, maternal half-sib and full-sib correlation method. The heritability estimates in N strain were 0.223 ± 0.112, 0.642 ± 0.078 and 0.433 ± 0.099 for six-week body weight, 0.278 ± 0.108, 0.372 ± 0.068 and 0.325 ± 0.095 for eight-week body weight and 0.219 ± 0.095, 0.379 ± 0.077 and 0.298 ± 0.104 for egg production based on sire, dam and sire + dam components of variance. The estimates in P strain based on sire, dam and sire + dam components of variance were 0.405 ± 0.110, 0.341 ± 0.103 and 0.373 ± 0.101 for six-week body weight, 0.354 ± 0.110, 0.443 ± 0.094 and 0.398 ± 0.118 for eight-week body weight and 0.530 ± 0.102, 0.230 ± 0.130 and 0.380 ± 0.131 for egg production.

In N strain heritability by sire component had been moderate for all the three characters. The estimates by dam component had been higher indicating maternal and/or non-additive gene effects. In P strain the heritability by sire component had been higher for egg production indicating a possibility of sex-linked variance.

The genetic correlation estimates between six-week and eight-week body weight were found to be high and almost unity in both the strains. The phenotypic correlations were also found to be positive but lower compared to the genetic correlations and similar in both the strains. The environmental correlations had also been positive though they were of still lesser magnitude in both the strains. Between chick weights and egg production, in general, genetic phenotypic and environmental correlations were of low magnitude in both the strains.

The results were not suggestive of any strong relationship between chick weight and egg production. Out of these three characters, only egg production deserved consideration in selection as chick weight in White Leghorns cannot be considered to be an economic trait. It was estimated that an improvement of 7.57 eggs per generation could be expected in both the strains for standard deviations of 16.04 and 15.41 and heritabilities of 0.219 and 0.230 in N and P strains respectively when selection of males is 8.5 per cent and females 16 per cent.

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INHERITANCE OF CHICK WEIGHT AND EGG PRODUCTION IN WHITE LEGHORN BIRDS

By

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ABSTRACT OF A THESIS

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ABSTRACT

A research work was undertaken in two strains of White Leghorn birds to study the inheritance of chick weight and egg production. The birds maintained at the poultry farm under All India Co-ordinated Research Project on Poultry for Eggs, Mannuthy were utilized for the study.

The mean values for six-week body weight (g), eight-week body weight (g) and egg production upto 280 days of age (number) were 319.4 ± 1.4, 452.9 ± 1.8 and 71.5 ± 0.4 for N strain and 351.2 ± 1.7, 513.7 ± 2.2 and 80.6 ± 0.5 for P strain.

Least squares analysis for effect of generations and hatches within generations were carried out. Generation effects were significant for the three characters in both the strains. Effect of hatches within generations were also found to be significant except for egg production in first generation hatches and for six-week body weight in second generation hatches in N strain. The data were adjusted for the generation and hatch effects. Adjusted data were used to estimate heritability, genetic, phenotypic and environmental correlations.

The heritability estimates in N strain were 0.223 ± 0.112, 0.642 ± 0.078 and 0.433 ± 0.099 for six-week body

weight, 0.278 ± 0.108, 0.372 ± 0.068 and 0.325 ± 0.095 for eight-week body weight and 0.219 ± 0.095, 0.379 ± 0.077 and 0.298 ± 0.095 for egg production based on sire, dam and sire + dam components of variance respectively. The respective estimates in P strain were 0.405 ± 0.110, 0.341 ± 0.103 and 0.373 ± 0.101 for six-week body weight, 0.354 ± 0.110, 0.443 ± 0.094 and 0.398 ± 0.118 for eight-week body weight and 0.530 ± 0.102, 0.230 ± 0.130 and 0.380 ± 0.131 for egg production.

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It was estimated that an improvement of 7.57 eggs per generation could be expected in both the strains for standard deviations of 16.04 and 15.41 and heritabilities of 0.219 and 0.230 in N and P strains respectively, when selection of males is 8.5 per cent and females 16 per cent.