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Genetic evaluation of short-term selection in synthetic coloured broiler male and female lines— Direct and correlated responses

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ABSTRACT

Broiler male line (PB-1) and female line (PB-2) were under continuous mass selection for 6 week body weight and independent culling level was applied for 40 week egg production in female line. Data obtained over 5 generations on juvenile body weights and production traits was analyzed to evaluate the short-term direct and correlated responses in both lines. In male line, genetic responses for 6 WK body weight, 20 WK body weight,40WK body weight, age at sexual maturity,32 WK egg weight,40 WK egg weight and 40 WK egg production were 31.6±21.31 g, –80.10±111.98 g, –38.60±102.58 g, 0.50±2.31days, 0.24±2.40 g,-0.49±0.81 g and 1.80±4.69eggs respectively. On genetic scale 6 WK body weight was improved significantly (P<0.05). Body weight at 20 WK and 40 WK were decreased and there was a marginal gain in ASM and egg production up to 40 weeks of age. On phenotypic scale in male line, body weights at 6 WK, 20 WK and 40 WK were increased, but non-significant, while, ASM, egg weight at 32 and 40 weeks of age were decreased, but non-significant. Egg production to 40 weeks of age was improved significantly (P<0.05). In female line genetic responses for 6 WK body weight, 20 WK body weight, 40 WK body weight, ASM, 32 WK egg weight, 40 WK egg weight and 40 WK egg production were 32.22±12.55 g, –44.30±122.79 g, –78.70±28.29 g, 1.70±2.99days, -0.09±0.73 g, 0.61±0.71 g and 0.35±2.92eggs respectively. On genetic scale 6 WK body weight was improved but non-significant. Body weight at 20 WK, 40 WK and egg weight at 32 WK were decreased, but non-significant. There was marginal genetic gain in ASM, 40 WK egg weight and 40 WK egg production. On phenotypic scale in female line body weights at 6WK, 20WK and 40WK were improved, but non-significant, while egg production was improved significantly (P<0.05), ASM and egg weight at 32 WK and 40WK were decreased, but non-significant

Key words: ASM, Body weights, Correlated response, Direct response, Egg weight, Egg production

Owing to genetic relationships (linkage and pleiotropy) among traits, correlated responses may occur when artificial selection is exercised for primary traits. Such relationships among growth traits and other economic traits were reviewed for short-and long-term selection responses in chickens (Marks 1985, Siegel and Dunnington 1985, 1987, Chambers 1990, Hunton 1990). Responses are influenced by initial population size, initial gene frequencies, rate of allelic fixation, mutation, chance and genetic and physiological limits as well as macro-and micro-environments (Dunnington and Siegel 1996). Evaluation of direct response to selection although is of prime importance in a selection experiment, estimation of magnitude and direction of correlated response are also of significance for developing effective breeding strategies. Earlier reports indicated that selection for high juvenile body weights in meat type chicken have been associated with gain in body weight at other ages. (Kinney and Shofner 1967 and Singh and Mohapatra 1988). Reddy *et al.* (1998) reported correlated responses to index selection in broiler sire and dam lines. The present study evaluates the direct response in primary trait and correlated responses in secondary traits when different selection procedures were applied to two different broiler breeder lines.

MATERIALS AND METHODS

Genetic stocks: Broiler lines i.e. synthetic coloured broiler male line (PB-1) and synthetic coloured broiler female line (PB–2) of the institute were utilized for the present study. These 2 synthetic lines were developed at AICRP on poultry breeding, Ludhiana centre and were brought to PDP during the year 1988. Male line and female lines were under continuous mass selection for 6 week body weight and in female line independent culling level selection was also practiced for 40 week egg production in addition to mass

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selection for 6 WK body weight. They have multi colour plumage and their crosses are also multi coloured. Their cross is named as "Krishibro" is a potential hybrid cross developed by the Directorate for commercial exploitation.

Control population: Control line of this Directorate was utilized for estimating genetic response and was obtained from AICRP on poultry for meat centre, Bangalore during the year 1989. It was synthesized utilizing a strain of White Plymouth Rock, two strains of New Hampshire, a strain of Cornish and a strain of synthetic meat line. Initially they were mated naturally with 50 sires and 200 dams. In later years they were mated by AI technique with 100 sires and 300 dams. At this Directorate they are maintained as pedigreed random bred control population by mating 50 sires and 250 dams by AI.

Traits recorded: In broiler male and female line the traits recorded in each generation were body weight at 6 weeks of age (6 WK BW), body weight at 20weeks of age (20 WK BW), body weight at 40 weeks of age (40 WK BW), age at sexual maturity (ASM), egg weight at 32 weeks (32 WK EW), egg weight at 40 weeks (40 WK EW) and egg production to 40 weeks of age (40 WK EP). In the present study data collected over 5 generations (1995–2000) were utilized in both male and female lines.

Management of the stocks: Immediately after hatching chicks were brooded up to 6 weeks of age by providing the recommended feeder, water and floor spaces by feeding chick ration containing 2900 Kcal/kg metabolisable energy and 22% crude protein. At 6 weeks of age mass selection was practiced for highest body weight and proportionate number of males and females were retained and were kept on restricted feeding. Chicks were maintained in brood-grow houses and they were continued in the same house up to 18 weeks of age by providing recommended feeder, water and floor spaces. At 18 weeks birds were housed in cages for recording of the production parameters. Breeder ration was fed during the period containing 2800 kcal/kg energy and 18% crude protein.

Statistical analysis: Since chicks were obtained in more than one hatch data were corrected for hatch effects by least square constants as per Harvey (1975). Least square means only were utilized for the estimation of the genetic and phenotypic responses. Phenotypic responses were obtained by regression of the generation means on generation number. Genetic responses were obtained by regression of the control deviated mean on generation number. The heritabilities were estimated by using variance component analysis (King and Henderson 1954). Realized heritabilities were obtained as simple regression of response on cumulative selection differential (Falconer and Mackay 1997).

RESULTS AND DISCUSSION

Response in primary traits: The direct phenotypic responses in 6WK BW were 59.40±32.91 g in male line and 60.10±23.89 g in female line (Table 1). The genetic responses, respectively, in these 2 lines were 31.61±21.31 g and 32.22±12.55 g. The short-term genetic and phenotypic responses in both the lines were positive for this trait under artificial selection indicating the improvement of this trait on both genetic and phenotypic scales. Time trend of 6WK BW in broiler male and female lines are presented in Fig. 1. Control deviated means of this trait are presented in Fig. 2.Time trend of 40WK EP in female line is presented in Fig. 3 and control deviated means of this trait are presented in Fig. 4.

Table 1. Direct response (genetic and phenotypic) in primary trait (6WK BW) in broiler male and female lines

Generation PB-1/PB-2	Least square mean (g)		Control deviated mean (g)	
	PB-1	PB-2	PB-1	PB-2
S1	1133.40	1183.73	360.60	387.10
S2	1181.28	1182.53	418.48	385.97
S3	1091.96	1200.10	329.16	370.95
S4	1279.81	1239.60	517.01	442.97
S5	1336.81	1249.00	469.40	519.73
B±S.E	59.40± 32.91	60.10± 23.89	31.61± 21.31	32.22± 12.55

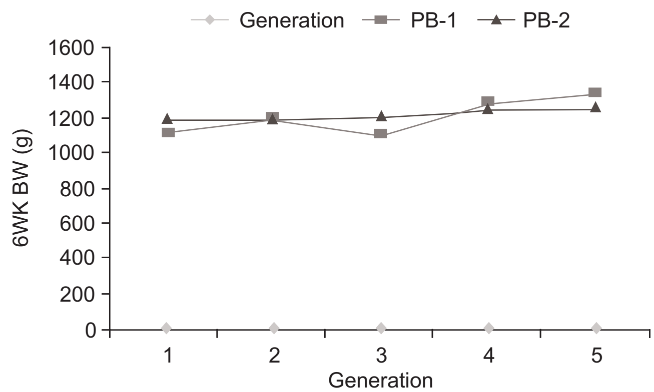

Fig. 1. Time trend of 6WK BW in broiler male and female lines.

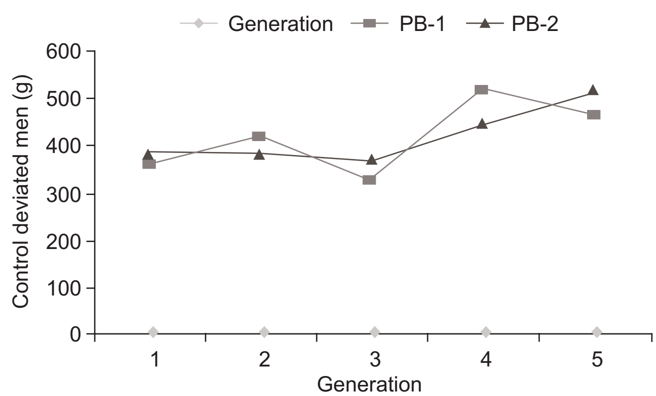

Fig. 2. Control deviated means (6WK BW) in broiler mail and female lines.

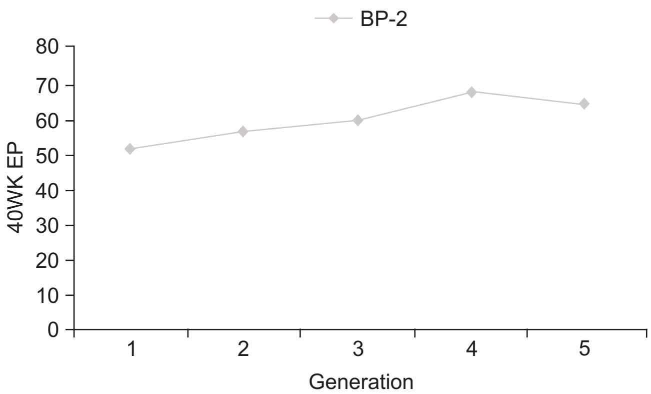

Fig. 3. Time trend of 40KW EP in broiler female line

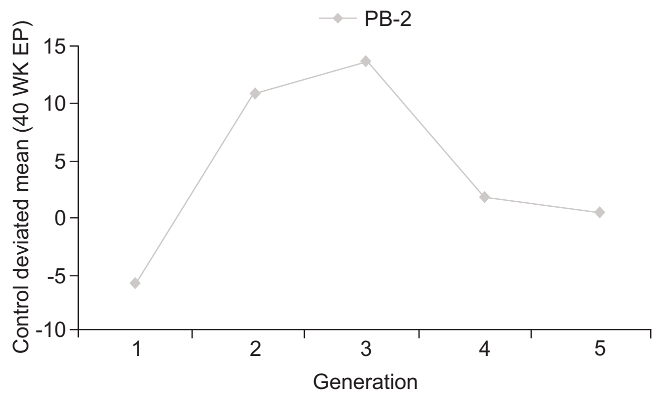

Fig. 4. Control deviated means of 40WK EP in female line

Response in secondary traits: The correlated phenotypic response for 20WK BW, 40WK BW and ASM in PB-1 were 109.40±54.45 g, 87.40±59.78 g and –3.50±1.19 days respectively. In female line these values respectively were 145.20±60.40 g, 71.40±27.21 g and –2.30±2.11. On phenotypic scale, 20WK BW and 40WK BW were increased non-significantly, while, ASM was decreased in both male and female lines. Genetic responses in 20WK BW, 40WK BW and ASM in male line were –80.10±111.98 g, –38.60±102.58 g and 0.50±2.31days respectively. In female line these values respectively were –44.30±22.79 g, –78.70±28.29 g and 1.70±2.99days.It indicated that on genetic scale 20WK BW and 40WK BW were decreased and there was marginal insignificant gain in ASM in male line. In female line also more or less similar trend was observed.

Correlated phenotypic response in 32 WK EWT, 40WK EWT and 40WK EP respectively in male line were -0.19±0.29 g, -0.39±0.18 g and 5.23±2.33 and in female line these values respectively were -0.52±0.39 g,-0.61±0.25 g and 3.79±0.93.On phenotypic scale 32WK EWT and 40WK EWT were decreased non- significantly, while egg production to 40WK was improved significantly ($P<0.05$) in both male and female lines. Correlated genetic responses in 32WK EWT, 40WK EWT and 40WK EP in male line respectively were 0.24±2.40 g, -0.49±0.81 g and 1.80±4.69.In female line these values respectively were -0.09±0.73 g,0.61±0.71 g and 0.35±2.92eggs.On genetic scale in male line 40WK EWT was decreased insignificantly while egg production was improved. In female line 32WK EWT was decreased, while response for egg production was positive.

Realized heritabilities: These are presented in Table 2 for both PB-1 and PB-2.For 20WK BW, 40WK BW, 40WK EWT realized heritabilities were higher than the estimated heritability.

Direct genetic and phenotypic responses in male line (PB-1) and female line (PB-2) were positive indicating the effectiveness of mass selection for 6 week body weight. Phenotypic responses were higher than the genetic responses. Dunnington and Siegel (1985), Dunnington *et al.* (1996), Liu *et al.* (1994) obtained positive responses for 8 week body weight in their long-term selection study. These responses indicated the effectiveness of mass selection for a short period (5 generations) in both male and female lines in the present study.

Correlated phenotypic responses were positive for 20WK BW and 40WK BW, while responses were negative for ASM in both male and female lines. However, correlated genetic responses were negative for these two body weights, while correlated genetic responses for ASM were positive. As a rule, selection for body weight at particular age usually alters the body weight at other age in the same direction. Since

Table 2. Selection intensity, realized and estimated heritability of primary and secondary traits in broiler male and female lines (1–5 generations)

Traits	Selection intensity		Realized heritability		Estimated heritability	
	PB-1	PB-2	PB-1	PB-2	PB-1	PB-2
6WK BW	1.16	1.31	0.21	0.34	0.40±0.12	0.38±0.18
ASM	–0.36	–0.40	0.16	0.36	0.12±0.25	0.20±0.25
20WK BW	0.28	0.31	0.98	0.58	0.89±0.34	0.27±0.28
40WK BW	0.51	0.42	0.82	>1.0	0.69±0.28	0.25±0.28
32WK EWT	0.14	0.18	0.44	0.23	0.59±0.26	0.17±0.22
40WK EWT	0.12	0.16	>1.0	>1.0	0.74±0.31	0.60±0.36
40WK EP	0.54	0.60	0.43	0.05	0.05±0.19	0.12±0.25

genes controlling the body weight at 6 weeks of age are supposed to be same genes controlling the body weight at 20 and 40 weeks. Positive genetic and phenotypic correlations were reported in the literature for body weights of nearby ages. Since, 20WK BW and 40WK BW are not adjacent to 6 week body weight and this may explain possibly the negative genetic responses in the present study. On the contrary to the present findings positive genetic and phenotypic responses were obtained by Dunnington and Siegel (1985), Pym *et al*. (1984) and Reddy *et al*. (1998) and explains the high estimated and realized genetic correlations among the growth traits.

Correlated phenotypic responses in 32WK egg weight and 40WK egg weight were negative, while the response for 40WK egg production was positive and significant ($P<0.05$) in both male and female lines. Since the most of the responses for ASM were negative in both the lines this may explain the improvement in egg production in both male and female lines. Correlated genetic response for 32 WK egg weight was positive in male line and was negative in female line. While the response for 40WK egg weight was negative in male line and was positive in female line. These responses were non significant and did not follow the definite trend in both the lines. As a rule egg weights are positively correlated with Juvenile body weights as per the literature reports (Chambers *et al.* 1984, Pym and Nicholls 1979, Reddy *et al*. 1996) responses supposed to be positive for egg weight at both the ages. Some of the results obtained in the present study were in confirmation with the findings of Dunnington and Siegel (1985) and Liu *et al*. (1995). Negative responses in ASM and positive responses in egg production will explain the negative genetic correlation between the ASM and egg production. Limiting the feed intake of meat breeders is a routine husbandry procedure used to delay on set of lay, with the length of delay depending on the severity of restriction. (North and Bell 1990). Restricted feeding programme should reduce the body weight at 20WK and 40WK. In the present study body weights at 20WK and 40WK were reduced on genetic scale and confirms that restricted feeding had positive effect on these two traits, but ASM was not delayed. This may suggest the further severe restriction on feed from 6 week of age onwards in both the lines under study.

In short-term selection for 6 WK body weight in male and female lines and independent culling level selection for 40 WK egg production in female line were evaluated the present study, majority of genetic and phenotypic responses in the primary and secondary traits were positive in direction and which are desirable for genetic improvement of lines. As there is genetic improvement in 6WK body weight in male line and 6WK body weight and 40 WK egg production in female line, it implies the efficacy of selection methods in both lines. Since most of the traits need longer time to show the well defined responses. Hence it may be advocated to observe the responses in long-term study. In the present study efforts were made to estimate the short-term responses to take immediate decisions about the selection procedures and to predict the direction of changes in primary and secondary traits in broiler lines.

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