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Evaluation of a short-term selection study in specialized Naked neck populations*

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Presently poultry meat production has an annual growth rate of about 10% and with this growth rate, projected estimates of poultry meat production are 3.0 million tonnes by 2010 and 8.0 million tonnes by 2020. Existing per capita availability of poultry meat is about 2.0 kg per person per year and at existing growth rate in poultry meat production, availability of poultry meat per person per year will be 2.49 kg and 5.62 kg by 2010 and 2020, respectively, which is far below the recommendation of the National Institute of Nutrition (NIN) which are 11 kg meat per person per year. To meet out this requirement, the existing levels of poultry meat production should be 12 millions tonnes of poultry meat, which about 5–6 times more than the current production levels. This level is difficult to achieve, but this gap can be narrowed by increasing the poultry meat production by adopting multifarious approaches. One of the strategies is to develop high yielding germplasm adaptable under high temperature and humid conditions of the most of part of our country through introgressing the major genes influencing tropical adaptability.

The naked neck gene is one of the major gene which offer enormous potential under tropical climate (Singh *et al*. 1998a). It has been demonstrated that the naked neck broilers performed better than their normally feathered counterparts when reared at constant high ambient temperatures of more than 30°C (Cahaner *et al*. 1992). Better growth rate, better feed efficiency, better carcass traits in naked neck genotype over the normal feathered birds under tropical climate is well reported (Yalcin *et al*. 1997). Hence, at the Central Avian Research Institute, Izatnagar, the naked neck gene was introduced in two broiler populations through successive backcrossing for 5 generations followed by random mating for 2 generations to stabilize the populations. Subsequently, Naked Neck White Population (NNWP) and Naked Neck Colored Population (NNCP) were subjected to intra-population selection for 5 generations (Nath 1999, Singh, 2001).

While NNWP improved for high sixth week body weight, NNCP was selected for high sixth week body weight as well as egg number up to 40th weeks of age. In 2003–04, the selection criterion was shifted to fifth week of body weight from sixth week body weight. Since the genetic structure of a population depends upon gene frequency, any changes in these frequencies are liable to change the genetic combination of the population. Therefore, the need was felt to evaluate NNWP and NNCP populations in term of phenotypic performance as well as genetic parameters during the period under modified selection programme.

Two naked neck broiler lines, i.e. Naked Neck White Population (NNWP) and Naked Neck Coloured Population (NNCP) maintained at the Central Avian Research Institute, Izatnagar were used. In 2003–04, the selection criteria was modified and shifted to 5th week body weight, hence this generation was taken as base generation (S_0). Subsequently these populations were subjected to specific selection for 3 generations. In NNWP, about 30 sires and 180 dams selected for high fifth week body weight were used to reproduce subsequent generation. In NNWP, after initial selection high fifth week body weight, birds were selected for high egg production up to 40th weeks of age. In each generation, about 30 sires and 180 dams were selected. A random bred control population was also maintained using 45–50 sires and 100 dams. Birds were reared on deep litter under identical feeding and managemental conditions.

The body weight at third and fifth weeks of age, feed consumption during the third to fifth weeks of age, carcass traits such as percent feathering loss, dressing percent and percent abdominal fat, number of eggs up to 40th week of age and average egg weight at 40th week of age were recorded. The weight gain as well as deed efficiency during third to fifth weeks of age were also estimated. Data were corrected for hatch effects by fitting least-squares constants (Harvey 1979). The heritability of different traits for the selected and control line were estimated by variance component analysis using the paternal half-sib methods as

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described by Becker (1986). Similarly, genetic and phenotypic correlation coefficients were estimated from variance and covariance component analysis using paternal half sib method as described by Becker (1986). Effective population size (N_e) in selected population and in control population was computed as per Wright (1940) and Gowe *et al.* (1959) respectively. Increase in coefficient of inbreeding (DF) per generation due to finite population size in selected population was calculated as per Wright (1931), while in control line, the inbreeding coefficient per generation was computed as per Gowe *et al.* (1959). The realised genetic responses per generation were calculated as regression of control deviated means over the generations, while the realized phenotypic responses per generation were estimated as regression of phenotypic means on generations.

The development of specialised sire and dam lines through unique selection programme contributed to the net improvement in broiler progeny performance. While the growth is the most important selection criteria in the sire line, broiler dam lines are selected for the growth as well as for egg production traits. Both the selected lines showed increasing trend for the selected traits over generations as in S_3 generation; NNWP birds had 556 g body weight at third week of age, while the fifth week body weight was 1280 g. Similarly with an upward trend, weight gain between third to fifth weeks of age was 724 g in S_3 generations. NNCP also showed similar trend. In S_3 generation, average feed consumption and feed efficiency was 1400 g and 0.51, respectively, in NNWP, while the respective estimates in NNCP were 1390 g and 0.50. The percent feather, dressing and abdominal fat was 3.04, 74.95 and 1.00 in NNWP and 3.09, 74.40 and 1.02 in NNCP in S_3 generation, respectively. A random-bred control population was also evaluated for various economic traits. The regressions of phenotypic means over generation number were non-significant for all the traits, which revealed stability of the control population over generations. Singh (2001) and Singh (2003) also showed nonsignificant time trend in their control populations.

Effective population size and inbreeding coefficient: The size of population in any selection experiment is important to maximise the rate of response. It is well-recognised that in small population, the genetic drift not only decreases response to selection and the realised heritability but also results in the loss of some desirable alleles, and consequently results in a decreased limit to selection. The average effective population sizes of 103 in both the selected populations and of 221 in control population were reasonably not to cause any decline in estimates of cumulative responses and realised heritability. Effective population size (Ne) is directly proportional to inbreeding effect per generation. In the present investigation, the large effective population size and very marginal increase of 0.0037 in rate of inbreeding indicated that the effect of inbreeding depression on broiler body weight was negligible. Nath (1999), Singh (2001) and Singh (2003) had also observed low rate of inbreeding per generation in broiler populations having sizable effective population size.

Genetic parameters: Populations that were subjected to selection over a long period lead to fixation of genes and results in reduction of additive genetic variance, which is reflected through lower estimates of heritability in later generations. In the present study, moderately high estimates of heritability for fifth week body weight (0.31 to 0.27 in NNWP and 0.29 to 0.26 in NNCP) over generations (Table 1) revealed the presence of sizable additive genetic variation for further exploitation. Though estimates showed declining trend over generations, but the decline was not significant statistically. Moderate to high heritabilities for early body weights have been reported by various workers in earlier as well as in later generations of selection for high body weights (Reddy *et al.* 1993, Singh *et al.* 1998b, Singh 2001, Singh 2003 and Nath *et al.* 2007).

High positive genetic and phenotypic correlations between third week body weight and fifth week body weight (Table 1) in both the selected populations over generations revealed that the direct selection of these populations for fifth week body weight will be effective in bringing positive correlated response in third week body weight also. Singh (2001) also reported highly positive genetic correlation (0.57–0.69) between 4 and 6-week body weight in naked neck populations. Similar high genetic correlations among early body weights in other broiler populations were also reported (Reddy *et al.* 1993, Singh *et al.* 2007).

Response to selection: For the primary trait under selection, i.e. fifth week body weight, the significant

Table 1. Heritability estimates for body weight at different weeks of age and phenotypic and genetic correlations among them in NNWP (in normal face) and NNCP (in bold italic face) over generations

Population/traits	Generations			
	S_0	S_1	S_2	S_3
Heritability				
3 week body weight	0.35±0.07***0.27±0.07***	0.33±0.08***0.28±0.06***	0.31±0.05***0.25±0.08***	0.30±0.09***0.23±0.07***
5 week body weight	0.31±0.06***0.29±0.06***	0.30±0.09***0.30±0.05***	0.28±0.08***0.28±0.07***	0.27±0.07***0.26±0.10***
Correlation between 3 week and 5 week body weight				
Genetic Correlation (r_G)	0.68±0.0***90.71±0.12***	0.70±0.11***0.68±0.08***	0.69±0.10***0.64±0.06***	0.66±0.11***0.61±0.08***
Phenotypic Correlation (r_P)	0.52±0.0***80.64±0.10***	0.63±0.09***0.63±0.06***	0.61±0.07***0.59±0.07***	0.58±0.09***0.58±0.10***

Table 2. Realized phenotypic and genetic responses in different traits in NNWP, NNCP and Control population

Traits	NNWP		NNCP		Control
	Phenotypic response	Genotypic response	Phenotypic response	Genotypic response	Phenotypic response
Primary selected trait					
5th wk body weight	98.60± 3.3**	50.10±2.4**	100.90±55.2**	58.40±13.17**	44.18±23.07^{ns}
Eggs laid up to 40th weeks of age	-	-	0.629±0.080**	-	–0.38± 0.93^{ns}
Correlated traits					
3rd wk body weight	51.60±10.51**	14.00±3.76**	60.50±16.04**	28.50±5.03**	35.23±20.39^{ns}
Weight gain (3–5 wk)	46.80±3.97**	17.80±27.08ns	40.40±9.42**	29.90±8.14**	8.95±2.96^{ns}
Feed consumption (3–5 wk)	58.90±31.45^{ns}	75.90±31.20**	70.40±24.97**	87.40±31.51**	0.01±0.01^{ns}
Feed efficiency (3–5 wk)	0.014±0.07 **	–0.032±0.023^{ns}	0.006±0.007^{ns}	–0.04±0.02^{ns}	0.03±0.77^{ns}
Feather %	–0.075±0.062^{ns}	-	–0.075± 0.042^{ns}	-	-
Dressing %	0.038±0.022^{ns}	-	0.032±0.073^{ns}	-	-
Abdominal fat %	–0.011±0.031^{ns}	-	–0.014±0.033^{ns}	-	-
Egg weight up to 40th weeks of age	-	-	–0.323±0.20^{ns}	-	-

**, P<0.01; ns, nonsignificant.

(P< 0.01) gains of 98.60 g and 50.10 g in NNWP and 100.90 g and 58.40 g in NNCP were realized at phenotypic and genotypic level, respectively. Sizable genetic gains in the selected trait in short term selection period have also been reported in Naked neck populations (Singh 2001) as well as in other broiler populations (Singh *et al.* 2000, Singh 2003). In NNCP, number of eggs laid up to 40th weeks of age, realised phenotypic response of 0.629 eggs per generation, was also significant (P < 0.01).

Significant (P < 0.01) positive genetic responses per generation of 51.60 g and 14.00 g in NNWP and 60.50 g and 28.50 g in NNCP, respectively in third week body weight were in desirable direction. Though the feed consumption (3–5 wk) showed significant increase of 75.90 g in NNWP and 70.10 g in NNCP at the genetic level in both the populations, but the feed efficiency showed non-significant genetic gains. Significant (P < 0.01) positive gains in fourth week body weight as well as feed efficiency and nonsignificant gains in feed consumption and carcass traits were also reported by Singh (2001) in the naked neck populations. Similarly Singh (2003) reported significant realised genetic correlated responses in fourth week body weight in the broiler populations selected for high growth (SG line) and for feed efficiency (SF line). High gains in fifth week body weight have not influenced that percent feather, abdominal fat as well as dressing percentage traits in the present study. Non-significant gains in carcass traits were also reported earlier in naked neck population (Singh 2001) as well as other broiler populations (Singh 2003). The time trend over generations was non-significant for all the traits in control population, suggesting stability of control population over generations.

Hence the intra-population selection was effective in bringing significant improvement in fifth week body weight in populations which have been continuously selected for sixth week body weight. Change in selection criterion has neither changed directions of genetic gains in correlated traits nor genetic correlations between the selected and correlated traits.

SUMMARY

Two naked neck populations, Naked neck White plumage (NNWP), under selection for fifth week body weight (5 wk BW) and Naked neck Coloured plumage (NNCP) under selection for 5 wk BW as well as number of eggs laid up to 40th weeks of age (40 EN) along with a pedigreed random mating control population were evaluated. The effective population size was large (Ne =103), and very marginal increase of 0.0037 in rate of inbreeding was observed over generations. Moderately high estimates of heritability for 5 wk BW (0.31 to 0.26) over generations were estimated in both the selected populations. High positive genetic and phenotypic correlations between third week body weight (3 wk BW) and 5 wk BW were found in both the selected populations over generations. Highly significant phenotypic (98.60–100.90 g) and genetic (50.10–58.40 g) correlation were realized for fifth wk BW. In NNCP, the realized gains were significant for 40 EN. Correlated gains were significant and positive for 3 wk BW in both the selected populations, however, the genetic gains in weight gain (3–5 wk) were significant only in NNWP. Feed consumption (3–5 wk) showed significant increase at genetic level in both the populations, but the feed efficiency showed non-significant genetic gains. Genetic gains were nonsignificant gains in carcass traits in both the populations. The time trend over generations was non-significant for all the traits in control population.

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