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Original Article

Effect of Non Genetic Factors on Growth Traits in Short Term Selection for Different Ages in Japanese quail

A. ASHOK[1,2,*] **and R. PRABAKARAN**[3]

[1] *Department of Poultry Science, Madras Veterinary College, TANUVAS, Chennai, Tamil Nadu, India*
[2] Present address: *Assistant Professor, College of Food and Dairy Technology, Tamilnadu Veterinary and Animal Sciences University, Koduvalli, Alamathi Post, Chennai, Tamilnadu, India.*
[3] *Vice-Chancellor, Tamilnadu Veterinary and Animal Sciences University, Chennai, Tamilnadu, India*

*Corresponding author's email: ashokvet13@gmail.com

ABSTRACT

Meat type Japanese quail were subjected to three different methods of individual phenotypic selection *viz.*, high two week body weight, four week body weight and high four week body weight coupled with low relative body weight gain between 4-6 weeks of age for three generations. The lines, generations, sexes and hatches had significant (P<0.01) effect on the body weight at hatch, 1,2,3,4,5, and 6 weeks of age, except the influence of sex on body weight at hatch which was not found to be significant. In base generation (S_0), the least squares means of body weights at hatch,1,2,3,4,5 and six weeks of age were 8.31±0.04, 38.53±0.29, 82.72±0.60, 120.13±0.74, 148.34 ±0.85, 173.15±0.89 and 191.15±1.04 g, respectively. The corresponding means were 8.04±0.04, 38.84±0.30, 77.51±0.61, 110.71±0.75, 144.77±0.86, 170.27±0.90 and 190.81±1.06 g in first generation (S_1); 8.93±0.04, 41.41±0.28, 78.81±0.58, 128.68±0.71, 165.83±0.82, 184.27±0.86 and 202.84 g in second generation (S_2) and 8.42 ± 0.04, 39.73±0.26, 78.17±0.53, 123.86±0.65, 160.75±0.76, 183.53±0.79 and 202.59±0.93 g, in third generation (S_3). The least squares means of body weights of males at hatch, 1, 2,3,4,5 and 6 weeks of age were 8.41±0.04, 39.32±0.26, 78.47±0.54, 118.72±0.66, 150.81±0.76, 169.87 ± 0.80 and 183.42±0.94 g, respectively and in females in the same were 8.44±0.04, 39.94±0.26, 80.14±0.52, 122.97±0.65, 159.04±0.75, 185.73±0.78 and 210.28±0.92 g, respectively.

Key Words: Japanese quail- selection- body weights-non-genetic factors

INTRODUCTION

The Japanese quail, *Coturnix japonica* is known to have been domesticated since the 12th century AD in Japan, mainly for its ability to sing. Intensive production of the species started in Japan in the 1920s. The first egg lines were then developed by selection (Wakasugi, 1984). They were successfully introduced from Japan to America, Europe, the Near and Middle East between the 1930s and 1950s, where specific lines were bred for egg and meat production. Extensive research on C*oturnix japonica* has showed that it was a valuable animal for avian research (Woodard et al., 1973). It has expanded from avian science-related topics to biology and medicine, as this bird could be kept easily in relatively large numbers in a small facility and be used as a model animal for a wide variety of work, from embryology (Le Douarin *et al.*, 1969) to space-related sciences (Orban et al., 1999).

Growth is moderately to highly heritable and can be rapidly improved through individual phenotypic selection. However, growth is a dynamic process that involves both an increase in mass and synchronous differentiation and maturation of many tissues. Consequently, selection results are highly dependent on the methods employed, including the age of primary selection, intensity of selection, selection emphasis placed on correlated traits and the environment (including nutritional aspects) under which selection is exercised (Emmerson, 1997). A selection experiment was designed. Individual phenotypic selection was contemplated to facilitate development of superior breeder flock suitable for production of optimum number of fast growing commercial meat type Japanese quails. The study was also designed to obtain an understanding of the relationship between selection age and growth with the following objectives, viz., to evaluate selection for juvenile, fourth-week and sixth-week body weights in Japanese quail.

MATERIALS AND METHODS

The study was carried out at the Institute of Poultry Production and Management, formerly known as Poultry Research Station, Tamilnadu Veterinary and

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Animal Sciences University, Nandanam, Chennai, India. A Japanese quail (*Coturnix japonica)* population, maintained at the institute formed the base population for this study. The foundation stock for the three selected and an unselected control populations was from a random mating Japanese quail line maintained at the Institute of Poultry Production and Management, Chennai. The line had no known history of artificial selection except for a short period during 1989 to 1992 when the population was subjected to selection on the basis of body weight at four weeks of age for four generations under two different nutritional environments of high and low protein diets. From the foundation stock, one hundred and eighty males and equal number of females were randomly selected, wing banded, weighed, and randomly assigned to four groups to have 45 pairs in each of the four groups. The breeder males and females were maintained in cages under single pair mating. Hatching eggs were collected and set for hatch. Chicks hatched from three groups were subjected to individual phenotypic selection for body weight at different ages. One group (SWL) was selected for high body weight at two weeks of age, the other (FWL) for high body weight at four weeks of age. The third group (LWL) was subjected to two stage selection with the initial selection practised at four weeks of age for high body weight, followed by selection for low relative body weight gain between four to six weeks of age. The fourth group (COL) was maintained as control line with random selection of parents.

The number of hatches obtained and the total number of progenies produced in the three selected lines and control were 2176, 1780, 2331 and 2343, respectively in S_0, S_1, S_2 and S_3 generations. Only those data of progenies with intact wing bands and whose sexes were phenotypicaly identifiable were included in the study. One of the four groups formed in the base generation (S_o) was treated as control line and raised separately along with the selected populations (other three lines) in each generation to observe and account for environmental influences. Single pair mating was followed with females assigned at random to individual males with the restriction that no full sib mating was permitted.

Statistical analysis

The data generated on body weight for age were corrected for the fixed effects of line, generation, sex and hatch by the least squares analysis (Harvey, 1979) using the following linear model based on pooled data.

$Y_{ijklm} = \mu+st_i+g_j+s_k+h_l+e_{ijklm}$

Where,

Y_{ijklm} = measurement of a trait on m^{th} bird belonging to l^{th} hatch, k^{th} sex, j^{th} generation and i^{th} line

μ = overall mean

st_i = effect of i^{th} line

g_j = effect of j^{th} generation

s_k = effect of the k^{th} sex

h_l = effect of l^{th} hatch

e_{ijklm} = random error, assumed to be distributed normally and independently with mean zero and variance σ^2

Duncan's multiple range test (Duncan, 1955) was employed to make all pair wise comparisons of means.

RESULTS

Results of the least squares analysis of variance of body weights based on pooled data are presented in Table 1 and corresponding least squares means are given in Table 2.

The lines, generations, sexes and hatches had significant (P<0.01) effect on the body weight at hatch, 1, 2,3,4,5, and 6 weeks of age, except the influence of sex on body weight at hatch which was not found to be significant.

Table 1. Least squares analysis of variance for body weights

	Lines		Generations		Sexes		Hatches		Error	
	df	M.S.S	d.f	M.S.S	d.f	M.S.S	d.f	M.S.S	d.f	M.S.S
BWH	3	27.49**	3	217.05**	1	1.68	5	49.79**	6532	0.83**
BW1	3	491.47**	3	2623.98**	1	628.54**	5	32479.74**	6528	38.65**
BW2	3	5939.19**	3	8473.43**	1	4545.33**	5	23994.88**	6540	189.36**
BW2£			3	158.88*	1	296.51*	4	3015.94**	351	57.33**
BW3	3	3026.94**	3	83466.30**	1	29403.57**	5	51190.63**	6517	243.03**
BW4	3	1746.78**	3	142152.50**	1	109539.17**	5	9900.86**	6490	308.86**
BW4£			3	10358.48**	1	5334.86**	5	700.69**	350	140.88**
BW5	3	5300.41**	3	67635.02**	1	390358.30**	5	5309.68**	6213	326.08**
BW6	3	7264.24**	3	54355.53**	1	1007416.17**	5	6603.82**	5586	400.21**
BW6£			3	10183.43**	1	48321.08**	3	2997.06**	352	264.72**

*Significant at P<0.05; ** Significant at P< 0.01

The overall least squares means for body weights were 8.42 ± 0.04,39.63 ± 0.25, 79.30± 0.51, 120.84±0.63, 154.93±0.72, 177.80±0.75 and 196.85±0.89 g at hatch, 1,2,3,4,5, and 6 weeks of age, respectively.

The least squares means of body weights ranged from 8.60±0.04 g at hatch to197.04±0.99 g at 6 weeks of age in SWL line, 8.43±0.04 g to 199.87± 0.97g in FWL line and 8.30±0.04 g to 196.31±1.02 g in LWL line. In COL, the means body weights varied from 8.36±0.04 g at hatch to 194.17± 1.03 g at six weeks of age. The least squares means of selected parents at two weeks of age (SWL) was 83.32±0.78 g, at four weeks of age (FWL) 166.99 ± 1.46 g and at six weeks of age (LWL) 203.33± 0.94 g.

Table 2. Least squares means of body weights (g) at various ages (0-6 weeks) on pooled data

	BWH			BW1			BW2			BW2£			BW3			BW4			BW4£			BW5			BW6			BW6£		
Overall	**n**	**Mean**	**SE**	**n**	**Mean**	**SE**	**n**	**Mean**	**SE**	**n**	**Mean**	**SE**	**n**	**Mean**	**SE**	**n**	**Mean**	**SE**	**n**	**Mean**	**SE**	**n**	**Mean**	**SE**	**n**	**Mean**	**SE**	**n**	**Mean**	**SE**
	6545	**8.42**	**0.04**	**6541**	**39.63**	**0.25**	**6541**	**79.30**	**0.51**	**-**	**-**	**-**	**6530**	**120.84**	**0.63**	**6503**	**154.93**	**0.72**	**-**	**-**	**-**	**6226**	**177.80**	**0.75**	**5599**	**196.85**	**0.89**	**-**	**-**	**-**
Line																														
SWL	1690	8.60^{a}	0.04	1689	39.88^{a}	0.28	1689	77.55^{c}	0.57	360	83.82	0.78	1686	119.50^{c}	0.71	1684	154.78^{b}	0.81	-	-	-	1650	177.71^{b}	0.84	1477	197.04^{b}	0.99	-	-	-
FWL	1565	8.43^{b}	0.04	1565	40.18^{a}	0.27	1565	81.75^{a}	0.55	-	-	-	1558	122.56^{a}	0.68	1546	156.34^{a}	0.78	360	166.99	1.46	1472	180.26^{a}	0.82	1309	199.87^{a}	0.97	-	-	-
LWL	1717	8.30^{c}	0.04	1716	38.90^{b}	0.29	1716	78.00^{c}	0.59	-	-	-	1716	121.33^{b}	0.72	1711	154.85^{a}	0.83	-	-	-	1626	177.64^{b}	0.87	1459	196.31^{b}	1.02	360	203.33	0.94
COL	1573	8.36^{c}	0.04	1571	39.55^{c}	0.29	1571	79.91^{b}	0.60	-	-	-	1570	119.99^{bc}	0.73	1562	153.74^{c}	0.84	-	-	-	1478	175.60^{c}	0.88	1354	194.17^{c}	1.03	-	-	-
Generation																														
S_0	1634	8.31^{c}	0.04	1634	38.53^{c}	0.29	1634	82.72^{a}	0.60	90	85.67^{a}	1.11	1633	120.13^{c}	0.74	1624	148.34^{c}	0.85	90	161.12^{b}	1.96	1528	173.15^{c}	0.89	1429	191.15^{b}	1.04	90	190.02^{c}	1.89
S_1	1461	8.04^{d}	0.04	1460	38.84^{c}	0.30	1460	77.51^{c}	0.61	90	83.09^{b}	1.11	1460	110.71^{d}	0.75	1460	144.77^{d}	0.86	90	153.49^{c}	1.95	1446	170.27^{c}	0.90	1289	190.81^{b}	1.06	90	197.46^{b}	1.86
S_2	1817	8.93^{a}	0.04	1815	41.41^{a}	0.28	1815	78.81^{b}	0.58	90	83.96^{ab}	1.06	1814	128.68^{a}	0.71	1810	165.83^{a}	0.82	90	177.86^{a}	1.88	1734	184.27^{a}	0.86	1544	202.84^{a}	1.01	90	211.80^{a}	1.72
S_3	1633	8.42^{b}	0.04	1632	39.73^{b}	0.26	1632	78.17^{bc}	0.53	90	82.58^{b}	0.95	1623	123.86^{b}	0.65	1609	160.76^{b}	0.75	90	175.50^{a}	1.59	1518	183.53^{b}	0.79	1337	202.59^{a}	0.93	90	214.05^{a}	1.72
Sex																														
Male	3263	8.41^{a}	0.04	3262	39.32^{b}	0.26	3262	78.47^{b}	0.54	180	82.92^{b}	0.89	3259	118.72^{b}	0.66	3247	150.81^{b}	0.76	180	163.14^{b}	1.60	3095	169.87^{a}	0.80	2794	183.42^{b}	0.94	180	191.75^{b}	1.27
Female	3282	8.44^{a}	0.04	3279	39.94^{a}	0.26	3279	80.14^{a}	0.52	180	84.73^{a}	0.87	3271	122.97^{a}	0.65	3256	159.04^{a}	0.75	180	170.85^{a}	1.58	3131	185.73^{b}	0.78	2805	210.28^{a}	0.92	180	214.92^{a}	1.27
Hatch																														
1	1939	8.91^{a}	0.02	1938	34.65^{d}	0.14	1938	70.44^{d}	0.29	110	75.28^{c}	0.72	1938	107.99^{e}	0.36	1934	153.49^{c}	0.40	96	169.00^{a}	1.22	1840	180.56^{a}	0.42	1646	200.32^{a}	0.50	91	209.53^{a}	1.71
2	1916	8.53^{c}	0.02	1915	29.02^{e}	0.14	1915	70.71^{d}	0.29	112	78.09^{b}	0.72	1914	122.36^{b}	0.36	1909	151.82^{c}	0.40	106	167.78^{b}	1.16	1832	180.07^{a}	0.42	1648	199.17^{a}	0.50	103	202.88^{b}	1.60
3	1782	8.76^{b}	0.02	1781	34.24^{d}	0.15	1781	77.10^{c}	0.31	94	88.60^{a}	0.78	1779	119.92^{c}	0.37	1768	157.87^{a}	0.42	106	173.52^{a}	1.17	1691	181.89^{a}	0.44	1529	200.56^{a}	0.52	122	208.27^{a}	1.51
4	810	8.42^{d}	0.03	809	46.09^{b}	0.23	809	82.15^{b}	0.48	39	88.49^{a}	1.29	809	119.98^{c}	0.59	808	158.96^{a}	0.66	43	173.38^{a}	1.94	784	174.65^{b}	0.69	709	192.66^{b}	0.81	44	192.65^{c}	1.55
5	70	7.82^{f}	0.11	70	49.62^{a}	0.76	70	83.01^{b}	1.57	5	88.67^{a}	2.05	62	137.17^{a}	2.02	57	155.69^{b}	2.38	4	161.82^{c}	6.06	52	176.08^{b}	2.55	42	189.93^{b}	3.14	-	-	-
6	28	8.11^{e}	0.18	28	44.14^{c}	1.19	28	92.40^{a}	2.46	-	-	-	28	117.64^{d}	2.99	27	151.71^{c}	-	5	155.46^{c}	5.44	27	173.55^{b}	3.53	25	198.45^{a}	4.06	-	-	-

£- Selected parents mean; Means with different superscripts within each column, trait and effect differ significantly (P<0.05)

In first generation (S_0), the least squares means of body weights at hatch,1,2,3,4,5 and six weeks of age were 8.31±0.04, 38.53±0.29, 82.72±0.60, 120.13±0.74, 148.34 ±0.85, 173.15±0.89 and 191.15±1.04 g, respectively. The corresponding means were 8.04±0.04, 38.84±0.30, 77.51±0.61, 110.71±0.75, 144.77±0.86, 170.27±0.90 and 190.81±1.06 g in $S_{1,}$ 8.93±0.04, 41.41±0.28, 78.81±0.58, 128.68±0.71, 165.83±0.82, 184.27±0.86 and 202.84 g in S_2 and 8.42 ± 0.04, 39.73±0.26, 78.17±0.53, 123.86±0.65, 160.75±0.76, 183.53±0.79 and 202.59±0.93 g, in S_3 generations.

The least squares means of body weights of males at hatch, 1, 2,3,4,5 and 6 weeks of age were 8.41±0.04, 39.32±0.26, 78.47±0.54, 118.72±0.66, 150.81±0.76, 169.87 ± 0.80 and 183.42±0.94 g, respectively and in females in the same were 8.44±0.04, 39.94±0.26, 80.14± 0.52, 122.97± 0.65, 159.04±0.75, 185.73±0.78 and 210.28±0.92 g, respectively. The females weighed significantly (P< 0.05) heavier than the males from one to six weeks of age.

The hatch effect on body weights was observed to be significant (P< 0.05) at all the ages studied and necessary corrections for hatch effect were applied on the data before subjecting the same for further analysis.

DISCUSSION

Results of the study carried out through individual phenotypic selection for body weights at different ages in the Japanese quail are discussed here in the light of the findings available in the literature to arrive at definitive inferences.

Effect of Genetic Group

Least squares means of body weights at all ages of all selected lines were significantly higher (P < 0.05) than the control line except SWL at two and three weeks of age. The same indicated that selection for high body weight at different ages effectively improved the character under selection by aggregating the favourable genes in the selected population. Praharaj et al. (1990) , Brah et al. (1997), Sreenivasulu (1997), Shalam (2003), Dhaliwal et al. (2004), Feroz Mohammed *et al*. (2006) and Punya Kumari (2007) also recorded similar observations on the significance of strain / line effect on body weights at different ages.

Effect of Generation

The generation had a significant (P < 0.01) influence on the body weight of Japanese quail at all ages studied with the exemption of the same at two weeks of age. Further, the body weights at different ages steadily improved from S_0 to S_3 indicating the positive influence of selection practised. Although the Japanese quail in different lines were selected for body weight at different ages, the least squares means of body weights at the corresponding age, as well as at other ages were also improved significantly which showed that the pleiotropic genes influenced the body weights of Japanese quail at different ages (Feroz Mohammed, 2004).

The above findings were in accordance with those of Brah et al. (1998) and El Deen (2003) who also observed significant effect of generation on body weight at four weeks of age.

However, Sefton and Siegel (1974) could not identify such effect of generation on body weight, which might be because their study was restricted to comparison of only two generations.

Effect of Sex

Least squares means of body weights indicated that sex had no significant influence on weight at hatch. However, the effect of sex of the bird on the trait was found to be significant (P< 0.01) at 1, 2,3,4,5 and 6 weeks of age with the females weighing heavier by 0.62, 1.67, 4.25, 8.23, 15.86 and 26.86 g than the males at the above ages respectively. The sexual dimorphism was found to become much wider at five and six weeks of age which might be because of the fact that the reproductive organs in female Japanese quail constitute relatively large proportion of total body weight (Wilson et al., 1961) and the difference becoming more conspicuous around the age of sexual maturity at six weeks of age (Sefton and Siegel, 1974). The higher feed intake and better protein utilization by females could help them attain higher body weights than in males (Moudgal, 1996).

Shrivastava et al. (1995), Brah et al. (1997), Kirmizibayrak and Altinel (2001), Pramod Kumar *et al.* (2002), Saatci et al. (2003), Dhaliwal *et al.* (2004) and Shokoohmand et al. (2007) also observed significant effect of sex on body weight of Japanese quail at different ages.

Effect of hatch

The differences in least squares means of body weights at all ages of study were significant (P< 0.01) between hatches, which was in agreement with the finding of Narayan (1977), Strong et al. (1978), Prakash Babu et al. (1980), Brah et al. (1997), Sreenivasaiah et al. (1997), Feroz Mohammed et al. (2006) and Punya Kumari (2007).

The significant hatch effect on body weights might be explained because of the fluctuation in environmental conditions between the hatches and however, the same was found to taper off beyond four weeks of age indicating that the hatch effect influences Japanese quail at a juvenile age and a compensatory growth sets in later on to bring down the magnitude of difference witnessed earlier.

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