Growth, Reproductive and Egg Production Performance in Japanese Quail

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ABSTRACT. A total number of 2110 Japanese Quail produced during three consecutive generations were used in this study. The data were analyzed by fitting two different mixed models for growth and carcass traits and for reproductive and egg production traits.

Mean BW0, BW1, BW2, BW3, BW4, BW5 and BW6 was 8.07, 21.97, 43.22, 78.12, 107.15, 122.98 and 134.98 g. Differences between generations were (p < .01) for BW0, BW3, BW4 and BW6, while (p < .05) differences were observed for BW2 and BW5.

Mean ADG02, ADG24, ADG46 and ADG06 was 2.511, 4.57, 1.97 and 3.02 g/day. Differences between generations were (p < .01) for ADG24 and ADG06, while they were non-significant for ADG02 and ADG46.

D% increased (p < .01) with advance in generations, was 63.6, 64.9 and 66.3% during the 1st, 2nd and 3rd generation. The average P, F and M per cent in meat was 23.06, 8.99 and 66.05%.

Mean FER% and HAT% for 45.7 days was 91.0 and 84.0%. AFE and FER% differed (p < .05), while HAT% differed (p < .01) from one generation to another. Mean EP70 was 50.9, 59.3 and 60.1 eggs during the 1st, 2nd and 3rd generation. Egg production during all periods studied differed (p < .01) from one generation to another.

Introduction

Beside the suitability of using Japanese Quail (*Coturnix coturnix Japonica*) as a pilot animal for the more expensive experiments on chickens or turkeys, Quail industry

has been developed in recent years in many countries such as Japan, France and Italy (Itoh *et al.*, 1982; Risse, 1980) for both meat and egg production. This is due to that Quail's meat could be a good source for animal protein for human consumption beside that Quail's egg is a raw material for many industries such as egg powder, pickles and other. The taxonomy, morphology, history and management of coturnix have been discussed by Stanford (1959), Padgett and Ivey (1959), Wetherbee (1959) and Toschi (1959).

Material and Methods

A total number of 240 Japanese quails (*Coturnix coturnix Japonica*) (80 males and 160 females) randomly taken at an average age of 15 weeks from the main quail experimental flock was considered as a base population. The mating system was in a ratio as one male : two females avoiding full and half-sibling.

One week egg production was collected from each dam, marked and incubated for 15 days. After incubation, the eggs were divided randomly into two groups in separate cages inside the hatcher and left for two days. The two hatched groups of chicks were identified by wing-bands and raised in an electrically heated battery brooder unit until 2 weeks of age. Then the birds were transferred to growing pens where they remained until 6 weeks of age.

At 6 weeks of age, birds of Group I were slaughtered, while birds of Group II were left to study reproductive traits and produce the chicks for the next generation. The same system was followed for three generations. A complete description of the management, feeding and breeding practices used was given by El-Fiky (1991).

Individual body weights (BW) were recorded weekly from hatch until 6 weeks of age. The hatch weight (BW0) was recorded to the nearest 0.1 g, while body weights measured at later ages were recorded to the nearest 1 g. Individual average absolute daily gain (ADG) was obtained biweekly from hatch until 6 weeks of age, as well as from hatch to 6 weeks of age by the following formula (Brody, 1945):

$ADG = (w_2 - w_1) / (t_2 - t_1)$ in which $(w_2 - w_1)$ is the weight increment in time interval $(t_2 - t_1)$. Individual relative growth rate (RGR) was obtained biweekly from hatch until 6 weeks of age as well as from hatch to 6 weeks of age by the following formula (Brody, 1945) :

$RGR = (w_2 - w_1) / (w_2 + w_1) / 2) \times 100$ so RGR is expressed in percentage. These measurements were recorded on all males and females produced in Group I and Group II during the three generations.

A total number of 473 birds (230 males and 243 females) were taken from Group I to study carcass traits in the three generations (Table 1). Three birds at the age of 6 weeks were taken from each dam and slaughtered. Individual dressing percentage (D%) were estimated on a live body weight basis as follows :

$$D\% = (\text{Hot carcass weight/Live body weight}) \times 100$$

The crude protein in meat was calculated according to Kjeldahl method as follows :

Crude protein = Total nitrogen content × 6.25 and protein percentage was calculated as :

$$p\% = (\text{Crude protein} / \text{Dry weight}) \times 100$$

The amount of ether extract fat and moisture percent (F and M%) were estimated according to A.O.A.C. (1975).

Individual housed females from Group II were observed once per day for laying their egg from the 6th week of age and individual age at first egg (AFE) was recorded in days. A total number of 649 females were available during the three generations for the analysis (Table 1).

TABLE 1. Number of sire groups and their offspring used to study growth traits, carcass, reproductive and egg production traits during the three generations.

Generation	Group I				Group II			
	Parent		Offspring		Parent		Offspring	
	S	D	M	F	S	D	M	F
1st	15	30	58	61	60	120	121	242
2nd	29	58	88	86	53	106	105	211
3rd	30	60	84	96	49	98	98	196
Total	74	148[1]	230	243	162	324	324	649

S = Sire; D = Dam; M = Males; F = Females

Individual fertility percent (FER) was estimated using the same number of females through incubating one week egg production during the 10th week of age from each hen.

The weight of the total hatched chicks of a certain dam was recorded to the nearest 0.1 g and divided by the number of hatched chicks to obtain the average hatch weight per hen (AHW) which was considered as a reproductive trait for hen. A total number of eggs produced during the first 70 days of production (EP70) was recorded individually. Egg production was also recorded individually during the first (EP1) and the 7th (EP7) week of production.

Prior to analysis, the measurements taken as percentages were transformed using arc sin transformation according to Winer (1971).

Body weight, absolute daily gain, relative growth rate and carcass traits were analyzed by fitting a mixed model including generation, sex and generation by sex as fixed effects and sire with generation, dam within sire as random effects. While, reproductive traits were analyzed by fitting a mixed model including generation as a

fixed effect and sire within generation and daughter within sire within generation as a random effect (Model type 5 of Harvey, 1987).

Results and Discussion

Body Weight

Mean BW0, BW1, BW2, BW4 and BW6 (Table 2) falls generally within the range of estimates 6.6-8.8, 21.6-24.6, 43.4-43.6, 106-108 and 132-135 g, reported by Sefton and Siegel (1974), Marks (1978), Chachil *et al.* (1975), Marks (1980) and Blohowiak *et al.* (1984). The estimates of 78.1 and 122.9 g for mean BW3 and BW5 are higher than the estimates of 64.0 and 107 g reported by Sefton and Siegel (1974) and Steigner *et al.* (1989a), respectively.

The discrepancies between the different reported estimates could be possibly due to the variations in climatic and managerial conditions under which different flocks were reared, differences in the genetic make up of the blocks and/or differences in the statistical manipulation of the data used to obtain the estimates.

The percentage of variation in body weight increased with advance in age to a maximum of 13.3% at the 2nd week of age, thereafter, it decreased to a minimum of 5.1% at 6 weeks of age. The highest variability was during the 1st, 2nd and 3rd weeks (Table 2). This phenomena could be utilized in any section program aiming at improving body weight in the present flock.

The least-square mean for weight at different ages varied from generation to

TABLE 2. Actual means, standard deviation (SD) and coefficient of varia-
tion (V%) of body weight, average daily gain and relative growth
rate recorded at different ages.

Body weight at	No.	Mean ± SD	CV%
Hatch	2110	8.07 ± 0.81	7.3
1st week	2110	21.97 ± 3.06	11.9
2nd week	2109	43.22 ± 6.53	13.3
3rd week	2109	78.12 ± 9.49	10.2
4th week	2098	107.15 ± 10.56	8.3
5th week	2072	122.98 ± 9.80	6.3
6th week	2062	134.98 ± 10.72	5.1
Growth rate			
ADG 0 2	2109	2.51 ± 0.45	16.2
ADG 2 4	2098	2.57 ± 0.57	11.0
ADG 4 6	2062	1.97 ± 0.57	28.2
ADG 0 6	2062	3.02 ± 0.64	5.4
RGR 0 2	2109	136 ± 8.00	5.6
RGR 2 4	2098	85 ± 9.00	10.5
RGR 4 6	2062	23 ± 8.00	30.4
RGR 0 6	2062	177 ± 2.00	0.9

another without clear trend for the effect of generation on weight (Table 3). However, the differences between generations in BW0, BW3, BW4 and BW6 were (p < .01), while they were (p < .05) for BW2 and BW5 and non-significance for BW1 (Table 4). In a randombred population of Japanese Quail, Marks and Lepore (1968) and Collins *et al.* (1970) found that body weight increased during consecutive generations but without obvious trend for the level of significance of generation differences.

The discrepancies between different reports concerning the trend of generation effects on weight of Japanese Quail at different ages could be attributed to differences in genetic and/or non-genetic effects included under this major effect *i.e.* peculiar from one generation to another.

The least-square mean for body weight at different ages differed between males and females (Table 3). At hatch it was 7.9 and 8.2 g for males and females, respectively. The differences between the two sexes remained in favour of females until 6 weeks of age. The same trend was also observed by Marks and Lepore (1968), Sefton and Siegel (1974) and Chachil *et al.* (1975). The present estimates for the mean body weight of the two sexes (Table 3) falls generally within the range of estimates reported by Marks and Lepore (1968), Sefton and Siegel (1974) and Chachil *et al.* (1975). However, the estimates of (74.84 and 81.03 g) and (118.4 and 126.88 g) obtained for males and females BW3 and BW5 were higher than the estimates of (63.0 and 65.0 g) and (94.5 and 99.5 g) reported by Sefton and Siegel (1974), Marks and Lepore (1968). Chachil *et al.* (1975) and Narayan (1976) found that female were (p < .05 or p < .01) heavier than males at different ages from the first to the 6th week of age. Wilson *et al.* (1961) interpreted the heavy weight of females by the heavier

TABLE 3. Least-square means of factors affecting body weight recorded at different ages.

Independent variable	Hatch		1st week		2nd week		3rd week		4th week		5th week		6th week	
	No.	Mean ± SE	No.	Mean ± SE	No.	Mean ± SE	No.	Mean ± SE	No.	Mean ± SE	No.	Mean ± SE	No.	Mean ± SE
Generation														
1st	734	7.88 ± 0.1	734	21.79 ± 0.1	733	42.43 ± 0.5	733	75.87 ± 0.5	732	105.24 ± 0.6	722	121.73 ± 0.6	719	132.89 ± 0.6
2nd	706	8.04 ± 0.1	706	21.96 ± 0.1	706	43.28 ± 0.3	706	78.01 ± 0.5	700	106.86 ± 0.6	691	122.37 ± 0.5	690	134.65 ± 0.6
3rd	670	8.27 ± 0.1	670	21.98 ± 0.1	670	43.53 ± 0.3	670	79.91 ± 0.5	666	108.66 ± 0.5	659	123.83 ± 0.5	653	135.89 ± 0.6
Sex														
Males	967	7.93 ± 0.03	967	20.98 ± 0.1	967	41.11 ± 0.20	967	74.84 ± 0.30	961	103.48 ± 0.40	945	118.40 ± 0.40	939	128.14 ± 0.40
Females	1143	8.19 ± 0.03	1143	22.83 ± 0.01	1142	45.05 ± 0.20	1143	81.02 ± 0.30	1137	110.36 ± 0.40	1127	126.88 ± 0.40	1123	140.82 ±0.40

gonads, liver and intestines, while the males had a relatively more muscle tissue than the females. However, the sexual dimorphism for post juvenile weight Quail suggests that body weight of the two sexes should be considered distinct characteristics of the population. Similar conclusion has been reported by El-Ebiary *et al.* (1966) and Strong *et al.* (1978) in Japanese Quail. However, female superiority in body weight during the pre-juvenile stage observed here and in other studies seems to be unique to the Quail and calls for future interest.

The remaining random and fixed effects included in the model of analysis (Table 4) indicate that, except for the (p < .05) sire effect on BW3 and BW4; sire and dam effects were (p < .01) for weight at different ages. Furthermore, generation by sex interaction effects were non-significant for BW3 and BW4; (p < .05) for BW5, otherwise they were (p < .01) for body weight at different ages studied.

TABLE 4. Least-square analysis of variance of factors affecting body weight at different ages.

S.O.V.[a]	BW0		BW1		BW2		BW3		BW4		BW5		BW6	
	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.	d.f.	M.S.
Generation (G)	2	26.09	2	7.65	2	237.82	2	2858.35	2	2039.74	2	781.85	2	1555.28
Sire : (G)	226	1.99	226	17.84	226	69.09	226	153.84	226	222.09	226	193.83	226	241.79
Dam : S : G	233	1.34	233	12.22	233	49.53	233	118.11	233	13.70	233	110.63	233	116.28
Sex (SX)	1	32.80	1	1560.27	1	7044.85	1	17354.89	1	21349.93	1	32065.64	1	7140.03
G : (SX)	2	4.36	2	117.74	2	204.66	2	130.79	2	81.89	2	173.87	2	282.28
Remainder	1644	00.35	1644	6.71	1644	33.20	1622	63.71	1633	78.21	1607	59.76	1597	47.42

[a] Generation effect tested against sire within generation and sire within generation effect was tested against dam within sire within generation, other effects in the model tested against remainder mean squares.

  p < 0.05

  p < 0.01

Growth Rate

Average daily gain during different growth periods (Table 2) are generally higher than the reported estimates for the same growth periods. The estimate for ADG02 (2.51 g/day) is higher than that of 2.34 g/day reported by Darden and Marks (1989). Also, the estimate of 4.57 g/day (from 2 to 4 weeks) is higher than the range of estimates (3.12-3.57 g/day) reported by Sefton and Siegel (1974), Marks (1978) and Darden and Marks (1989). The estimate of 1.97 and 3.02 g/day (ADG46 and ADG06) are higher than that of 1.54 and 2.34 g/day reported by Sefton and Siegel (1974), Marks (1978) and Darden and Marks (1989). Daily gain as a growth trait is the result of the union and intersection operations between the set of genetic and the set of non-genetic factors affecting this trait. These two sets of factors vary considerably from one flock to another within the same species. This might interpret the discrepancies between the present and other reported estimates for daily gain during different growth periods.

The percentage of variation in daily gain (Table 2) was high for ADG46 (28.2%). This might be due to sex differences in body weight during that period which is in the neighborhood of the age at sexual maturity. Otherwise, the variation in daily gain ranged between low (5.4% for ADG06) and moderate (11.0-16.2%) for ADG24 and ADG02, respectively. However, the observed magnitude of variation in daily gain indicate the possibility of improving this trait in the present flock through selection.

The least-square mean for ADG24 and ADG06 differed ($p < .01$) between generations (Table 5). On the other hand, generation effects on ADG02 and ADG46 were not significant. Unfortunately, the literature consulted seems devoid of information concerning the effect of generation on daily gain in Japanese Quail. Therefore, it is difficult to compare the present results with others to deduce a conclusion concerning the trend of generation effect on this trait.

TABLE 5. Least-square means of factors affecting average daily gain and relative growth rate during different growth periods.

Independent variable	0-2 weeks			2-4 weeks			4-6 weeks			0-6 weeks		
	No.	ADG	RGR	No.	ADG	RGR	No.	ADG	RGR	No.	ADG	RGR
Generation												
1st	733	2.47 ± 0.02	137 ± 4.9	732	4.48 ± 0.03	85 ± 5.9	719	1.94 ± 0.04	23 ± 4.9	719	2.97 ± 0.01	178 ±1.7
2nd	706	2.52 ± 0.02	137 ± 4.5	700	4.54 ± 0.03	85 ± 4.8	690	1.97 ± 0.03	23 ± 3.9	690	3.01 ± 0.01	178 ±1.5
3rd	670	2.52 ± 0.02	136 ± 5.4	666	4.66 ± 0.03	86 ± 6.2	653	1.94 ± 0.03	22 ± 3.8	653	3.04 ± 0.01	177 ±1.8
Sex												
Males	967	2.37 ± 0.02	137 ± 4.6	961	4.46 ± 0.02	86 ± 2.9	939	1.73 ± 0.02	21 ± 3.1	939	2.86 ± 0.01	177 ±3.2
Females	1142	2.63 ± 0.02	138 ± 3.5	1137	4.66 ± 0.02	84 ± 3.4	1123	2.17 ± 0.02	24 ± 2.9	1123	3.16 ± 0.01	178 ±4.2

Females have ($p < .0$) higher daily gain than males during all growth periods (Table 6). Similarly Sefton and Siegel (1974) and Marks (1978) found that females have generally higher rate of growth than males during the consecutive growth periods from hatch to 6 weeks of age. However, the present results were expected since daily gain was computed as the differences between consecutive weights which in turn were higher in females than in males at all ages studied.

Mean for relative growth rate during different growth periods (Table 2) falls within the range of estimates reported by Lepore and Marks (1971), Sefton and Siegel (1974), Marks (1978) and Darden and Marks (1989). However, the estimates of 136% for RGR02 is lower than that of 146% reported by Darden and Marks (1989). While, the estimates of 85, 23 and 177% for RGR24, RGR46 and RGR06 were

TABLE 6. Least-square analysis of variance of factors affecting average daily gain and relative growth rate during different growth periods.

S.O.V.[+]	0-2 weeks			2-4 weeks			4-6 weeks			0-6 weeks		
	d.f.	ADG	RGR	d.f.	ADG	RGR	d.f.	ADG	RGR	d.f.	ADG	RGR
Generation (G)	2	0.63	0.231*	2	5.32**	0.019	2	0.18	0.009	2	0.63	0.005*
Sire (G)	226	0.31*	0.009*	226	0.63**	0.014*	226	0.73**	0.010**	226	0.13**	0.001*
Dam : S : G	233	0.23**	0.008**	233	0.39**	0.010**	233	0.36*	0.005	233	0.06**	0.001**
Sex (SX)	1	31.43**	0.437**	1	19.19**	0.188**	1	88.17**	0.483**	1	38.64**	0.73**
G : (SX)	2	0.69	0.004	2	0.21	0.050**	2	0.02	0.001*	2	0.09*	0.001
Remainder	1644	0.17	0.006	1633	0.25	0.008	1597	0.31	0.005	1597	0.03	0.001

[+] Generation effect tested against sire within generation and sire within generation effect was tested against dam within sire within generation. other effects in the model tested against remainder mean squares.

* $p < 0.05$
** $p < 0.01$

higher than the estimates of 78, 19 and 168% reported by Darden and Marks (1989), Lepore and Marks (1971) and Sefton and Siegel (1974), respectively.

The high variability observed in RGR46 (30.4%) is consistent with the same trend observed in body weight and average daily gain (Table 2). This might be due to sex differences in body weight during the growth period nearest the age at sexual maturity. Otherwise, the variability ranged between 0.9% (for RGR06) and 10.5% (for RGR24).

The estimates for RGR02 and RGR06 differed ($p < .05$) from one generation to another (Table 5). However, the differences between generation in RGR24 and RGR46 failed to reach the level of significance. Similar observations have been reported by Marks and Lepore (1968) and Collins et al. (1970) in Japanese Quail.

The least-square means for relative growth rate during different growth periods varied ($p < .01$) between the two sexes (Table 5). Females RGR02, RGR46 and RGR06 were higher than those for males. While, males had higher rate from 2 to 4 weeks of age (86 vs. 84%, respectively). Lepore and Marks (1971) reported ($p < .05$) sex differences during the first 4 weeks of growth while thereafter the rate of growth was almost similar for the two sexes.

The remaining random and fixed effects included in the model (Table 6) indicate that sire had ($p < .01$) effect on ADG24, ADG46 and ADG06 and on RGR46. Otherwise, sire effect on both traits was ($p < .05$). Except for the ($p < .05$) and non-significant dam effect on ADG46 and RGR46, respectively dam effect was ($p < .01$) on both traits. Generation by sex interaction effect was ($p < .05$) for ADG02 and ADG06 and ($p < .01$) for RGR24. Otherwise it was non-significant for both traits.

Carcass Traits

Dressing Percentages (D%)

The mean D% (65.14%) fall within the range of 63.90 and 69.35% reported by Bacon and Nestor (1983) and Wilson *et al.* (1961) in Japanese Quail. However, Jones *et al.* (1979) reported a higher estimate of 77% for Japanese Quail slaughtered at 10 and 18 weeks of age, respectively. Generally, the present estimate for D% in Japanese Quail is almost similar to those of 71 and 72% reported for broiler chickens and turkey by Hays and Marion (1973) and Dobson (1969), respectively which indicates the efficiency of Quail in meat production.

Dressing percentage varied (p < .01) from one generation to another (Table 8). The literature consulted seems devoid of any information concerning the effect of generation on D% in Japanese Quail.

The least-square mean for D% of females and males (64.7 and 65.2%) were lower than those estimates of 82.8 and 69.2% reported for the two sexes, respectively, by Collins and Abplanalp (1968). Sex differences in D% were (p < .05). On the other hand, Marks (1971), Hardy (1981) and Bacon and Nestor (1983) reported that sex did not influence D% significantly.

The differences in D% between males and females in spite of the heavy live body weight of the females may be due to that females at 5 weeks of age have heavier sexual organs, where the observed age at first egg in the present flock was 45 days. Therefore, the heavy sexual organs in females decreasing the D% than that of males when both were slaughtered at 6 weeks of age.

The overall mean for P, F and M% was 23.06, 8.9 and 55.05%, respectively. The variability in the three traits respectively was 8.96, 26.95 and 4.61%. The present estimates are in good agreement with the estimates of 22.6, 9.0 and 66.3% reported for P, F and M% in Japanese Quail meat by Hamm and Ang (1982), Lepore and Marks (1971) and Sadjadi and Becker (1980).

On the other hand, the estimates for P and F% were higher than the range of estimates 19.8-21.1% and 4.3-7.88% reported by Sadjadi and Becker (1980), Hardy (1981), Marks (1981) and Bacon and Nestor (1983) for P and F% in Japanese Quail meat. The estimates for M% is lower than the estimates of 70.7, 75.4 and 70.1%, reported by Lepore and Marks (1971), Hamm and Ang (1982) and Bacon and Nestor (1983).

The discrepancies between the present estimates for P and F% and other reported estimates might be due to the differences in the constituents of the diet on which the flock was reared before slaughter, to the differences in the methods of chemical analysis used and/or to sampling error.

In broiler chickens slaughtered at 8 weeks of age, Singh and Essary (1974) reported an estimate of 21.3, 5.0 and 73.4% for P, F and M%. This indicates that Japanese Quail meat have a similar percent of P, which is in favor of utilizing this bird in compensating the deficiency in meat production in Egypt and similar countries.

Also, the relatively high F% in Japanese Quail meat gives Quail meat better marbling characteristic than chicken meat.

Protein, F and M% fluctuated from one generation to another (Table 7). Generations differed (p < .05) in P and M%, while they did not differ significantly in F%. These results could not be compared with other results because the literature consulted is devoid of any information concerning the effect of generation on the chemical analysis of Japanese Quail meat.

TABLE 7. Least-square means[+] of factors affecting carcass traits.

Independent variable	No.	Mean			
		D%	P%	F%	M%
Generation					
1st	119	63.6	22.9	8.2	67.2
2nd	174	64.9	23.2	9.3	65.5
3rd	180	66.3	22.9	9.2	65.9
Sex					
Males	230	65.2	23.1	8.3	66.7
Females	243	64.7	22.9	9.5	65.7

[+] Means presented are the re-transformed estimates from the arc sin to the original scale and consequently are not associated with standard errors.

The least-square analysis of variance for the chemical components of meat of the two sexes showed that sex has (p < .01) effect on F and M%, while it has (p < .05) effect on P in meat. This should be considered in any breeding plan aimed at improving Japanese Quail meat quality. Generally, the present results indicate the high nutritive value of Japanese Quail meat. This calls for putting more emphasis on utilizing this bird in meat production on large scale to compensate the deficiency in meat production in Egypt and similar countries.

Sire and dam effects on F and M% were (p < .01), while they were (p < .05) for P% and not significant for D%. Generation by sex interaction effects were (p < .05) for D% and F%, while it was non-significant for P and M% (Table 8).

Reproductive Traits

The average AFE (45.7 days) is in good agreement with the range of estimates (45.3-58.9 days) reported by Marks (1979) and Steigner *et al.* (1989b). A lower estimate of 40.0 days was reported by Garrett *et al.* (1972) and a higher estimate of 49.49 days was reported by Kadry *et al.* (1986). The differences in the estimates might be due to differences in managerial and climatic conditions, differences in the genetic make up of the flocks, the size of data used, the numbers of generations studied, the mating system used and differences in the light regime imposed on the flock.

The least-square means indicate that AFE increased (p < .05) from the 1st to the 3rd generation. This may be due to the improvement in body weight with advance of

TABLE 8. Least-square analysis of variance of factors affecting carcass traits.

S.O.V.[+]	d.f.	M.s.s.			
		D%	P%	F%	M%
Generation (G)	2	273.39**	4.29*	45.99	105.55*
Sire : (G)	71	10.24*	1.01	•21.79**	26.70**
Dam : S : G	74	7.55*	0.95	11.55**	14.60**
Sex (SX)	1	28.95*	3.38*	129.19**	100.89**
G. SX	2	6.11*	0.32	26.34*	18.53
Remainder	322	5.35	0.84	5.87	9.29

[+] Generation effect tested against sire within generation and sire within generation effect was tested against dam within sire within generation, other effects in the model tested against remainder mean squares.

* $p < 0.5$

** $p < 0.01$

generations, due to the improvement in the managerial conditions of the block because no selection for high body weight was applied. Similarly Marks (1979) reported that body weight increased during the consecutive generations so that AFE was delayed. On the other hand, Marks (1980) reported that AFE remained constant during 5 consecutive generations which indicate no clear trend for the effect of generation on this trait.

Fertility

The average FER% (91%) is in good agreement with that of 93.9% reported by Gildersleeve *et al.* (1987). However, the present estimate is higher than the range of estimates (67.0-88.4%) reported by Marks (1980), Blohowiak *et al.* (1984), Woodard and Abplanalp (1967) Line *et al.* (1988) and Marks (1979). The differences between the estimates is expected, since this traits is highly affected by several factors other than the genotype such as age, rate of laying as well as the system of mating and climatic and managerial conditions.

The least-square mean indicate that FER% increased ($p < .05$) from the 1st to the 3rd generation. However, it should be noted that there was no any kind of selection towards improving prolificacy in the present flock. Therefore, the observed improvement in fertility might be due to non-genetic factors and/or to the system of mating used where full and half-sib mating were strictly prohibited. Kulenkamp *et al.* (1973) reported that continuous full-sib mating reduce fertility in Japanese Quail by 19.6, 42.0 and 34.0% during the 1st, 2nd and 3rd generation, respectively.

Hatch

The average HAT% (84.0%) is in good agreement with that of 84.7% reported by Sachdev *et al.* (1985). Collins and Abplanalp (1968), Chachil and Johnson (1974), Gildersleeve *et al.* (1987) and Havenstein *et al.* (1988) reported estimates ranging from 63.0 to 88.8%, while Marks (1980) reported a lower range of (42.0-64.0%) estimated for 5 consecutive generations.

TABLE 9. Least-square means of reproductive and egg production traits
during the three generations studied.

Traits	Mean ± SE		
	1st generation	2nd generation	3rd generation
AFE	44.9 ± 0.5	45.9 ± 0.5	56.5 ± 0.5
FER%	89.5	91.6	92.4
HAT%	78.8	86.0	88.5
AHW per hen	8.3 ± 0.1	8.5 ± 0.1	8.3 ± 0.2
E P			
EP1	2.7 ± 0.0	3.4 ± 0.1	3.6 ± 0.5
EP7	5.8 ± 0.3	6.5 ± 0.1	6.6 ± 0.6
EP70	50.9 ± 0.6	59.3 ± 0.8	60.1 ± 0.6

[+] Means presented are the re-transformed estimates from the arc sin to the original
scale and consequently are not associated with standard errors.

The discrepancies between the different estimates might be due to differences in
age of dam, rate of laying, pre-incubation storage of the eggs and to differences in
hatching machine used.

The least-squares mean indicate that HAT% increased ($p < .01$) from the 1st to
the 3rd generation. The improvement in HAT% with advance of generation may be
due to the same reasons mentioned before through which FER% was improved dur-
ing the consecutive generations. Kulenkamp *et al.* (1973) reported that continuous
full-sibling mating reduced HAT% by 16.1, 41.4 and 45.5% during the 1st, 2nd and
3rd generation, respectively. On the other hand, Marks (1980) reported that HAT%
fluctuated ($p < .05$) from 42.0 to 64.0% during five consecutive generations.

The average AHW per hen was 8.37 g. This trait was taken into account as a very
important trait for selecting dams for meat production because the Quail egg is con-
sidered as an intermediate production to produce next generations of Quail for meat.
To our knowledge, this trait was not taken into account or estimated before in
Japanese Quail studies. Therefore, the present estimate cannot be compared with
others.

The least-squares mean indicate that generations did not differ significantly in
their AHW per hen.

Egg Production

The average EP increased with advance of age where the production during the
EP1 was 3.19 egg/bird and during the EP7 was 6.29 egg/bird. The average 70 days EP
was 56.4 egg/bird. Similar estimates of 59 and 58.6 egg/bird was reported by Garrett
et al. (1972) and Strong *et al.* (1978) for the same period of production. However, the
present estimate is higher than that of 45.6 egg/bird reported by Havenstein *et al.*
(1988) for the same period.

The variability in EP decreased from the 1st to the 7th week (32.4 to 13.2%, respectively) and it was lower when the total EP during 70 days of production was taken into consideration (7.65%). The high variability during the 1st week was expected since EP is always irregular during this period, due to the irregularity in clutch of laying eggs among the birds of the flock.

The least-squares mean indicate that EP during the different periods studied increased (p < .01) from the 1st to the 3rd generation. This may be due to the mating system used where full and half-sib mating was avoided. Kulenkamp *et al.* (1973) reported that inbreeding causes depression in reproduction in Japanese Quail. On the other hand, Collins *et al.* (1968) and Bacon and Nestor (1983) reported that generation differences in Quail EP failed to reach the level of significance.

Sire and dam effects were (p < .01) for AFE, AHW per hen and EP70 and (p < .05) for EP1. On the other hand, sire effects were non-significant for F, H% and EP7, while dam effects were (p < .01) for the three traits (Table 10).

TABLE 10. Least-square analysis of variance of factors affecting reproductive and egg production traits recorded during different periods.

S.O.V	d.f.	Mean square						
		AFE	FER%	HAT%	AHW	EP1	EP/EP2	EP70
Generation	2	148.50*	0.48*	5.08**	2.97	42.55**	41.79**	5794.80**
Sire : (G)	146	53.65**	0.20	0.19	1.36**	1.79*	1.09	69.09**
Dam : S : G	150	20.11**	0.19**	0.21**	0.79**	1.31*	1.03**	38.31**
Remainder	350	8.53	0.13	0.11	0.28	1.07	0.69	18.64

Generation effect tested against sire within generation and sire within generation effect was tested against dam within sire within generation.
* p < 0.05
** p < 0.01

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قدرات النمو والتناسل وإنتاج البيض في السمان الياباني

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المستخلص : استخدم في هذه الدراسة عدد ٢١١٠ طائر من السمان الياباني تم إنتاجها خلال ثلاثة أجيال متعاقبة وقد تم تقييم قدرات النمو من خلال تسجيل أوزان الجسم عند أعمار مختلفة إلى جانب معدل النمو خلال فترات النمو المختلفة . كما تمت دراسة خصائص الذبيحة وإنتاج البيض ونسبة الخصوبة ونسبة الفقس ومتوسط وزن الكتاكيت عند الفقس لكل دجاجة . وكان متوسط وزن الجسم الأسبوعي ٨,٠٧ ، ٢١,٩٧ ، ٤٣,٢٢ ، ٧٨,٢٢ ، ١٠٧,١٥ ، ١٢٢,٩٨ ، ١٣٤,٩٨ جرام من الفقس حتى الأسبوع السادس من العمر . وكان متوسط معدل النمو اليومي المقدر كل أسبوعين ٢,٥١ ، ٤,٥٧ ، ١,٩٧ ، ٣,٠٢ جرام/يوم خلال فترات النمو من الفقس حتى الأسبوع السادس ومن الفقس إلى ٦ أسابيع . وارتفع معدل النمو اليومي في الإناث عنه في الذكور بدرجة عالية المعنوية خلال جميع فترات النمو المختلفة ، وكان معدل النمو النسبي المقدر كل أسبوعين ١٣٦ ، ٨٥ ، ٢٣ ، ١٧٧ خلال فترات النمو من الفقس وحتى ٦ أسابيع ومن الفقس إلى ٦ أسابيع ، واختلفت الأجيال بصورة عالية المعنوية في نسبة تصافي الذبيحة حيث بلغت ٦٣,٦ ، ٦٤,٩ ، ٦٦,٣ خلال الثلاثة أجيال على التوالي ، كانت نسبة البروتين والدهن والرطوبة في اللحم ٢٣,٠٦ ، ٨,٩٩ ، ٦٦,٠٥ . كان متوسط العمر عند أول بيضة ونسبة الخصوبة ونسبة الفقس ٤٥,٧ يوم و ٨٤,٩١ على التوالي . وكان متوسط إنتاج البيض خلال ٧٠ يوم ٥٠,٩ ، ٥٩,٣ ، ٦٠,١ بيضة خلال الثلاثة أجيال على التوالي .