MEDWELL PUBLISHING
Journal of Animal and Veterinary Advances 8 (5): 962-970, 2009
ISSN: 1680-5593

Effects of Divergent Selection Methods Based on Body Weights of Quail on Improvement of Broiler Quail Parents

[1]Mikail Baylan, [1]Sibel Canogullari, [3]Suat Sahinler, [2]A. Nazim Uluocak and [3]Gulsen Copur
[1]Samandag Vocational School, Mustafa Kemal University, Samandag, Hatay, Turkey
[2]Department of Animal Science, Faculty of Agriculture, Cukurova University, Adana, Turkey
[3]Department of Animal Science, Faculty of Agriculture, Mustafa Kemal University, Hatay, Turkey

Abstract: The purpose of this study, was to investigate the effects on body weight, weight gain, feed intake and feed efficiency of different selection methods for Body Weight (BW) in Japanese quail. For this purpose, line M_{55} was subjected to individual selection for 5 week BW while, a reciprocal recurrent selection method was applied to lines R_{33} and S_{55}. Selection lasted 2 generations. Five weeks body weights in the parents of M_{55}, R_{33} and S_{55} lines were obtained and were 273.5, 258.9 and 259.0 g in the beginning generation; 282.9, 284.8 and 279.5 g in the first generation and 284.6, 285.5 and 284.3 g in the 2nd generation. Average 5 weeks old body weights in the offspring of mass selection lines (M_{55}) and offspring of cross-bred lines (R_3S_5 and S_5R_3) obtained from reciprocal mating were 279.5, 267.3 and 264.0 g in the 1st generation and the values obtained were 300.7, 300.5 and 300.2 g in the 2nd generation. In the 2nd generation, body weight increases were higher than the 1st generation, especially in the reciprocal selection lines. Feed consumption of the 1st generation in M_{55}, R_3S_5 and S_5R_3 lines were 768.62, 682.61 and 674.18 g and in the 2nd generation were 776.77, 790.64 and 791.71 g, respectively. Feed conversion efficiency was also calculated and was 2.83, 2.63 and 2.63 in the 1st generation and 2.66, 2.71 and 2.73 in the 2nd generation. Applying different selection methods in the present study seeking to increase body weight in quails either in parents or in offspring showed that reciprocal selection lines resulted in higher body weight than initial body weight. Feed consumption and feed conversion efficiency are similar to in the reciprocal selection lines both in the 1st and 2nd generations.

Key words: Quail, selection, body weight, feed intake, feed conversion efficiency

INTRODUCTION

Recently, Japanese quail (*Coturnix coturnix Japonica*) has become an important livestock in Turkey. The advantages of Japanese quail, which have been widely used for biological and genetic studies (Narayan *et al*., 1998) because they require less time and space. They are easier to handle and have lower amount of feed requirements, more rapid growth, earlier sexual maturity, greater laying ability, shorter time of hatching and resistant to diseases as compared with chickens (Wilson *et al*., 1961). The short generation interval (4 or more generations per year) and similarity of the genetic parameters with domestic fowl are the main advantages of Japanese quail. Besides this, in spite of the small body size of the Japanese quail, its meat and eggs are widely consumed all over the world. Commercially produced quail are reared mainly for meat in Europe and for eggs in Japan and are often bred as dual-purpose birds in other Asian countries (Minvielle, 1998). Recently, meat quail have begun to attract the interest of quail producers, but most producers find it difficult to obtain superior quality parents.

Selection has an important role in genetic improvement in animal production. Individual selection is particularly indispensable in selection experiments for BW in poultry. In such experiments, high heritability of body weight provides major benefits.

Many researchers have reported that the heritability of BW in Japanese quail is moderate to high (Marks and Lepore, 1968; Collins *et al*., 1970; Darden and Marks, 1988; Marks, 1989; Kocak *et al*., 1995).

Selection experiments with different selection methods in different environments have been performed, but most involved individual selection and used BW at the 3rd, 4th and 5th week of age as the criterion.

Experiments using selection methods have also been carried out to obtain heterosis. Reciprocal recurrent

Corresponding Author: Mikail Baylan, Samandag Vocational School, Mustafa Kemal University, 31780 Samandag/ Hatay, Turkey

selection, which involves 2 types of selection in favour of additive and nonadditive genetic variation, is an important breeding method to obtain heterosis and to achieve stable lines. First developed by Comstock *et al.* (1949), this method enables to be developed with selection that will be done within own with regards combination capability of lines. That is to say, reciprocal recurrent selection designed to increase genetic distance between lines should eventually achieve maximum heterosis.

There are many experiments demonstrating significant genetic improvement and heterosis in selection experiments for BW in Japanese quail. Woodard *et al.* (1973) conducted an experiment using mass selection over 29 generations for 6 weeks BW and demonstrated higher (70%) BW increase in the selected line compared to the unselected line. Darden and Marks (1988) reported that different environment selection continued for 11 generations based on 4 weeks BW in Japanese quail, which resulted in higher increases (48.9 and 49.7%) in selected lines in comparison to the control line. Marks (1989) also reported that the BW increase was 31, 44 and 51% from the 27-70th generation. Camci (1992) reported that 5 generations of selection for high 5 weeks BW in Japanese quail resulted in increases in BW in the 1st and 3rd generation, but this increase was steady during 3rd and then started to increase. An experiment on different quail genotypes was conducted and found that groups selected by BW showed higher performance than control groups and that the crossbred genotype was superior to the pure genotype (Testik *et al.*, 1993). Uluocak *et al.* (1997) reported that 5 generations of selection for 5 weeks BW in Japanese quail led to higher BW in the following generation. Baylan and Uluocak (1999) explained that 2 generations of selection for high 3rd, 4th and 5th week BW in Japanese quail produced an increase in BW, especially in the 4th and 5th week selection groups.

In quails, the heaviest lines have better feed efficiency (Lepore and Marks, 1971; Darden and Marks, 1988). Marks (1993) observed in quails that the selection for body weight improved feed utilization even though there was an increase in total feed intake due to the need for maintenance (nutritional) requirements of a larger body mass.

Therefore, the purpose of this study was to investigate effects on body weight, weight gain, feed consumption and feed efficiency of different selection methods for body weight in Japanese quail.

MATERIALS AND METHODS

The quail lines used were M_{55}, R_{33} and S_{55}. These lines were developed previously by selection for BW in our Research Unit. Details regarding the establishment of these lines can be found in Baylan (2003). Briefly, M_{55} was obtained after 9 generations of individual selection for 5 weeks BW. Lines R_{33} and S_{55} were obtained following 3 generations of individual selection based on 3 and 5 weeks BW at the beginning, respectively and followed by 3 generations of reciprocal recurrent selection.

In this study, line M_{55} was subjected to individual selection for 5 weeks BW while reciprocal recurrent selection was applied to lines R_{33} and S_{55}. Selection lasted for 2 generations.

Individual selection was applied to M_{55} and 70 parents were selected from the quail population based on the sex ratio (3♀:1♂) per generation. Eighty male and 80 female pullets were obtained from each generation from lines R_{33} and S_{55} and these parents were transferred to individual cages in order to perform reciprocal crosses (80 pair-matings R_3S_5 and 80 pair-matings S_5R_3) at the end of 5 weeks of age. One male and one female were kept together in individual cages (15×25×20 cm). Hatchery management started when these parents were 13 weeks old. Eggs were collected separately from individual cages and transferred to an incubator after the necessary sanitary management. After hatching, each cross offspring (R_3S_5 and S_5R_3) was identified humanely with an aluminium wing-tag and was reared for 5 weeks.

Individual data belonging to cross offspring were analysed using the Derivative Free Restricted Maximum Likelihood DFREML Ver 3.0 β programme under the individual Animal Model (AM) (Meyer, 1998). Based on the 5 weeks performance of cross offspring, the breeding values of parents were calculated and then superior male and female parents were selected (in the proportion 9:27). Thus, R_{33} and S_{55} parents were selected as the parents of the next generation (The mating model is shown in Fig. 1).

Offsprings ($M_{55,}$ R_3S_5 and S_5R_3) were tested for body weight, weight gain, feed intake and feed utilisation at the same point in each generation. The test in offspring was made twice for per generation.

During the study, the quail were fed with grower diet containing 22% crude protein and 3000 kcal ME kg^{-1} for 0-5 weeks. After 5 weeks, they were fed with layer diet containing 17% CP and 2650 kcal ME kg^{-1}. Feed and water were provided *ad-libitum*. Light was provided for 24 h during the growing period (0-5 weeks) and for 16 h during the laying period. All hatched chicks were raised in the battery brooder until 2 weeks of age and were then transferred to growing cages until 5 weeks of age. After this, line M_{55} was transferred into laying cages while, lines R_{33} and S_{55} were transferred into individual cages (a pair-mating in each individual cage) in order to perform the reciprocal cross (R_3S_5 and S_5R_3). In all lines, individual BW data were recorded weekly until 5 weeks of age by using

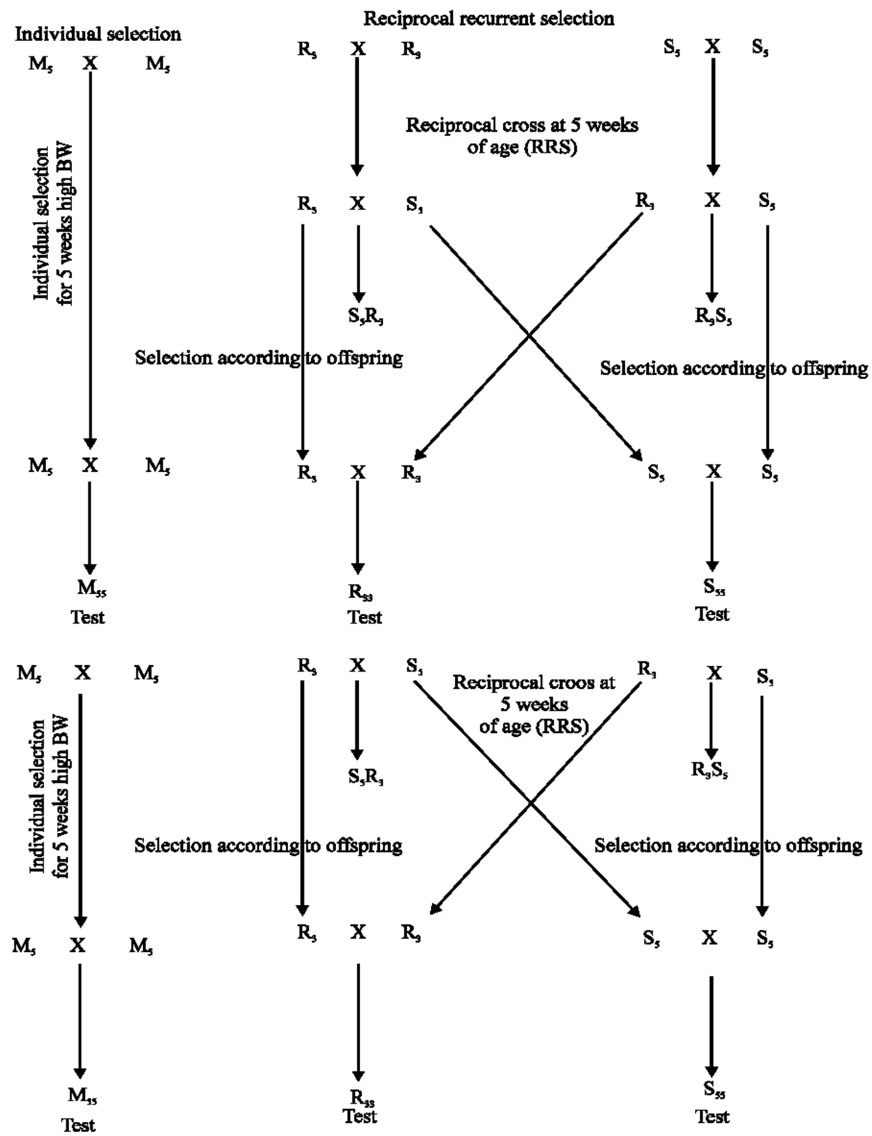

Fig. 1: Selection carried out

a 0.1 g sensitive electronic scale. Data were analysed by using the ANOVA procedure of SPSS. Significant differences between means were ranked by using Duncan's Multiple Range Test (Windows version of SPSS, release 10.01).

RESULTS

The body weight of parents: Body weights of generations at 5 weeks old are illustrated in Table 1. Body weights were determined as 273.5, 282.9 and 284.6 g in line M_{55}; 258.9, 284.8 and 285.5 g in line R_{33} and 259.0, 279.5 and 284.3 g in line S_{55} for the initial, first and second generations, respectively.

Differences between body weight of lines in the initial and the first generations were found statistically significant ($p<0.05$). In the second generation, significant differences between BWs of lines were not found ($p>0.05$). At the end of the second generation, increases in BW were 11.1, 26.6 and 25.3 g compared to BWs of initial generations of M_{55}, R_{33} and S_{55} lines. Percentage deviations of BW were obtained and were 4.05, 10.27 and 9.76% in these lines, respectively. The increase in BW of lines subjected to reciprocal selection was higher than the M_{55} line subjected to individual selection.

Results regarding the performance of offspring

Body weight: Table 2 shows the weekly body weights of offspring of the M_{55} line and crossbred (R_3S_5 and S_5R_3)

Table 1: Fifth week body weight means of parents according to generation (*)

		Initial generation		I. Generation		II. Generation	
Line	Sex	N	X±Sx	N	X±Sx	N	X±Sx
M_{55}	Female	105	261.5±2.27^{a}	115	270.7±2.38^{b}	48	270.1±4.09^{b}
	Male	95	287.4±2.99^{A}	124	294.3±2.42^{A}	40	302.1±4.80^{A}
	Mean	200	273.5±2.05^{a}	239	282.9±1.86^{ab}	88	284.6±3.54
R_{33}	Female	155	252.3±1.75^{b}	236	275.5±1.31^{a}	43	282.1±3.57^{a}
	Male	140	266.2±2.08^{B}	231	294.8±1.72^{A}	51	288.3±3.21^{B}
	Mean	295	258.9±1.41^{b}	467	284.8±1.16^{a}	94	285.5±2.39
S_{55}	Female	165	252.4±1.59^{b}	227	271.6±1.34^{ab}	43	274.6±3.43^{ab}
	Male	168	265.6±1.81^{B}	220	287.9±1.52^{B}	32	297.3±4.13^{AB}
	Mean	333	259.0±1.26^{b}	447	279.5±1.08^{b}	75	284.3±2.93

(*). In same generation, means shown with different superscripts differ significantly ($p<0.05$) between females (A,B) and males (a,b) in lines

Table 2: Body weight and body weight gain of offspring in the first generation (*)

Age (week)	Line	Sex	N	Body weight (g)	Average body weight (g)	B.W.G.[1] (g)	B.W.G.[1] Mean (g)	B.W.G.[1] (%)	B.W.G.[1] Mean (%)
0	M_{55}	M,F	175	8.7±0.07^{a}	8.7±0.07^{a}	---	---	---	---
	R_3S_5	M,F	632	8.4±0.03^{b}	8.4±0.03^{b}	---	---	---	---
	S_5R_3	M,F	525	8.1±0.03^{c}	8.1±0.03^{c}	---	---	---	---
1	M_{55}	M,F	164	38.0±0.46^{a}	38.0±0.46^{a}	29.3	29.3	10.48	10.48
	R_3S_5	M,F	545	35.8±0.20^{b}	35.8±0.20^{b}	27.4	27.4	10.25	10.25
	S_5R_3	M,F	458	37.7±0.30^{c}	37.7±0.30^{c}	29.6	29.6	11.21	11.21
2	M_{55}	M,F	159	84.1±0.97^{a}	84.1±0.97^{a}	46.1	46.1	16.49	16.49
	R_3S_5	M,F	535	84.1±0.43^{a}	84.1±0.43^{a}	48.3	48.3	18.06	18.06
	S_5R_3	M,F	446	83.6±0.47^{a}	83.6±0.47^{a}	45.9	45.9	17.38	14.38
3	M_{55}	M	77	161.0±2.48^{a}		76.9		28.99	
		F	80	162.4±2.15^{A}	161.7±1.63^{a}	78.3	77.6	26.77	27.76
	R_3S_5	M	254	154.9±0.87^{b}		70.8		27.50	
		F	278	158.4±0.90^{A}	156.7±0.63^{b}	74.3	72.6	26.88	27.16
	S_5R_3	M	211	154.6±0.93^{b}		71.0		27.88	
		F	235	158.4±1.0^{A}	156.6±0.70^{b}	74.8	73.0	27.42	27.65
4	M_{55}	M	72	227.4±2.86^{a}		66.4		25.03	
		F	82	236.9±2.99^{A}	232.4±2.11^{a}	74.5	70.7	25.47	25.29
	R_3S_5	M	255	216.4±1.09^{b}		61.5		23.19	
		F	274	224.6±1.44^{B}	220.7±0.93^{b}	66.2	64.0	22.64	23.94
	S_5R_3	M	215	217.9±1.25^{b}		63.3		24.59	
		F	239	227.0±1.26^{B}	222.7±0.91^{b}	68.6	66.1	24.81	24.72
5	M_{55}	M	73	265.2±3.63^{a}		37.8		14.68	
		F	80	292.4±3.73^{A}	279.5±2.82^{a}	55.5	47.1	18.98	16.85
	R_3S_5	M	251	257.4±1.19^{b}		41.0		15.96	
		F	272	276.4±1.60^{B}	267.3±1.09^{b}	51.8	46.6	18.74	17.43
	S_5R_3	M	219	254.6±1.43^{b}		36.7		14.41	
		F	238	272.7±1.59^{B}	264.0±1.15^{b}	45.7	41.3	16.75	15.64

(*). In same week, means within same column with different superscripts (a,b,c)differ significantly ($p<0.05$), In same week, means shown with different superscripts differ significantly ($p<0.05$) between females (A,B) and males (a,b) in lines, [1]. BWG: Body Weight Gain

obtained by reciprocal crossing. In the first generation, 5th week Bws in the M_{55} line were 265.2, 292.4 and 279.5 g, in male, female and mixed sex on average, respectively. These parameters were 257.4, 276.4 and 267.3 g in R_3S_5 cross; 254.6, 272.7 and 264.0 g in S_5R_3 cross in male, female and mixed sex on average, respectively. The M_{55} line had the significantly higher BW almost all weeks ($p<0.05$), except the 2nd week.

Weekly body weight of offspring in the M_{55} line and the crossbred lines (R_3S_5 and S_5R_3) obtained with reciprocal crosses in the second generation are given in Table 3. Fifth week BW in the M_{55} line was 285.8, 316.2 and 300.7 g, in male, female and mixed sex on average, respectively. Fifth week BWs of R_3S_5 cross were 290.3, 311.7 and 300.5 g in male, female and mixed sex on average, respectively. These values were 290.3, 311.7 and 300.5 g in the S_5R_3 cross. As shown in Table 3, the crossbred lines (R_3S_5 and S_5R_3) had higher BW than the offspring of the M_{55} line until the 4th week of age ($p<0.05$), but these differences became insignificant in the 5th week of age.

In the event BWs of M_{55}, R_3S_5 and S_5R_3 offspring were 279.5, 267.3 and 264.0 g at 5 weeks old in the 1st generation; these values were determined as 300.7, 300.5 and 300.2 g in the 2nd generation, with the result that the increases in BW in the second generation were higher than those of the first generation, especially those obtained by reciprocal crossing.

Body weight gain: Weekly body weight gain in offspring is shown both relatively, as a percentage and quantitatively (Table 2 and 3). In the 1st generation, BW

Table 3: Body weight and body weight gain of offspring in the second generation (*)

Age (week)	Line	Sex	N	Body weight (g)	Average body weight (g)	B.W.G.[1] (g)	B.W.G.[1] Mean (g)	B.W.G.[1] (%)	B.W.G.[1] Mean (%)
0	M_{55}	M,F	185	9.4±0.05^a	9.4±0.05^a	---	---	---	---
	R_3S_5	M,F	611	9.1±0.03^b	9.1±0.03^b	---	---	---	---
	S_5R_3	M,F	504	8.8±3.94^c	8.8±3.94^c	---	---	---	---
1	M_{55}	M,F	164	34.1±0.40^b	34.1±0.40^b	24.7	24.7	8.21	8.21
	R_3S_5	M,F	567	39.1±0.21^a	39.1±0.21^a	30.0	30.0	9.98	9.98
	S_5R_3	M,F	473	38.8±0.19^a	38.8±0.19^a	30.0	30.0	9.90	9.90
2	M_{55}	M,F	160	87.8±1.15^b	87.8±1.15^b	48.7	48.7	16.19	16.19
	R_3S_5	M,F	576	97.0±0.49^a	97.0±0.49^a	58.2	58.2	19.36	19.36
	S_5R_3	M,F	444	96.1±0.50^a	96.1±0.50^a	57.3	57.3	18.92	18.92
3	M_{55}	M	82	162.9±2.08^b		75.1		26.27	
		F	80	171.3±2.20^B	167.0±1.54^b	83.5	79.2	26.40	26.33
	R_3S_5	M	297	176.8±0.77^a		79.8		27.48	
		F	275	179.5±1.10^A	178.1±0.66^a	82.5	81.1	26.46	26.98
	S_5R_3	M	223	177.6±0.92^a		81.5		28.04	
		F	248	180.0±1.00^A	178.9±0.68^a	83.9	82.8	26.69	27.34
4	M_{55}	M	85	233.5±2.25^b		70.6		24.70	
		F	77	246.3±2.58^B	239.6±1.77^b	75.0	72.6	23.71	24.14
	R_3S_5	M	299	242.8±1.00^a		66.0		22.73	
		F	267	249.6±1.31^{AB}	246.0±0.82^a	70.1	67.9	22.48	22.59
	S_5R_3	M	218	243.9±1.19^a		66.3		22.81	
		F	247	252.8±1.22^A	248.7±0.88^a	72.8	69.8	23.16	23.05
5	M_{55}	M	83	285.8±2.42		43.0		15.04	
		F	80	316.2±4.04	300.7±2.61	69.9	61.1	22.10	20.31
	R_3S_5	M	293	290.3±1.19		47.5		16.36	
		F	267	311.7±1.86	300.5±1.17	62.1	54.5	19.92	18.13
	S_5R_3	M	225	290.6±1.46		46.7		16.07	
		F	241	314.3±1.79	302.8±1.28	61.5	54.1	19.56	17.86

(*). In same week, means within same column with different superscripts (a,b,c) differ significantly ($p<0.05$). In same week, means shown with different superscripts differ significantly ($p<0.05$) between females (A,B) and males (a,b) in lines, [1].B.W.G: Body Weight Gain

gain in the M_{55}, R_3S_5 and S_5R_3 offspring was found to be 10.48, 10.25 and 11.21% in the 1st week and 16.49, 18.06 and 14.38% in the 2nd week, respectively. Body weight gains were higher in these lines in the 3rd week, at 27.76, 27.16 and 27.65%. Fourth week BW gains were determined as 25.29, 23.94 and 24.72% in these lines, respectively, but this BW increase declined to 16.85, 17.43 and 15.64% at the 5th week in these lines, respectively. All lines were similar with respect to relative body weight gain but M_{55} offspring were heavier than the other lines after 2 weeks, quantitatively (Table 2).

In the 2nd generation, BW increases were found to be 8.21, 9.98 and 9.90% in M_{55}, R_3S_5 and S_5R_3 lines at the first week; and 16.19, 19.36 and 18.92% at the 2nd week, respectively. As shown in the 1st generation, body weight gains were higher in the third week in these lines, at 26.33, 26.98 and 27.34%, respectively. The increases in BW were found to be 24.14, 22.59 and 23.05% at the 4th week. These increases were 20.31, 18.13 and 17.86% at the 5th week in these lines, respectively. The decreases in BW increase at the 5th week were lower than those obtained in the first generation.

Feed consumption and feed conversion: Feed conversion, weekly feed consumption and cumulative feed consumption in all weeks are shown in Table 4. This Table 4 shows that feed consumption increased in lines when the birds were getting older. It was shown that feed intake increased by age in both the 1st and 2nd generations. Feed intake by week in the 1st generation was high in the line M_{55} in all weeks, except the 1st week. At the end of the fifth week, cumulative feed consumption was determined as 768.62, 682.61 and 674.18 g in the M_{55}, R_3S_5 and S_5R_3 lines, respectively. Daily feed consumption was found to be 21.96, 19.50 and 19.26 g in the same lines, respectively.

In the 2nd generation, cumulative feed intake was found to be 776.77, 790.64 and 791.71 g; daily feed intake was found to be 22.19, 22.58 and 22.61 g in the lines, respectively. Feed intake in all lines was high in the 2nd generation paralleling the increases in body weight of quails.

As shown in Table 4, feed conversion increases by age in both 1st and 2nd generations. In the 1st generation, crossbred lines had better feed conversion in all weeks when compared to M_{55}, except the 1st week. While, feed conversion ratios were 1.86, 1.98 and 1.95 in the 1st week in the M_{55}, R_3S_5 and S_5R_3 lines, these values were realized as 4.94, 4.49 and 4.90 in the 5th week. In the 2nd generation, feed conversion ratios were 1.84 1.85 and 1.85 in the 1st week, 4.33, 4.88 and 4.90 in the 5th week in the M_{55}, R_3S_5 and S_5R_3 lines, respectively. Although, feed consumption and feed conversion were better in the reciprocal selection lines than mass selection

Table 4: Feed intake and feed conversion efficiency according to generations in selection lines(*)

Age (week)	Line	1. Generation Feed intake (g/week/bird)	Additive feed intake	Feed conversion	2. Generation Feed intake (g/week/bird)	Additive feed intake	Feed conversion
1	M_{55}	54.57	54.57	1.86	45.58	45.58	1.84
	$R_3 S_5$	55.07	55.07	1.98	55.74	55.74	1.85
	$S_5 R_3$	57.93	57.93	1.95	55.59	55.59	1.85
2	M_{55}	125.21	179.78	2.71	123.97	169.55	2.54
	$R_3 S_5$	102.02	157.09	2.11	125.60	181.34	2.15
	$S_5 R_3$	102.12	160.05	2.22	123.52	179.11	2.15
3	M_{55}	155.75	335.53	2.00	149.18	318.73	1.88
	$R_3 S_5$	135.85	292.94	1.87	156.87	338.21	1.93
	$S_5 R_3$	132.51	292.56	1.81	156.83	335.94	1.89
4	M_{55}	200.35	535.88	2.83	192.92	511.65	2.65
	$R_3 S_5$	180.33	473.27	2.81	186.12	524.33	2.74
	$S_5 R_3$	169.70	462.26	2.56	202.28	538.22	2.89
5	M_{55}	232.74	768.62	4.94	265.12	776.77	4.33
	$R_3 S_5$	209.34	682.61	4.49	266.31	790.64	4.88
	$S_5 R_3$	211.92	674.18	4.90	266.49	804.71	4.90

(*). Feed conversion efficiency (grams of feed: grams of gain)

line in the 1st generation, in the 2nd generation, these parameters proved to be better value in the second generation of the mass selection line.

DISCUSSION

This study was applied to two generations selection according to body weight. At the end of the 2nd generation, body weight increase realized was 11.1, 26.6 and 25.3 g in the M_{55}, R_{33} and S_{55} parents. Percentage deviations of BW were obtained of 4.05, 10.27 and 9.76% in the same lines, respectively and BW increases in reciprocal selection lines were determined to be higher than individual lines. Similarly, many researchers announced that body weight increased with selection (Marks, 1989; Nestor and Bacon, 1982; Baylan and Uluocak, 1999).

Turedi and Duzgunes (1984) reported that body weight increase was 5.25 g in selection according to 6th weeks BW. Similar results related to BW increase were reported by Marks (1980, 1996). Collins and Abplanalp (1967) reported that BW of quails selected by 6th week BW was 20 g higher than the base population. Nestor and Bacon (1982) reported that seven generations selected by fourth week BW resulted in increases of 6, 10, 11, 11, 19, 20 and 26 g in BWs according to the seven generations, respectively. Tozluca (1993) also, reported that BW increase for the selection method was 18.95% for males and 20.37% for females. These results are in line with the results of the present study. In addition to these results, Oguz and Turkmut (1999) and Baylan and Uluocak, (1999) obtained similar results related to BW increase. They also obtained negative values for some groups.

In long term selection under divergent environments for 4th week BW, percentage deviations of body weight were found to be 48.9 and 49.7% in lines studied by Darden and Marks (1988). Marks (1989) also reported these deviations as 31, 40 and 51% in lines selected with the same method. Deviations in the present study were 4.05, 10.27 and 9.76%. To obtained better percentage of body weight, long term selection experiments can be suggested.

Body weights of offspring were found to be higher than parents in both generations and it was shown differences from the point of view of sex in lines. It was previously known that the body weight of males and females is different, with females being heavier than males. The values obtained in this study are similar to other studies. Bessei (1977) showed that females were 25-30% heavier than males.

Uluocak *et al.* (1997) carried out 2 generations of reciprocal recurrent selection and found that 5h week BW was 196.6±3.06 g in males and 202.7±4.51 g in females in R_3S_5; 193.7±3.58 in males and 203.6±4.03 g in females in S_5R_3. Baylan and Uluocak, (1999) also reported that mean body weight was 261.7±2.17 and 249.8±2.18 in the same lines. Baik and Marks (1993) reported that in a selection study according to 4th week BW under different nutritional conditions, 6th week BW of offspring obtained with reciprocal cross of lines was 180.7, 181.8, 182.7 and 180.9 g, which was lower than those of the present study. Kohler (1984) found 118-152 g BW at week 6 in quail. Kesici (1978) also reported 96.2±0.62 and 102.5±1.20 g 6th week BW in crossbred lines obtained with reciprocal crosses. These BW values were obtained at 3 weeks of age in the present study. Similarly, BW of offspring in this study was higher than that found by Flak *et al.* (1979), Marks (1991), Nestor and Bacon (1982) and Okan *et al.* (1997). Hussein *et al.* (1995) obtained similar results, 261 g BW at 5th week in an experiment carried out on 10 generations for increasing meat yield in Japanese quails. On the other hand, the value reported as 253 g 4th week BW at the end of 80 generations by Marks (1996) was higher according to the same week of study.

The highest BW gain was obtained at 3-4 weeks in both generations in all lines. This value was obtained in 25 days, 7-21 days and 3-5 weeks by Nicholas *et al.* (1986), Baylan and Uluocak, (1999), respectively.

Mean daily BW gain for the 5th week in offspring of M_{55}, R_3S_5 and S_5R_3 lines were determined as 7.98, 7.63 and 7.54 g day^{-1} in the 1st generation and 8.59, 8.58 and 8.65 g day^{-1} in the 2nd generation. BW gain of females and males were calculated separately after the 3rd week and BW gain of males obtained was lower than females.

Our data are higher than those of Inal *et al.* (1996) who carried out a selection during generations 1-5 for high and low 5 week body weight of Japanese quails. They reported mean body weight gain of 4.78, 4.14 and 5.54 g day^{-1} for control, low and high at the end of 5 weeks. Also, Baylan and Uluocak, (1999) obtained 5.64, 5.58 and 5.60 g day^{-1} 5th week BWG in lines carried out according to 3rd, 4th and 5th week age selection. Again, the same researcher found 6.50, 6.87 and 6.60 g day^{-1} 5th week BWG.

In this experiment, at the end of the 5th week in the 1st generation, cumulative feed consumption was 768.62, 682.61 and 674.18 g; feed conversion ratios were 2.83, 2.63 and 2.63 in the M_{55}, R_3S_5 and S_5R_3 lines, respectively. In the 2nd generation, these values were 776.77, 790.64 and 791.71 g and 2.66, 2.71 and 2.73 in the same lines. Selection lines of both generations had higher feed intake due to higher body weight, but feed efficiency was better than the values found by Marks (1991), Kocak *et al.* (1995) and Inal *et al.* (1996). In quails, the heavier lines have better feed efficiency and feed conversion (Lepore and Marks, 1971; Darden and Marks, 1988). Marks (1993) observed that in quails selection for body weight improved feed utilization, although total feed intake increased due to the need for maintenance of a larger body mass. Total feed intake at the end of the 5th week was obtained at 674.71, 664.29 and 650 g; feed efficiency was found to be 2.90, 3.30 and 3.35 by Baylan *et al.* (1997), Inal *et al.* (1996) and Kocak *et al.* (1995), respectively. It is shown that selection lines in this study consumed less feed per gram of BW.

CONCLUSION

The selection method was applied in the present study to increase body weight in quails either in parents or in offspring, with reciprocal selection lines resulting in having higher body weight than initial body weight. Although, feed consumption and feed conversion in the 1st generation were better in the reciprocal selection lines, these parameters proved to be better value in the second generation of the mass selection line. It can be concluded that the continuation of the present selection method in present lines by body weight may be suggested. Also, for the male line, there is a need to take into consideration carcass traits besides body weight and for the female line, there is a need to take into consideration egg yield and egg weight besides body weight.

ACKNOWLEDGEMENT

Supported by Turkish Scientific and Tecnical Council. Project No: VHAG 2045.

REFERENCES

Baik, D.H. and H.L. Marks, 1993. Divergent selection for growth in Japanese quail under split and complete nutritional environments 7. Heterosis and combining ability among diallel crosses following 27 generations of selection. Poult. Sci., 72: 1449-1458. DOI: 10.3382. PMID: 8378218.

Baylan, M., T. Ayasan, A.N., Uluocak and F. Okan, 1997. The effect of sex and age on growing parameters in quails. Trakya Region II. Anim. Symposium, Tekirdag/Turkey, pp: 331-334.

Baylan, M. and A.N. Uluocak, 1999. Productivity of selection for body weight at different ages in Japanese quails. Int. Poult. Fair Conf. YUTAV, Istanbul/Turkey, pp: 626-632.

Baylan, M., 2003. Effects on productivity of divergent selection methods according to body weight in Japanese quail. Ph.D. Thesis, University of Mustafa Kemal, Hatay, Turkey. http://fenbilimleri.mku.edu.tr/tezadi.htm.

Bessei, W., 1977. Quail Breeding in France. Anim. Breed. Abst., 45: 5685. ISBN: 0301-6226.

Camci, O., 1992. Changing of body composition by selection in Japanese quails (*Coturnix coturnix japonica*). Tech. Poult. Mag., 75: 52-61.

Collins, F. and H. Abplanalp, 1967. Changes in body and organ weights of Japanese quail selected for 6 week body weight. Br. Poult. Sci., 9: 231-242.

Collins, F., H. Abplanalp and W.G. Hill, 1970. Mass selection for body weight in quail. Poult. Sci., 49: 926-933. DOI: 10.3382.

Comstock, R.E., H.F. Robinson and P.H. Harvey, 1949. A breeding procedure designed to make maximum use of both general and specific combining ability. J. Am. Soc. Agron., 41: 360-367.

Darden, J.R. and H.L. Marks, 1988. Divergent selection for growth in Japanese quail under split and complete nutritional environments. 1. Genetic and correlated responses to selection. Poult. Sci., 67: 519-529. DOI: 10.3382.

Flak, P., J. Granat, J. Bulla and J. Zelnik, 1979. Genetic determination of the allometric growth of body measurements. Anim. Breed. Abst., 4: 2. ISBN: 0301-6226.

Hussein, S.A., Y.S. Chee and M. Jamilah, 1995. Selection of quails for meat production. Proceedings of the 17th Malaysian Society of Animal Production (MSAP), Penang/Malaysia, pp: 124-125. ISBN: 983-99710-2-6.

Inal, S., M.A. Tekes, F. Inal and S. Dere, 1996. The effects of selection according to body weight on body weight, body weight gain, feed consumption and feed conversion efficiency in quails (*Coturnix coturnix japonica*). J. Vet. Sci., 12 (1): 5-14.

Kesici, T., 1978. Additive and nonadditive gene effects on growth and egg production characters in Japanese Quails. IV. Sci. Congress, Ankara/Turkey, pp: 1-7.

Kocak, C., O. Altan and Y. Akbas, 1995. An investigation of different production traits of Japanese quail (*Coturnix coturnix japonica*). Turk. J. Vet. Anim. Sci., 19 (1): 65-71.

Kohler, D., 1984. Phenotypic parameters of japanese quail. Anim. Breed. Abst., 52: 8. ISBN: 0301-6226.

Lepore, P.D. and H.L. Marks, 1971. Growth rate inheritance in Japanese quail 4. Body composition following four generations of selection under different nutritional environments. Poult. Sci., 50: 1191-1193. DOI: 10.3382.

Marks, H.L. and P.D. Lepore, 1968. Growth rate ýnheritance in Japanese quail. 2. Early responses to selection under different nutritional environments. Poult. Sci., 47: 1539-1546. DOI: 10.3382.

Marks, H.L., 1980. Reverse selection in a Japanese quail line previously selected for 4-week body weight. Poult. Sci., 59 (6): 1149-1154. DOI: 10.3382.

Marks, H.L., 1989. Long-term selection for 4-week body weight in Japanese quail following modification of the selection environment. Poult. Sci., 68: 455-458. DOI: 10.3382.

Marks, H.L., 1991. Divergent selection for growth in Japanese quail under split and complete nutritional environments. 4. Genetic and correlated responses from generations 12-20. Poult. Sci., 70: 453-462. DOI: 10.3382.

Marks, H.L., 1993. Divergent selection for growth in Japanese quail under split and complete nutritional environments. 6. Differential body weights in reciprocal crosses. Poult. Sci., 72: 1847-1854. DOI: 10.3382.

Marks, H.L., 1996. Long-term selection for body weight in Japanese quail under different environments. Poult. Sci., 75: 1198-1203. DOI: 10.3382.

Meyer, K., 1998. User notes, Version 3.0 β. User Notes. http://agbu.une.edu.au/~kmeyer/homepage.html.

Minvielle, F., 1998. Genetics and breeding of Japanese quail for production around the world. Proc. 6th WPSA Asian Pacific Poultry Congress, Nagoya, Japan, pp: 122-127.

Narayan, R., S.K. Agarwal, B.P. Singh, D.P. Singh, S. Majumdar and R.V. Singh, 1998. Development of specialized strains of meat and egg type quails in hot climate. WPSA-Israel Branch 10. Eur. Poult. Conf. Jerusalem Israel, pp: 322-324.

Nestor, K. and W.L. Bacon, 1982. Divergent selection for body weight and yolk precursor in *Coturnix coturnix japonica*. 3. Correlated responses in mortality, reproduction traits and adult body weight. Poult. Sci., 61: 2137-2142. DOI: 10.3382.

Nicholas, B.A., E.N. Karl and L.B. Wayne, 1986. Growth curves of japanese quail as modified by divergent selection for 4 week body weight. Poult. Sci., 65: 1825-1833. DOI: 10.3382.

Okan, F., A.N. Uluocak, T. Ayasan and M. Baylan, 1997. The effects of vitamin C on egg production, egg weight and hatching performance in layer Japanese quail diet. Trakya Region II. Animal Symposium, Tekirdag/Turkey, pp: 285-288.

Oguz, I. and L. Turkmut, 1999. Effect of selection for 4-week body weight on some parameters in Japanese quail (*Coturnix coturnix japonica*) 2. Production traits and genetic gains. Turk. J. Vet. Anim. Sci., 23: 311-319.

Testik, A., A.N. Uluocak and M. Sarica, 1993. Some production parameters of different genotypes Japanese Quails (*Coturnix coturnix japonica*). Turk. J. Vet. Anim. Sci., 17 (2): 167-173.

Tozluca, A., 1993. Productivity of selection according to body weight in different nutrition condition and the effects on the others production parameters in Japanese Quails (*Coturnix coturnix japonica*). Ph.D. Thesis, University of Selcuk, Konya, Turkey. http://tez2.yok.gov.tr/fmi/xsl/tez/listevedetay_liste.xsl?-db=TezVT&-lay=web_arama&-max=20&-token.error=liste.xsl&AdSoyad=Abdurrahman%20 Tozluca.

Turedi, L. and O. Duzgunes, 1984. Genetic improvements provided for body weight of divergent selection methods in Japanese Quails. Sciences Ins. of Ankara University. Publication number: ZT-1, pp: 1-13.

Uluocak, A.N., H. Nacar and M. Baylan, 1997. Studies on improvement of broiler quail parents. Inte. Poult. Fair Conf. YUTAV-97 Istanbul/Turkey, pp: 438-443.

Wilson, W.O., U.K. Abbott and H. Ablanalp, 1961. Evaluation of Coturnix (Japanese quail) as pilot animal for poultry. Poult. Sci., 40: 651-657. DOI: 10.3382.

Woodard, A.E., H. Abplanalp, W.O. Wilson and P. Vahro, 1973. Japanese quail husbandry in the laboratory (*Coturnix coturnix japonica*). Department of Avian Science. Univ. of California, USA: Dawis, pp: 1-22. http://animalscience.ucdavis.edu/Avian/Coturnix.pdf.