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The Effects of Selection and Season on Clutch Traits and Egg Production in Japanese Quails (*Coturnix coturnix Japonica*) of Different Lines

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Abstract: The aim of this research was to investigate the effects of selection and season on age at sexual maturity, clutch traits, and egg production in 11 generations selected Japanese quails (*Coturnix coturnix japonica*) of different lines. The material used in this research was selected for 11 generations from high (HL) or low (LL) body weight Japanese quail lines according to 5-week body weights and their random bred control line (C) and layer line (L) for 120 d egg production, which were bred in the Akdeniz University, Faculty of Agriculture in Turkey. First egg weight, age at sexual maturity, body weight at sexual maturity, total egg number, total egg weight, clutch length, clutch number, pause length and pause number were determined. Egg production was recorded daily throughout 12 weeks. The season had a significant effect on total egg number, age at sexual maturity, clutch size and pause size. Selection for increased or decreased 5-week body weights in Japanese quail resulted in a delay in age at sexual maturity. Also, selection for increased 5-week body weight increased body weight at sexual maturity. The season had no significant effect on first egg weight, total egg weight, body weight at sexual maturity, clutch number and pause number. There were significant relationships among the first egg weight, age at sexual maturity, body weight at sexual maturity, total egg number, total egg weight, clutch length, clutch number, pause length and pause number.
Key words: Selection, season, clutch traits, Japanese quail

Seleksiyon ve Mevsimin Farklı Japon Bıldırcını (*Coturnix coturnix japonica*) Hatlarında Klaç Özelliklerine ve Yumurta Verimine Etkileri*

Özet: Bu çalışmada, 11 generasyon seleksiyon uygulanmış Japon bıldırcınlarında (*Coturnix coturnix japonica*) seleksiyon ve mevsimin eşeysel olgunluk yaşı, klaç özelliklerine ve yumurta verimine olan etkilerinin belirlenmesi amaçlanmıştır. Hayvan materyali olarak beşinci hafta canlı ağırlığına göre yüksek canlı ağırlık ve düşük canlı ağırlık hatları ile yüz yirmi günlük yumurta verimi yönünde seleksiyon uygulanan yumurtacı hat ile kontrol hattı kullanılmıştır. İlk yumurta ağırlığı, eşeysel olgunluk yaşı, eşeysel olgunluk ağırlığı, toplam yumurta sayısı, toplam yumurta ağırlığı, klaç uzunluğu ve sayısı ile klaçlar arası süre ve sayısı saptanmıştır. Yumurta verimi 12 hafta boyunca günlük olarak kaydedilmiştir. Mevsimin toplam yumurta sayısı, eşeysel olgunluk yaşı, klaç uzunluğu ve klaçlar arası süreye etkisi önemli bulunmuştur. Seleksiyon yüksek canlı ağırlık ve düşük canlı ağırlık hatlarında eşeysel olgunluk yaşının gecikmesine neden olmuştur. Ayrıca, yüksek canlı ağırlık yönünde yapılan seleksiyon eşeysel olgunluk ağırlığını arttırmıştır. Mevsimin ilk yumurta ağırlığı, toplam yumurta ağırlığı, eşeysel olgunluk ağırlığı, klaç uzunluğu ile klaçlar arası süre sayısına etkisi önemsiz bulunmuştur. İlk yumurta ağırlığı, eşeysel olgunluk yaşı, eşeysel olgunluk ağırlığı, toplam yumurta sayısı, toplam yumurta ağırlığı, klaç uzunluğu ve sayısı ile klaçlar arası süre ve sayısı arasında önemli ilişkiler saptanmıştır.

Anahtar kelimeler: Seleksiyon, mevsim, klaç özellikleri, Japon bıldırcını

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Introduction

Studies in quails have been aimed to increase meat and egg production. With this goal, mostly new breeds of quails have been obtained for meat and egg yield types. For egg type quails the intension was to increase total egg mass, to get an earlier sexual maturity and to optimize egg weight in order to increase laying performance (Camci et al., 2002). Sachdev and Ahuja (1986) found that quails having 181-200g body weight at sexual maturity were 65,6 days old. Also, their total egg production at 50 weeks of age was found to be 205.7. Sreenivasaiah and Joshi (1988) found in quails, body weight at sexual maturity as 122,9 - 128,2 g, Thomas and Ahuja (1988) reported in their study that the age of sexual maturity was 48,9 - 49,6 days in quails, while their 126 days egg production was 55,0 - 64,9. Egg weights in quails increased when they are becoming older according to Nagarajan et al. (1991). Kocak et al. (1995) observed a body weight at onset of sexual maturity at an age of 58 days of 2002,2 g. Also, they found that egg production at the age of 25 weeks was 84. Sonoda et al. (1985) reported that with aging of quails clutches size of 1 - 3 eggs decreased and clutches consisting of 4 - 6 eggs increased with highly individual variation. Furthermore, it was observed that one-day pauses occurred in 60 % of clutches and the incidence increased by aging. Aggrey et al. (1993) did not find an evident correlation between clutch size and pause size in quails. Abdallah and Harms (1997) reported for laying hens at 32 weeks of age, that clutch size ranged between 2 eggs and 20 egg weights decreased gradually over the clutch. Also, Miyoshi et al. (1997) found that successive eggs in a clutch got lighter by degrees and the last egg of the clutch was 4 - 6 percent lighter than first egg. Turkyilmaz et al. (2005) reported that average egg weight for control line as 13 g. Sonoda et al. (1997) observed that under continuous lighting the percent of short clutch sizes (up to 6 eggs) decreased and greater clutch sizes (over 10 eggs) increased in quails. Many researchers reported that selection for body weight causes a decrease in egg production (Marks, 1979; Nestor and Bacon, 1982). Erensayin and Camci (2003) found that clutch number decreased when egg yield increased.

Chambers (1990) observed that in long term selection studies, onset of sexual maturity in low weight line pullets may be inhibited because of the failure to attain the necessary body weight or composition.

Marks (1979) noticed that long term selection for body weight was decreased egg production in respect to the control group of quail. Also, Nestor and Bacon (1982) and Testik et al. (1991) reported that the end of divergent selection for body weight resulted in high and light lines of egg production, which were lower than that of the control group. Marks (1991), found that divergent selection for 4-wk body weight decreased egg production but increased sexual maturity. However, Turkmut et al. (1999) found no effect on sexual maturity of Japanese quail by divergent selection for 4-wk live weight.

The purpose of this research was to determine the effects of season (spring and summer seasons) and selection on clutch traits and egg production in Japanese quail (Coturnix coturnix japonica).

Material and Methods

The birds were obtained from four genetic lines selected for 11 generations for either a high (HL) or a low body weight (LL) at five weeks of age, a randomly bred control line (C) and a layer line (L) selected for egg production for 120 days. The birds were bred at the Akdeniz University, Faculty of Agriculture in Turkey. Birds were kept individually in cages. They received a quail diet ad libitum, containing 240 g protein kg^{-1} and 11,9 MJ ME kg^{-1} feed for the first five weeks, and then a diet containing 210 g protein kg^{-1} and 11,7 MJ ME kg^{-1} feed (NRC, 1994). A lighting schedule of 16 h light day^{-1} was applied. Selection intensities were adjusted for males and females as 10 % and 40 %, respectively.

Individual egg yields were recorded daily for 12 weeks in each season. The body

weight at sexual maturity and egg weights were measured by electronic scale with sensitivity of 0,01 g. In this research, first egg weight, total egg number, total egg weight, age at sexual maturity, body weight at sexual maturity, clutch size, clutch number, pause size and pause number were determined. A clutch was described as an uninterrupted laying period during egg yield term. Each non-laying period between two clutches was defined as a pause (Erensayin and Camci, 2003). The clutch size is the number of eggs laid on consecutive days, which is one of the components of the total number of the eggs laid along a production cycle. The average clutch size was calculated as the arithmetic mean of all clutches recorded (Chen and Tixier-Boichard, 2003). Age at sexual maturity was determined as the first egg laying-day of females. The temperature and humidity of poultry house were measured continuously by the thermo-hygrograph. Data were subjected to analysis of variance using the General Linear Model Procedure of SAS (1999). Following model was used for determination of the effect of line and season on clutch traits and egg production of quails.

$Y_{ijk} = \mu + L_i + S_j + e_{ijk}$

Y_{ijk}: represents the clutch traits and egg production

L_i: effect of the i^{th} line

S_j: effect of the j^{th} season

e_{ijk}: error term, ~N (0, σ_e^2)

Results

Average temperature and humidity values were calculated as 28,20 ± 0,235 ^oC and 70,64 ± 1,07 % for summer season, and 18,.06 ± 0,399 ^oC and 75,85 ± 1,31 % for spring season in the quail house. Effects of seasons and lines on some egg production traits and clutch traits, and Pearson's correlation coefficients were presented in Table 1 and 2. In Table 1, also comparisons of subgroups were presented for traits where there were significant line*season interactions.

Discussion

The highest first egg weight was obtained in HL with regard to lines. But, there was no significant difference between the seasons in terms of first egg weight. Increasing or decreasing body weight had affected negatively total egg number in all seasons. Also, significant difference was determined for total egg number between the spring (65,82) and summer seasons (60,25). The lowest total egg weight was obtained in LL line in both seasons. Since, LL line was selected for low body weight of 5-weeks; generally, this line has lower egg weight. There was found a significant difference between the both seasons and the lines in terms of age at sexual maturity. It was affected negatively by the selection of increasing or decreasing body weight in both seasons. Generally, age at sexual maturity is related to day length. Age at sexual maturity decreased when day length increased. Although the day length in summer season is longest than the other seasons, the lowest age at sexual maturity occurs in summer seasons. The highest age at sexual maturity was determined in LL line in summer and spring season. Marks (1979) determined that selection for body weight increased age at sexual maturity.

The age at sexual maturity was found as 41,7-48,0 days by Reddish et al. (2003). Also, Darden and Marks (1988) and Marks (1991) reported that long-term selection for high body weight delayed age at sexual maturity. But, Turkmut et al. (1999) reported that divergent selection for body weight of quail did not affect age at sexual maturity, which was not in agreement with findings of this research. Age at sexual maturity in this study lower than those of reported by Kocak et al. (1995), and similar that reported by Thomas and Ahuja (1988), Gunes and Cerit (2001). The phenotypic correlation (0,215) between age at sexual maturity and body weight at sexual maturity is lower than the correlation (0,25) reported by Gebhardt-Henrich and Marks (1995). It can be explained that when the body weight at sexual maturity increased (HL line) or decreased (LL line), the clutch size decreases.

Table 1. Effects of season and lines on some egg production traits and clutch traits (± SD)
Çizelge 1. M*evsimin ve hatların bazı yumurta verim özelliklerine ve klaç özelliklerine etkileri*

		Season Mevsim		
	Line	*Spring*	*Summer*	
	Hat	*İlkbahar*	*Yaz*	
FEW (g)	*C*	9,96±0,56 rs	8,02±0,49 pr	8,99±0,37 AB
İlk yumurta ağırlığı	*L*	8,07±0,48 pr	7,52±0,47 p	7,79±0,34 A
	HL	9,80±0,61 prs	10,93±0,51 s	10,36±0,40 B
	LL	7,28±0,64 p	7,84±0,52 pr	7,56±0,41 A
		8,76±0,29	8,58±0,25	
TEN	*C*	70,38±2,15	63,81±1,90	67,10±1,44 B
Toplam yumurta sayısı	*L*	74,11±1,85	70,19±1,82	72,15±1,30 B
	HL	64,40±2,36	54,76±1,97	59,58±1,54 A
	LL	54,41±2,47	52,25±2,01	53,33±1,59 A
		65,82±1,11 X	60,25±0,96 Y	
TEW (g)	*C*	745,02±24,09	709,01±21,25	727,01±16,06 B
Toplam yumurta ağırlığı	*L*	705,42±20,68	717,35±20,33	711,39±14,50 B
	HL	728,51±26,39	727,99±22,08	728,25±17,21 B
	LL	521,69±27,60	507,17±22,54	514,43±17,82 A
		675,16±12,42	665,38±10,78	
ASM (day)	*C*	41,02±0,97 P	39,79±1,10 P	40,40±0,73 A
Eşeysel olgunluk yaşı	*L*	40,68±0,93 P	39,19±0,94 P	39,94±0,66 A
	HL	54,16±1,01 S	42,94±1,20 PR	48,55±0,79 B
	LL	56,96±1,03 S	47,72±1,26 R	52,34±0,81 C
		48,20±0,49 Y	42,41±0,57 X	
BWSM (g)	*C*	186,18±4,43 R	188,14±3,90 R	187,16±2,95 C
Eşeysel olgunluk ağırlığı				
	L	176,78±3,80 R	156,33±3,73 P	166,55±2,66 B
	HL	281,11±4,85 S	292,02±4,06 S	286,56±3,16 D
	LL	145,85±5,07 P	143,58±4,14 P	144,72±3,27 A
		197,48±2,28	195,02±1,98	
CS (day)	*C*	70,38±2,15	63,81±1,90	67,10±1,44 B
Klaç uzunluğu	*L*	74,10±1,85	70,19±1,82	72,15±1,30 B
	HL	64,40±2,36	54,76±1,97	59,58±1,54 A
	LL	52,41±2,47	52,25±2,01	53,33±1,59 A
		65,82±1,11 Y	60,25±0,96 X	
CN	*C*	4,07±0,30	4,93±0,26	4,50±0,20 BC
Klaç sayısı	*L*	3,60±0,26	3,64±0,25	3,62±0,18 A
	HL	4,97±0,33	4,90±0,27	4,94±0,21 C
	LL	4,25±0,34	3,58±0,28	3,92±0,22 AB
		4,22±0,15	4,26±0,13	
PS (day)	*C*	13,14±2,10	20,94±1,85	17,04±1,40 A
Klaçlar arası süre	*L*	9,33±1,80	13,98±1,77	11,66±1,26 A
	HL	19,37±2,30	29,40±1,93	24,38±1,50 B
	LL	27,81±2,41	31,77±1,97	29,79±1,55 B
		17,42±1,08 X	24,02±0,94 Y	
PN	*C*	3,38±0,31 pr	4,48±0,27 r	3,93±0,20 A
Klaçlar arası sayı	*L*	3,02±0,26 p	3,19±0,26 p	3,10±0,18 A
	HL	4,91±0,33 st	4,92±0,28 t	4,92±0,22 B
	LL	4,31±0,35 prst	3,60±0,29 prs	3,96±0,23 AB
		3,91±0,16	4,05±0,14	

a,b,c,d) Means of lines with no common letter differ significantly
x, y) Means of seasons with no common letter differ significantly
p, r, s, t) Means of line*season groups with no common letter differ significantly
*) lowercase for p<0.05 and uppercase for p<0.01
CS: clutch size, CN: Clutch number, PS: Pause size, PN: Pause number, ASM: Age at sexual maturity, BWSM: Body weight at sexual maturity, FEW: First egg weight, TEN: Total egg number, TEW: Total egg weight
C: Control, L: Layer, HL: High body weight, LL: Low body weight

Table 2. Pearson's correlation coefficients between clutch traits and some egg production traits
Çizelge 2. Y*umurta verim özellikleri ve klaç özellikleri arasındaki pearson korelasyon katsayısı*

Traits Özellikler	*CN Klaç sayısı*	*CS Klaç süresi*	*PN Klaçlar arası sayı*	*PS Klaçlar arası süre*	*ASM Eşeysel olgunluk yaşı*	*BWSM Eşeysel olgunluk ağırlığı*	*FEW İlk yumurta ağırlığı*	*TEN Toplam yumurta sayısı*
CS Klaç süresi	-0,350**							
PN Klaçlar arası sayı	0,933**	-0,454**						
PS Klaçlar arası süre	0,356**	-0,976**	0,461**					
ASM Eşeysel olgunluk yaşı	-0,006	-0,648**	0,112*	0,652**				
BWSM Eşeysel olgunluk ağırlığı	0,212**	-0,134**	0,251**	0,146**	0,215**			
FEW İlk yumurta ağırlığı	0,015	-0,119*	0,032	0,126*	0,224**	0,325**		
TEN Toplam yumurta sayısı	-0,350**	1,000**	-0,454**	-0,976**	-0,648**	-0,134**	-0,119*	
TEW Toplam yumurta ağırlığı	-0,218**	0,834**	-0,292**	-0,835**	-0,531**	0,193**	-0,027	0,834**

*, ** P<0,05 and P<0,01, respectively
CS: clutch size, CN: Clutch number, PS: Pause size, PN: Pause number, ASM: Age at sexual maturity, BWSM: Body weight at sexual maturity, FEW: First egg weight, TEN: Total egg number, TEW: Total egg weight

There was a significant negative correlation (-0,134) between the clutch size and body weight at sexual maturity. The season had significant effect on clutch size. It was determined as 65,82 days in spring and 60,25 days in summer season.

There was no significant difference between the seasons for clutch numbers. Generally, lowest clutch number was found in L and LL lines in both seasons. The negative correlation coefficient of -0,350 (P<0,01) between clutch size and clutch number indicates that clutch size would decrease when clutch number increases. In the same way, with increasing clutch numbers, pause numbers increased, as well. The significant correlation coefficient between these parameters was 0,933 (P<0,01). It was shown that the highest pause size values were determined in HL and LL lines in both seasons. It was determined that increase or decrease in body weight at sexual maturity resulted in increase in pause size. Also, there was a significant correlation (0,146) determined between the pause size and body weight at sexual maturity.

Furthermore, a significant negative correlations were determined between egg production and clutch number (-0,350) and pause number (-0,454) (P<0,01). Also, a significant negative correlation of -0,976 (P<0,01) between total egg number and pause size shows that egg production is highly decreases when pause numbers increases. Another significant correlation of -0,454 was found between clutch size and pause number (P<0,01). The result indicates that clutch size will increase when pause number decreases. There was a significant negative correlation found (-0,531) (P<0,01) between total egg weight and age at sexual maturity. This negative correlation indicates that total egg weight increases with an

earlier age at sexual maturity. There was a highly significant correlation between clutch size and total egg number (1,00). It was determined that a decrease clutch size resulted in an increase in egg production. Furthermore, a significant correlation of 0,834 ($P < 0,01$) between total egg weight and clutch size indicates that an increase in total egg weight was observed with increasing clutch size. These results agreed with the previous studies of Abdallah and Harms (1997), Miyoshi et al. (1997) and Sonoda et al. (1997).

These findings suggest that selection for growth, while being obviously very effective in terms of increasing overall body weight at a given age, has altered some physiologic relationships that are critical with respect to optimizing sexual development in terms of age. If aim of selection is to increase egg production and body weight, it must be investigated for various production characteristics connected with them. Because, any change in body weight should be directly reflected in egg yield in the quails. In such a way that clutch length increased when clutch number decreased and it is directly related with egg yield. Generally, expected results were obtained in this study. But, these studies should be continued using different poultry species and different seasons in another regions.

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