J. Agric. & Env. Sci. (Damanhour University) 2023, 22 (1): 285-308
Print: ISSN 1687-1464 Online: 2735-5098

GENETIC IMPROVEMENTS FOR PRODUCTIVE PERFORMANCE OF WHITE JAPANESE QUAIL UNDER SELECTION PROGRAM.

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ABSTRACT

The current study was conducted to investigate the effect of short-term selection for 6-weeks body weight (BW_6) on the growth performance of white Japanese quail. A selected line for high BW_6 and a random-bred control line were chosen from a base population of white Japanese quail. Three generations included in this study were used to estimate the heritability and genetic trends for traits characterizing growth. There was a significant effect of generation and line within generation ($P<0.001$) on body weight and daily weight gain at different ages studied. The results showed that the selected line had a significantly higher body weight at six weeks of age and daily weight gain during the growing period compared to the control line in the three generations of study. The heritability estimates derived from the sire components of variance for body weight at 6 weeks of age and daily weight gain from hatch up to 6 weeks of age were 0.38 and 0.37, respectively. The genetic trend for body weight at 6 weeks of age was about 2.02 g per generation, while for daily weight gain during the growing period, the genetic trend increased by 0.05 g/day for each generation. Results of heritability estimates, and genetic evaluation obtained in the current study indicate that body weight at 6 weeks of age and daily

weight gain during growing period seem to be suitable for use as selection criteria to improve growth traits in quail's flocks.

Keywords: Japanese quail, Selection, growth performance, heritability, genetic trend.

https://doi.org/10.21608/jaesj.2023.205557.1078

INTRODUCTION

The Japanese quail is a species of poultry that is commonly bred for both its meat and eggs. Like chickens, it belongs to the order *Galliformes*, family *Phasianidae*, genus *Coturnix*, and species *japonica* **(Türkmut *et al.,* 1999)**. There exist various genotypes of Japanese quail, and one interesting variety to examine is the White Japanese quail. The reason for their white feather plumage is that these quails possess a homozygous (B/B) semi-dominant silver mutation B, which is localized in the MITF (microphthalmia-associated transcription factor) **(Minvielle *et al.,* 2010)**.

Japanese quails (*Coturnix coturnix japonica)* are primarily farmed for their meat in Europe and for their eggs in Japan. In other Asian nations, they are frequently raised as dual-purpose poultry, serving both meat and egg production purposes. **(Maiorano *et al.,* 2012)**. Japanese quail can be used as pilot animals for research, as they necessitate less time and space, are more manageable, and have lower feed requirements compared to other animals. They exhibit more rapid growth, earlier sexual maturity, greater laying capacity, shorter hatching duration, and are more resilient to diseases in comparison to chickens **(Hasan, 2013)**. Intensive production of Japanese quail started in the 1920s in Japan, and the first egg lines were then developed by selection **(Wakasugi, 1984).**

Selection is a crucial aspect of genetic enhancement in animal production. In poultry, individual selection is particularly vital for selection experiments targeting body weight **(Aggrey *et al.,* 2003)**. In quail flocks, body weight and the daily weight gain until reaching slaughter weight are essential factors that greatly impact production efficiency **(El-Attrouny *et al.,* 2020)**.

Understanding the components of variance is crucial for developing breeding strategies aimed at enhancing genetics **(Resende *et al.,* 2005)**. Heritability, which is a function of variance components, offers valuable insights into the genetic nature of a particular trait. This information is necessary for genetic assessments and selection plans and in selection experiments **(Getabalew *et al.,* 2019)**. High heritability values for body weight can be advantageous. Studies have indicated that the heritability of body weight in Japanese quail is moderate to high **(El-Deen *et al.,* 2016; Karabag *et al.,* 2017)**.

The analysis of genetic trend allows for the visualization of the effectiveness of the selection procedures used and quantification of the genetic changes of traits under selection over time, additionally, it allows for the identification and correction of potential errors in the direction of selection. **(van Melis *et al.,* 2001)**. Tracking and interpreting estimates of genetic trends facilitate the monitoring of the efficiency of improvement strategies and ensure that the selection pressure is aimed towards economically important traits, besides it helps in defining selection objectives **(Hudson and Kennedy, 1985)**. The main objectives of the present study were to estimate genetic parameters and evaluate the genetic trend of body weight and daily weight gain traits of Japanese quail selected for body weight (BW) at 6 weeks of age.

MATERIALS AND METHODS

Experimental birds were produced at the Poultry Production Department, Faculty of Agriculture, Alexandria University where selected quails for high body weight at 6 weeks of age during three successive generations were bred.

Selection and mating methods

Throughout a selection experiment, a total of 1583 white Japanese quails as a base population were obtained from random mating which pedigreed and weighted individually in biweekly basis from hatch to 6-weeks of age, then divided into two groups based on the average body weight at 6-weeks of age (BW_6). Individual phenotypic selection was then practiced, 140 sires and 280 dames which possessed the highest BW_6 were selected to form the selected line (Line S), while the control line (Line C) consisted of 40 sires and 80 dam that were randomly mated without selection. Data was collected over 2 consecutive hatches for 3 generations.

Studied Traits

The following growth traits were recorded:

- **Individual body weights (BW)** in grams were recorded at hatch, two, four and six weeks of age (BW_0, BW_2, BW_4 and BW_6, respectively).
- **Daily weight gain (DWG)** during the different growth periods from hatch to 2, from 2 to 4, from 4 to 6 and from hatch to 6 weeks of age (DWG_{0-2}, DWG_{2-4}, DWG_{4-6}, and DWG_{0-6}, respectively), were calculated as follows:

Daily Weight gain = (W_2-W_1)/ Length of period (days)

Where:

W_1 = weight at the beginning of the period (g), and W_2 = weight at the end of the period (g).

Statistical analysis

Estimates of fixed effects

Data of body weight at different ages, daily weight gains during different periods were analyzed using Statistical Analysis System software **(SAS ® version 9.4, 2013)**. To test for significant differences between means for each studied trait, Duncan's multiple range test **(Duncan, 1955)** was used. Significance of the effects was tested at probability levels P<0.05 (*), P<0.01 (**) and P<0.001 (***) with appropriate F statistic. Before analysis, all percentage data were transformed to their corresponding arcsine angle values according to **(Snedecor and Cochran, 1980)**. The body weight (BW) and daily weight gain (DWG) data at different ages were analyzed according to the following linear model:

$$\boldsymbol{Y_{ijkl} = \mu + G_i + S_j + (L * G)_{ik} + e_{ijkl}}$$

Where:
Y_{ijkl} is the observation of a dependent variable,
μ is the overall mean,
G_i is the effect of i^{th} generation,
S_j is the fixed effect of j^{th} sex,
$(L * G)_{ik}$ is the effect of the interaction between the k^{th} line within the i^{th} generation,
e_{ijkl} is the random residual error.

Genetic Parameters

Heritability (h^2)

Estimates of variance components for studies traits were estimated separately for each trait using Restricted Maximum Likelihood (REML) method **(Rao, 1972)** via the Mixed Model Equation using variance component procedure described by **(SAS, 2013)**. Estimates of variance components were for sire and residual random effects for all traits studied. These estimates were used then to calculate heritability estimates for the studied traits from the following equation:

$$h^2 = \frac{4\sigma_s^2}{\sigma_s^2 + \sigma_e^2}$$

Where:

σ_s^2 is the sire variance component, σ_e^2 is the residual variance component, σ_A^2 is the additive variance, σ_P^2 is the total phenotypic variance.

The approximate standard errors for the heritability were computed according to the following formula:

$$S.E\,(h^2) = 4\sqrt{\frac{2(1-t)^2(1+(K-1)t)^2}{K(K-1)(S-1)}}$$

Where:

t= intra-class correlation, calculated from the following formula:

$$t = Var(S)\,/(Var(S) + Var(E))$$

S= number of sires, and K= weighting factor

Genetic Trend

Genetic trends were estimated for the studied growth traits using Best Linear Unbiased Prediction (BLUP) of breeding values. Individual breeding values by single trait were estimated using Variance Components Estimation program (VCE ver. 6.0.2, computer packaged) according to **(Groeneveld *et al.,* 2008)** . Estimates of variance components for sire and residual random effects (σ_s^2 and σ_e^2) obtained by REML procedure were used in the Animal Model program as (σ_s^2 and σ_e^2) guessed values (starting values) to estimate the breeding values of birds for the studies traits. The breeding values were estimated for all birds, mean of expected breeding values were computed according to the following model:

$$\boldsymbol{y = Xb + Za + e}$$

Where:
y is the vector of observations,
b is the vector of fixed effect,
a is the vector of sire effect,
X, Z are the incidence matrices relating the observations to the fixed and sire effects, respectively,
e is the vector random residual effect.
The regression of these breeding values on generation was used to estimate genetic trends according to the following linear regression model:

$$\boldsymbol{y = a + bx + e}$$

Where:
y is the average breeding value,
a is the equation constant,
b is the linear regression coefficient,
x is the generation,
e is the random residual.
The standard error of linear regression estimates was used as the standard error for the genetic trend.

RESULTS AND DISCUSSIONS

Body weight at different ages (BW)

Data in **Table (1)** represents least square means for the effect of generation on BW in grams during the first 6 weeks of age. The results indicate that there is a significant increase in body weight at different ages with the advancing of generation. The body weight at six weeks of age increased by 13.38g (5.28%) and 5.33g (2.04%) for growing quails in the third generation compared with those for the quails of the first and second generations, respectively.

However, there was a significant decrease in body weight at two weeks of age in the third-generation quails compared with those of the first and second generations (-3.49 and -10.61 g, respectively). in agreement with these results, **(El-Attrouny *et al.,* 2020)** found that selection for BW at 4 weeks of age resulted in significant increase in body weight means at 2, 4 and 6 weeks of age with generation advance. Likewise, **(Hussen *et al.,* 2016)**, reported that 15.7% superiority in 6-weeks body weight after one generation of selection for 6-weeks body weight. Significant differences were observed by **(Hussain *et al.,* 2013; Narinç *et al.,* 2015)** in weekly body weight among different generations increasing with advancing in generation. Moreover, similar results were obtained by **(Amrabit *et al.,* 2021)**, generation had a significant effect on body weights at hatch, two, four and six weeks of age in Japanese quail when selected to 6-weeks body weight for two generations, the highest recorded body weight means were the second-generations birds weighed 270.56 g for BW_6. **(Manaa *et al.,* 2022)** reported similar results in their selection study for 5-weeks body weight for four generations in Japanese quail, differences between generations with regard to hatch, 2-weeks, 4 weeks and 6-weeks body weights were significant where the means increased with generations, they recorded body weight of 253.13 g at 6-weeks of age after four generations of selection.

Table (1) Least Square Means for the effect of generation on body weight (BW) in grams during the first 6 weeks of age

Generation	BW_0	BW_2	BW_4	BW_6
G_1	9.24	80.03^b	191.18^a	253.58^c
G_2	9.18	87.15^a	181.91^c	261.63^b
G_3	9.18	76.54^c	186.59^b	266.96^a
SEM	0.02	0.36	0.70	0.88
P value	0.11	<0.0001	<0.0001	<0.0001
Level of Significance	NS	***	***	***

G_1= the first generation, G_2= the second generation, G_3= the third generation. [abc] Means within the same column not having similar superscripts are significantly different (P≤0.05), SEM= standard error of mean, P value= probability level, *** (P≤0.001), NS= Non-significant (P>0.05).

Results in **Table (2)** represent the least-square means of body weight at different ages varied between selected and control groups of growing quails within three generations of selection. These results reveal that there was always a significant difference within the same generation in favor of the selected group at all studied ages. The selected line was heavier in body weight at six weeks of age than the control line by 19.22g (7.97%), 23.30g (9.56%) and 25.96g (10.49%) in first, second and third generations, respectively. At four weeks of age the differences between lines were 14.4g (7.92%), 12.29g (7.13%) and 12.28g (6.93%) %) in first, second and third generations, respectively. Moreover, it is also apparent that the difference in BW_6 increases with advance in generation reflecting the benefit of selection for body weight at six weeks of age in improving the genetic performance of growing quails.

These results agree with **(Narinc *et al.,* 2014)** who reported significant differences in body weight attributed to line, where the selected line quail were consistently heavier than control line at all ages, **(Aggrey *et al.,* 2003)** and **(Reddish *et al.,* 2003)** reported similar results for their selection studies. Similar effect of line within generation was reported by **(Varkoohi and Kaviani, 2014)** were the selected line had a superiority of 10.2% in four-week body weight over the control line after three generations of selection, this superiority in our study was 6.92% and 10.49% for four- and six-weeks body weights, respectively. **(Emam, 2021)** also reported that line significantly affected studied body weights (except hatch weight) up to 6 weeks of age in selection study in Japanese quail for body weight at 4 weeks, selected line had heavier body weights than the control line. Significant higher body weights favoring the selected line were also reported by **(Rezvannejad *et al.,* 2013)**. Likewise, **(Amrabit *et al.,* 2021)** found that body weight at different ages for selected line were higher than control line with highly significant differences in both selected generations, with reported comparable 6-weeks body weight means (269.85 and 247.12 for selected and control lines, respectively).

The significant increase in BW with respect to selection can be attributed to genetic changes that result in the production of more muscle and fat tissues as the selection for higher body weight will result in selecting for specific genes that contribute to increased muscle and fat development. Over time, this selective breeding results in an accumulation of these desirable genes in the quail population, leading to an overall increase in body weight. Additionally, environmental factors such as nutrition and housing can also contribute to the observed increase in body weight.

Table (2) Least Square Means for the of effect of line within generation on body weight (BW) in grams during the first 6 weeks of age

Treatment		BW_0	BW_2	BW_4	BW_6
Selected	**G_1**	9.43^{a}	82.02^{b}	196.32^{a}	260.51^{c}
	G_2	9.35^{b}	88.57^{a}	184.70^{c}	267.11^{b}
	G_3	9.25^{c}	77.93^{c}	189.58^{b}	273.38^{a}
Control	**G_1**	8.90^{d}	76.48^{d}	181.92^{d}	241.29^{e}
	G_2	8.78^{e}	82.58^{b}	172.41^{f}	243.81^{de}
	G_3	8.97^{d}	72.35^{e}	177.30^{e}	247.42^{d}
SEM		0.03	0.54	1.07	1.28
P value		<0.0001	<0.0001	<0.0001	<0.0001
Level of Significance		***	***	***	***

G_1= the first generation, G_2= the second generation, G_3= the third generation. [abcdef] Means within the same column not having similar superscripts are significantly different (P≤0.05), SEM= standard error of mean, P value= probability level, *** (P≤0.001).

Daily weight gain during different periods (DWG)

Data in **Table (3)** shows the least-square means of daily weight gain for growing quails during different studied of age in the three studied generations. The results indicate that daily weight gain at the fattening period (0 to 6 weeks) is significantly higher in the third generation by 0.32 (4.69%) and 0.13 (2.16%) grams per day when compared to those for growing quails in first and second generations, respectively. The highest daily weight gains were recorded between weeks 2 to 4 of age, the overall daily weigh gain from hatch to 6 weeks of age was at its highest in the third-generation quails which recorded 6.14 g/d.

Similar findings were reported by **(El-Attrouny *et al.,* 2020)**, significant increases with generation were recorded between weeks 4-6 and hatching to 6 weeks daily weigh gains. However, their highest daily weight gains were found between weeks 4 to 6, in agreement with **(Hussain *et al.,* 2013)** who reported significantly higher body weight gain in second generation which was attributed to selection for higher body weight having positive response to selection. **(Amrabit *et al.,* 2021)** noticed that generation had a significant effect on daily weight gain at all studied interval, like what obtained in the current study, highest daily weight gains were calculated between weeks 2 to 4 of age in the second generation (8.26 g/d), while the highest DWG_{0-6} was 6.21 g/d also in the second generation. Significant differences between generations were also observed by **(Manaa *et al.,* 2022)**, where the fourth generation showed the highest values for average daily gain at 0-2-, 2-4- and 0–6-week intervals (4.67, 6.36 and 5.79 g, respectively), their calculated daily weight gains were slightly less than the measures in the present study.

Table (3) Least Square Means for the of effect of generation on daily weight gain (DWG) in grams/day during the first 6 weeks of age

Generation	DWG_{0-2}	DWG_{2-4}	DWG_{4-6}	DWG_{0-6}
G_1	5.05^b	7.93^a	4.41^b	5.82^c
G_2	5.55^a	6.70^b	5.68^a	6.01^b
G_3	4.81^c	7.84^a	5.70^a	6.14^a
SEM	0.02	0.04	0.04	0.02
P value	<0.0001	<0.0001	<0.0001	<0.0001
Level of Significance	***	***	***	***

G_1= the first generation, G_2= the second generation, G_3= the third generation. [abc] Means within the same column not having similar superscripts are significantly different (P≤0.05), SEM= standard error of mean, P value= probability level, *** (P≤0.001).

Least squares means and standard errors for daily weight gain during hatch (0) - 2, 2 - 4, 4 -6 and 0 - 6 weeks of ages for control and selected lines of Japanese quail during base and two generations of selection for BW_6 are presented in **Table (4)**. These results show that daily weight gains for selected line growing quails exhibited significant differences over the control line quail at all studied periods in the three generations. The highest recorded daily weight gain difference was between the fourth and sixth weeks of age at the third generation, recording a 1 g/day difference followed by 0.75 g/day difference between the selected and control lines of the second generation. Generally, the results show the significant differences between selected and control line in daily weight gain during the growth period (0 to 6 weeks of age) were 0.45, 0.54 and 0.62 gram/day in first, second and third generations, respectively.

Table (4) Least Square Means for the of effect of line within generation on daily weight gain (DWG) in grams/day during the first 6 weeks of age

Treatment		DWG_{0-2}	DWG_{2-4}	DWG_{4-6}	DWG_{0-6}
Selected	G_1	5.18^{b}	8.17^{a}	4.54^{c}	5.98^{c}
	G_2	5.65^{a}	6.79^{d}	5.84^{a}	6.13^{b}
	G_3	4.90^{c}	7.97^{b}	5.94^{a}	6.29^{a}
Control	G_1	4.83^{c}	7.51^{c}	4.19^{d}	5.53^{e}
	G_2	5.25^{b}	6.36^{e}	5.09^{b}	5.59^{de}
	G_3	4.52^{d}	7.40^{c}	4.94^{b}	5.67^{d}
SEM		0.04	0.06	0.07	0.03
P value		<0.0001	<0.0001	<0.0001	<0.0001
Level of Significance		***	***	***	***

G_1= the first generation, G_2= the second generation, G_3= the third generation. [abcde] Means within the same column not having similar superscripts are significantly different ($P\leq0.05$), SEM= standard error of mean, P value= probability level, *** ($P\leq0.001$).

These results agree with **(Amrabit *et al.,* 2021)** who reported that daily weight gains during different periods were significantly higher in selected line than control line, and among generations, highest from hatch to 6-weeks daily weight gain was in second generation's selected line, also **(Hussain *et al.,* 2013)** found that selected line had significantly body weight gains than control line witch was attributed to the better utilized in selected birds.

Heritability (h^2)

The heritability estimates -derived from the sire component- for the studied growth traits are provided in **Table (5)**. The results indicate that a trend of increase was observed in heritability estimates of body weight at 6 weeks of age and daily weight gain between 0 and 6 weeks of age with generation advancing. Heritability estimates for body weight at six weeks of age and daily weight gain from 0 to 6 weeks of age were 0.38 and 0.37, respectively. Meanwhile, heritability estimates for body weight at four weeks of age was 0.33.

Such moderate estimates were found similar to **(Balcıoğlu *et al.,* 2005; Kaplan *et al.,* 2016; toelle *et al.,* 1991; Vali *et al.,* 2005)**. **(Khaldari *et al.,* 2010)** estimated heritability for 4-week body weight for generations 1-20 as 0.29. Estimates of heritability reported by **(Badawy *et al.,* 2010)** were 0.46, 0.35 and 0.38 for BW_2, BW_4 and BW_6, respectively, those values are close to the estimates in the current study. Comparable heritability ranges have been reported by **(Adeogun and Adeoye, 2004; Zerehdaran *et al.,* 2012)**. **(Karami *et al.,* 2017)** reported a heritability of 0.39 for body weight at 42 days of age which emphasizes our estimations of 0.38. **(El-Attrouny *et al.,* 2020)** estimated heritability of 0.22 and 0.23 for 6-weeks body weight and hatching to 6 weeks daily weight gain, respectively in a four-generations selection experiment for high 4-weeks body weight. The nearly equal heritability of BW_6 and DWG_{0-6} were observed in the present study. Moderate heritability (0.26) for 4-weeks body weight was also reported by **(El-Full *et al.,* 2021; Khaldari *et al.,* 2010)**, such moderate heritability estimate was also reported by **(Resende *et al.,* 2005)**.

The heritability values showed a general curve-linear relationship with age, it tends to decrease with age to a given age then restore upward rising thereafter, similarly reported by **(Aggrey and Cheng, 1994; Badawy *et al.,* 2010; El-Attrouny *et al.,* 2020; Karami *et al.,* 2017).** However, heritability for particular trait can take different values according to population, environmental conditions surrounding the animals, breed type, estimation method and sampling error due to small data set or sample size **(Falconer, 1960; Prado-Gonzalez *et al.,* 2003)**.

In light of these results, it is clear that estimates of heritability for growth traits studied were high. The high variability due to sires shows that there is a possibility to improve growth traits through selection. Individual body weight at 6 weeks seems to be best criteria for selection if we are looking to improve growth performance, being more heritable and much easier to measure.

Table (5) Heritability estimates (h^2± S.E.) for body weight (BW) and daily weight gain (DWG) with their standard errors during three generations of selection

	h^2± S.E.			
	G1	**G2**	**G3**	**Overall**
BW_2	0.53 ± 0.08	0.52 ± 0.08	0.48 ± 0.08	0.51 ± 0.05
BW_4	0.27 ± 0.06	0.24 ± 0.05	0.51 ± 0.08	0.33 ± 0.04
BW_6	0.23 ± 0.06	0.37 ± 0.07	0.60 ± 0.09	0.38 ± 0.04
DWG_{0-6}	0.22 ± 0.06	0.36 ± 0.06	0.59 ± 0.09	0.37 ± 0.04

G_1= the first generation, G_2= the second generation, G_3= the third generation. BW2= Body weights at 2 wks of age, BW4= Body weights at 4 wks of age, BW6= Body weights at 6 wks of age and DWG0-6 = Daily weight gain during hatch to 6 wks of ages.

Genetic trends

Genetic trends estimated as a regression coefficient of trait breeding values on generation number, for growth traits studied are provided in **Table (6)**. The results show that genetic trends were about 2.02 g per generation for body weight at 6 weeks of age. Whereas, for daily weight gain during 6 weeks of age, the genetic trend was increased by 0.05 g/ day for each generation.

The value of genetic trend of body weight at 6 weeks of age - which used as criterion of the selection- means 20.2 grams more per individual can be obtained each 10 generations, which take about 2 years. in other words, it is apparent from these results that the values of genetic trend of body weight at 6 weeks and daily weight gain up to 6 weeks of age were significantly increased with the generation number. These may reflect the improvement of growth performance of quails through increasing their body weight at marketing and daily weight gain during fattening period generation by generation.

Table (6) Estimated Genetic Trend by generation for studied growth traits

Trait	Genetic Trend	S.E.
BW_6	2.02	0.330
DWG_{0-6}	0.05	0.008

BW6= Body weights at 6 wks of age and DWG0-6 = Daily weight gain during hatch to 6 wks of ages

Genetic trends of body weight at 6 weeks of age and daily weight gain up to 6 weeks of age as affected by generation were illustrated in **Figures (1 and 2)**, respectively. The genetic trends for both 6-weeks body weight and daily weight gain up to six weeks of age were positive over the three studied generations. Likewise, positive trend was observed by **(Badawy *et al.,* 2010)** only at 4 weeks of age, the weight at which selection was carried out, whilst for the other body weights they tend to be negative. Also, they noted that genetic trend estimates tend to be higher with advance of generation. **(El-Attrouny *et al.,* 2020)** concluded the breeding value estimates for BW_6 increased gradually as the generation advanced and reached 5.50 in G_3 compared to 4.15 in the current study, for DWG_{0-6} it reached 0.17 in G_3 compared to 0.1 in our study. This also was in agreement with those of **(Hussain *et al.,* 2014)** who observed a linear increasing trend of BW at three weeks of age in selected populations as the generations progressed.

Moreover, **(Khaldari *et al.*, 2010, 2011)** genetic trends indicated an approximately constant response over generations. In a similar way, **(Grosso *et al.*, 2009)** observed positive trends in a commercial broiler line selected for higher body weights regarding absolute carcass weight. This increased genetic trend in the selected generations illustrated the efficiency of selection for BW at six weeks of age.

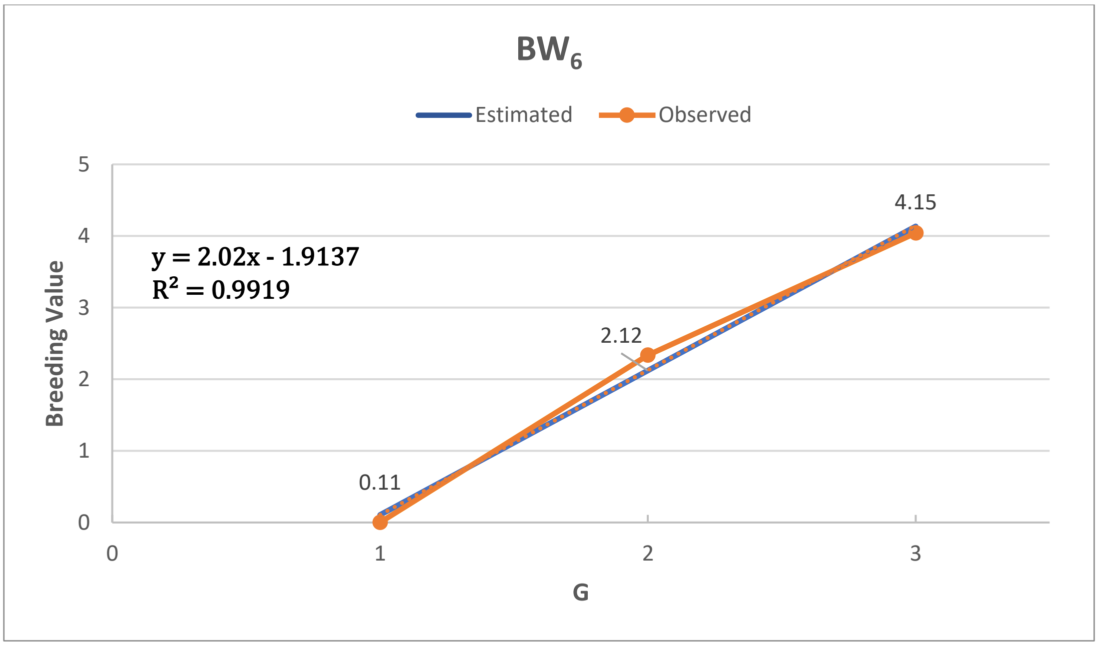

Figure (1) Genetic Trend of body weight at 6 weeks of age by generation

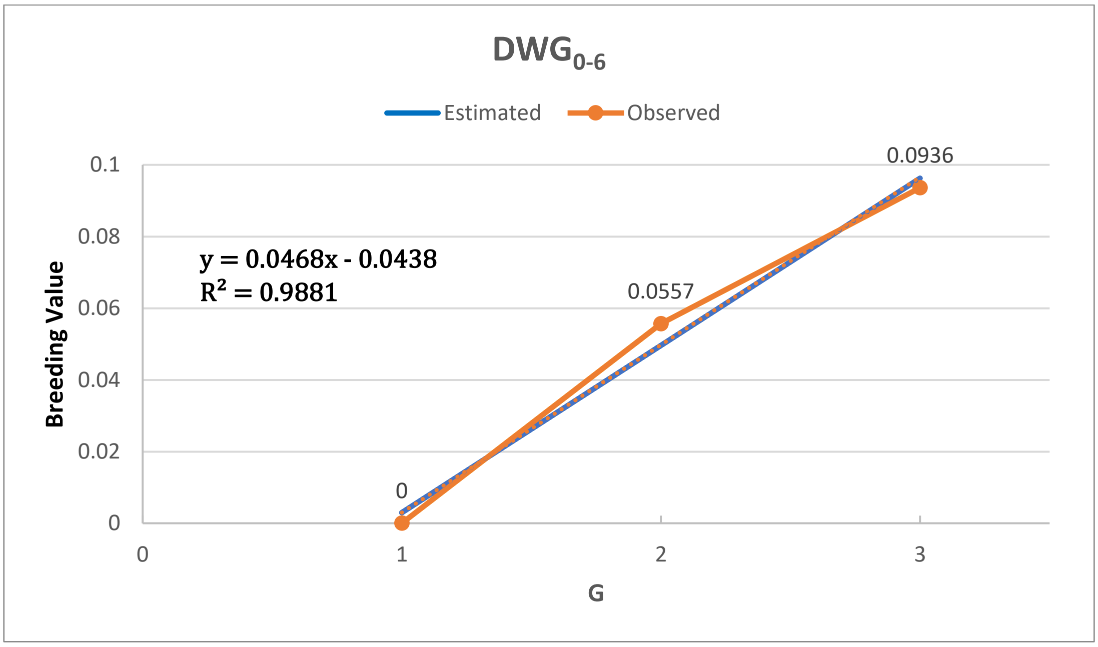

Figure (2) Genetic Trend of daily weight gain at 6 weeks of age by generation

CONCLUSION

Genetic improvements have been observed in terms of body weight and daily weight gain during the growing period due to selection for high BW_6 in Japanese quail. Furthermore, the high variability due to genetic differences among individual sires suggests that there is potential for further improvement of growth traits through selection for high six-week body weight. Additionally, the observed increase in genetic trends indicates a consistent enhancement of growth performance over generations, specifically in terms of body weight at the time of marketing and daily weight gain during the fattening phase. This highlights the effectiveness of selecting for six-week body weight in improving growth traits in quail populations.

REFERENCES

Adeogun, I. O.; and Adeoye, A. A. (2004). Heritability's and Phenotypic Correlations of Growth Performance Traits in Japanese Quails. *Livestock Research for Rural Development*, *16*(12): 102–106.

Aggrey, S. E.; Ankra-Badu, G. A.; and Marks, H. L. (2003). Effect of Long-Term Divergent Selection on Growth Characteristics in Japanese Quail. *Poultry Science*, *82*(4): 538–542.

Aggrey, S. E. and Cheng, K. M. (1994). Animal Model Analysis of Genetic (Co)Variances for Growth Traits in Japanese Quail. *Poultry Science*, *73*(12): 1822–1828.

Amrabit, A. A.; EL-Raffa, A.; Eldlebshany, A.; and Soliman, A. S. (2021). Growth Responses to Selection for High Body Weight in Meat Line of Japanese Quail. *Egyptian Poultry Science Journal*, *41*(3): 615–625.

Badawy, A. Y.; Abdel-Ghany, A. M.; Sabri, H. M.; and Khattab, M. S. (2010). Genetic Evaluation and Trends of Japanese Quail Data Selected for 4-Wk Body Weight. *Agri. Res. J. Suez Canal Univ.; 10*(2): 11–16.

Balcıoğlu, M. S.; Kızılkaya, K.; Yolcu, H. I.; and Karabağ, K. (2005). Analysis of Growth Characteristics in Short-Term Divergently Selected Japanese Quail. *South African Journal of Animal Science*, *35*(2): 83–89.

Duncan, D. B. (1955). Multiple Range and Multiple F Tests. *Biometrics*, *11*(1): 1–42.

El-Attrouny; M.; Manaa, E.; and Ramadan, S. (2020). Genetic Evaluation and Selection Correlated Response of Growth Traits in Japanese Quail. *South African Journal of Animal Sciences*, *50*(2): 325–333.

El-Deen, M. B.; Nour, A. A.; El-Tahawy, W. S.; and Fouad, H. A. (2016). Selection for Weight of Early Eggs in Japanese Quail: Correlated Response and Heritability. *Asian Journal of Poultry Science*, *10*(2): 64–71.

El-Full, E. A.; Mahmoud, B. Y. F.; Semida, D. A. M.; and Emam, A. M. (2021). Selection Responses for Augmenting Early Growth Rate in Japanese Quail. *Egypt. Poult. Sci.*: *41*(1): 63–76.

Emam, A. M. (2021). Growth Curves Models in Two Lines of Japanese Quail Selected for High Body Weight. *Egyptian Poultry Science Journal*, *40*(4): 915–928.

Falconer, D. S. (1960). Selection of Mice for Growth on High and Low Planes of Nutrition. *Genetical Research*, *1*(1): 91–113.

Getabalew, M.; Alemneh, T.; and Akeberegn, D. (2019). Heritability and Its Use in Animal Breeding. I*nt J Vet Sci Technol*, *4*: 001–005.

Groeneveld, E.; Kovac, M.; and Mielenz, N. (2008). VCE 6.0. 2. *Co-Variance Components Estimation Package, Institute of Farm Animal Genetics, Mariensee, Germany*.

Grosso, J.; Balieiro, J.; Eler, J.; Ferraz, J.; Mattos, E.; Michelan Filho, T.; Felício, A.; and Rezende, F. (2009). Estimates of Genetic Trend for Carcass Traits in A Commercial Broiler Line. in *Genetics and Molecular Research* (Vol. 8, Issue 1).

Hasan, K. H. (2013). Evaluation of Productive Performance of Japanese Quail in Summer of Iraq. *Diyala Agricultural Sciences Journal*, *5*(2): 69–80.

Hudson, G. F. S.; and Kennedy, B. W. (1985). Genetic Evaluation of Swine for Growth Rate and Backfat Thickness. *Journal of Animal Science*, *61*(1): 83–91.

Hussain, J.; Akram, M.; Sahota, A. W.; Javed, K.; Ahmad, H. A.; Mehmood, S.; Ahmad, S.; Sulaman, R.; Rabbani, I.; and Jatoi, A. S. (2013). Selection for Higher Three Week Body Weight in Japanese Quail: 1. Effect on Growth Performance. *Journal of Animal and Plant Sciences*, *23*(6): 1496–1500.

Hussain, J.; Akram, M.; Sahota, A. W.; Javed, K.; Ahmad, H. A.; Mehmood, S.; Jatoi, A. S.; and Ahmad, S. (2014). Selection for Higher Three Week Body Weight in Japanese Quail: 2. Estimation of Genetic Parameters. *Journal of Animal and Plant Sciences*, *24*(3): 869–873.

Hussen, S. H.; Abdulrahman Al-Khdri, A. M.; and Hassan, A. M. (2016). Response to Selection for Body Weight in Japanese Quail (Coturnix Coturnix Japonica). *Iranian Journal of Applied Animal Science*, *6*(2): 453–459.

Kaplan, S.; Narinç, D.; and Gürcan, E. K. (2016). Genetic Parameter Estimates of Weekly Body Weight and Richard's Growth Curve in Japanese Quail. *European Poultry Science*, *80*.

Karabag, K.; Alkan, S.; Üniversitesi, O.; Karsli, T.; Soner Balcıoğlu, M.; Karabağ, K.; Alkan, S.; Karslı, T.; and Balcıoğlu, M. S. (2017). Genetic Changes in Growth Curve Parameters in Japanese Quail Lines Divergently Selected for Body Weight. *European Poultry Science*, *81*: 1–10.

Karami, K.; Zerehdaran, S.; Tahmoorespur, M.; Barzanooni, B.; and Lotfi, E. (2017). Genetic Evaluation of Weekly Body Weight in Japanese Quail Using Random Regression Models. *British Poultry Science*, *58*(1): 13–18.

Khaldari, M.; Pakdel, A.; Mehrabani Yegane, H.; Nejati Javaremi, A.; and Berg, P. (2010). Response to Selection and Genetic Parameters of Body and Carcass Weights in Japanese Quail Selected for 4-Week Body Weight. *Poultry Science*, *89*(9): 1834–1841.

Khaldari, M.; Yeganeh, H. M.; Pakdel, A.; Javaremi, A. N.; and Berg, P. (2011). Response to Family Selection and Genetic Parameters in Japanese Quail Selected for Four Week Breast Weight. *Archives Animal Breeding*, *54*(2): 212–223.

Maiorano, G.; Sobolewska, A.; Cianciullo, D.; Walasik, K.; Elminowska-Wenda, G.; Sławińska, A.; Tavaniello, S.; Żylińska, J.; Bardowski, J.; and Bednarczyk, M. (2012). influence of in-ovo Prebiotic and Synbiotic Administration on Meat Quality of Broiler Chickens. *Poultry Science*, *91*(11): 2963–2969.

Manaa, E. A.; El-Attrouny, M. M.; Baloza, S. H.; and Ramadan, S. I. (2022). Selection for High Body Weight and Its Association with The Expression Profiles of Somatotropic Axis and Mitochondrial Genes in Japanese Quail. *Pakistan Veterinary Journal*, *42*(2): 261–265.

Minvielle, F.; Bed'Hom, B.; Coville, J.-L.; Ito, S.; inoue-Murayama, M.; and Gourichon, D. (2010). The" Silver" Japanese Quail and The MITF Gene: Causal Mutation, Associated Traits and Homology with the" Blue" Chicken Plumage. *Bmc Genetics*, *11*(1): 1–7.

Narinç, D.; Aksoy, T.; and Kaplan, S. (2015). Effects of Multi-Trait Selection on Phenotypic and Genetic Changes in Japanese Quail (Coturnix Coturnix Japonica). *The Journal of Poultry Science*, 0150068.

Narinc, D.; Karaman, E.; and Aksoy, T. (2014). Effects of Slaughter Age and Mass Selection on Slaughter and Carcass Characteristics in 2 Lines of Japanese Quail. *Poultry Science*, *93*(3): 762–769.

Prado-Gonzalez, E. A.; Ramirez-Avila, L.; and Segura-Correa, J. C. (2003). Genetic Parameters for Body Weights of Creole

Chickens from Southeastern Mexico Using an Animal Model. *Livestock Research for Rural Development*, *15*(1): 27–31.

Rao, C. R. (1972). Estimation of Variance and Covariance Components in Linear Models. *Journal of The American Statistical Association*, *67*(337): 112–115.

Reddish, J. M.; Nestor, K. E.; and Lilburn, M. S. (2003). Effect of Selection for Growth on onset of Sexual Maturity in Randombred and Growth-Selected Lines of Japanese Quail. *Poultry Science*, *82*(2): 187–191.

Resende, R. O.; Martins, E. N.; Georg, P. C.; Paiva, E.; Conti, A. C. M.; Santos, A. I.; Sakaguti, E. S.; and Murakami, A. E. (2005). Variance Components for Body Weight in Japanese Quails (Coturnix Japonica). *Brazilian Journal of Poultry Science*, *7*: 23–25.

Rezvannejad, E.; Pakdel, A.; Miraee Ashtianee, S. R.; Mehrabani Yeganeh, H.; and Yaghoobi, M. M. (2013). Analysis of Growth Characteristics in Short-Term Divergently Selected Japanese Quail Lines and Their Cross. *Journal of Applied Poultry Research*, *22*(4): 663–670.

SAS ®. (2013). *Statistical Analysis Software. Users' Guide Statistics Version 9.4* (9.4). SAS institute inc.

Snedecor, G. W.; and Cochran, W. G. (1980). Statistical Methods. IOWA. *Iowa State University Press. Starkstein, SE, and Robinson, RG (1989). Affective Disorders and Cerebral Vascular Disease. The British Journal of Psychiatry*, *154*: 170–182.

Toelle, V. D.; Havenstein, G. B.; Nestor, K. E.; and Harvey, W. R. (1991). Genetic and Phenotypic Relationships in Japanese Quail.: 1. Body Weight, Carcass, and Organ Measurements. *Poultry Science*, *70*(8): 1679–1688.

Türkmut, L.; Altan, Ö.; Oğuz, İ.; and Yalçin, S. (1999). Effects of Selection for Four Week Body Weight on Slaughter, Carcass, and Abdominal Fat and Some Organ Weights and Blood Serum Parameters in Japanese Quail. *Turkish Journal of Veterinary and Animal Sciences*, *23*(7): 63–68.

Vali, N.; Edriss, M. A.; and Rahmani, H. R. (2005). Genetic Parameters of Body and Some Carcass Traits in Two Quail Strains. *International Journal of Poultry Science*, *4*(5): 296–300.

Van Melis, M. H.; Eler, J. P.; and Ferraz, J. B. S. (2001). Tendências Genéticas Para Características Produtivas E De Avaliação Visual Em Bovinos da Raça Nelore. *Anais*.

Varkoohi, S.; and Kaviani, K. (2014). Genetic Improvement for Body Weight of Japanese Quail. *Annual Research and Review in Biology*, 347–353.

Wakasugi, N. (1984). Japanese Quail. *Evolution of Domesticated Animals*.

Zerehdaran, S.; Lotfi, E.; and Rasouli, Z. (2012). Genetic Evaluation of Meat Quality Traits and Their Correlation with Growth and Carcase Composition in Japanese Quail. *British Poultry Science*, *53*(6): 756–762.

J. Agric. & Env. Sci. (Damanhour University) 2023, 22 (1): 285-308
Print: ISSN 1687-1464 Online: 2735-5098

الملخص العربي

التحسين الوراثي للأداء الإنتاجي للسمان الياباني الأبيض المربى تحت برنامج انتخاب

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الخلاصة: أجريت الدراسة الحالية بهدف معرفة تأثير الانتخاب قصير المدى في السمان الياباني لصفة وزن الجسم عند عمر 6 أسابيع على أداء نمو السمان الياباني الأبيض. تم اختيار خط منتخب لأعلى وزن عند عمر 6 أسابيع وخط كنترول بشكل عشوائي من عشيرة الأساس للسمان الياباني الأبيض. خلال هذه الدراسة ولمدة ثلاثة أجيال تم تقدير المكافئ الوراثي والاتجاهات الوراثية للصفات التي تميز النمو. كانت هناك فروق معنوية لتأثير الجيل وأيضا التداخل بين تأثير الجيل والخط ($p<0.001$) على وزن الجسم والزيادة اليومية في وزن الجسم في مختلف الأعمار المدروسة. أظهرت النتائج أن الخط المنتخب كان له وزن جسم أعلى بشكل معنوي عند عمر 6 اسابيع وكذلك الزيادة اليومية في وزن الجسم مقارنة بخط الكنترول في كل من الأجيال الثلاثة محل الدراسة. كانت تقديرات المكافئ الوراثي المحسوبة من مكونات التباين للذكر لكل من صفة وزن الجسم عند عمر 6 أسابيع وصفة زيادة الوزن اليومية من الفقس حتى عمر 6 أسابيع حيث كانت 0.38 و0.37 على التوالي وأيضا كان الاتجاه الوراثي حوالي 2.02 جرام لكل جيل لصفة وزن الجسم عند عمر 6 أسابيع بينما كان الاتجاه الوراثي لصفة الزيادة اليومية في الوزن حتى عمر 6 أسابيع يزيد بمقدار 0.05 جم / يوم لكل جيل. تشير تقديرات المكافئ الوراثي والتقييمات الوراثية التي تم الحصول عليها من خلال هذه الدراسة إلى أن صفة وزن الجسم عند عمر 6 أسابيع وصفة الزيادة اليومية في وزن الجسم خلال فترة النمو تبدو مناسبة للاستخدام كمعيار انتخاب لتحسين صفات النمو في قطعان السمان.

الكلمات الدالة: السمان الياباني، الانتخاب، أداء النمو، المكافئ الوراثي، الاتجاه الوراثي.