Journal of Genetic and Environmental Resources Conservation, 2023, 11(1):24-32.
www.gercj.com Print ISSN: 2306-8663, Online ISSN: 2306 – 8280

Effect of genotype on some reproductive parameters, body weight and phenotypic correlations of Japanese quail

Haitham Rajab Manhee Al-kaisi*, Sohaib Mahmood Abd and Samawal sadi Abdullah Al-Tikriti
Dep. of Animal Production, College of Agriculture, Tikrit University, Iraq
***Corresponding author: haithamalkaisi85@tu.edu.iq**
Received: November 14th 2022; Accepted: December 29th 2022

Abstract

This study aimed to know the effect of pure and hybrid genotype and sex on some reproductive and productive traits in Japanese quail, which allows early selection. The hatching eggs were collected from three Japanese quail genotypes a pure genotype (♂ White × White ♀), a pure genotype (♂ Black × Black ♀) and a hybrid genotype (♂ Black × White ♀). The results of the study showed a significant superiority of the hybrid genotype (♂ Black × White ♀) over the pure genotype (♂ White × White ♀) and (♂ Black × Black ♀) in terms of hatching percentage of total eggs and body weight at the age of 7 days. Whereas, the hybrid genotype (♂ Black × White ♀) was superior to the pure genotype (♂ Black × Black ♀) in terms of hatching egg weight, fertility percentage, and body weight at the age of 1, 14, 21, 28, 35, and 42 days. As for the effect of sex, females outperformed males in the trait of body weight at the age of 35 and 42 days. As for the interaction between genotype and sex, the results showed a significant superiority of the females of the hybrid genotype (♂ Black × White ♀) and the pure genotype (♂ White × White ♀) in body weight at the age of 35 and 42 days. A positive and significant phenotypic correlation was found between the weight of the hatching eggs with the fertility rate and with the body weight at the age of 7 days, as well as between the body weight at the age of 1 day with the body weight at the age of 7 and 28 days. While a significant correlation was found between the body weight at the age of 7 with 28 days, while there was a positive and highly significant phenotypic correlation between the body weight at the age of 1 with 14 days and the body weight at the age of 14 with 21 days.

Keywords: Hybrid genotype, Pure genotype, Japanese quail, Reproductive indicators, Body weight.

Introduction

The breeder always desires to improve the production of his herd by getting to know more about the genotypes of his animals, which can only be reached through manifestations of traits that can be measured and an estimate of the genetic parameters that achieve his goal (Sultan, 2005). In addition, information about growth performance and plumage color mutations is insufficient to evaluate their use in commercial production. Therefore, the required improvement strategy approach can be implemented by conducting a direct comparative study between several strains of Japanese quail (Inci et al., 2015).

Fertility and hatching are among the important economic traits, and their decrease causes a great economic loss (Diab, 1988). Fertility expresses the ability to reproduce because it is the factor that determines the number of hatching chicks out of the number of eggs (Obeid, 2010). The hatching period of Japanese quail eggs also varies, ranging from 17-18 days (Vali, 2008). One of the basic conditions for efficient quail breeding is producing fertile eggs and obtaining the highest hatching rate for eggs. And that the breeding of relatives reduces the rate of hatching, while crossbreeding improves the rate of hatching (Al-Zubaidi, 1986). It was also found that the hatching rate varies according to the color of the plumage, where the hatching rate was high in brown Japanese quail compared to white (Aboul-Hassan et al., 1999).

Growth is one of the most important traits for evaluating different types of birds, especially in meat-producing animals and birds, because it forms the basis for evaluating growth and feed efficiency as well as in making economic and market decisions in farm animals (Momoh and Kershima, 2008). Selection of heavier individuals also leads to genetic improvement of the trait (Oke et al., 2004). The traits of body weight is affected by genetic and non-genetic factors. Growth is usually measured by observing the differences in body weight recorded at different ages or the body weight gain obtained during different periods of growth (Chambers, 1993). Body weight also plays an important role in determining many other economic traits in farm animals (Pesmen and Yanrdimen, 2008). The body weight of the Japanese quail differs from the rest of the farm animals, as the males are smaller than the females, and the weight of the wild quail ranges between 90-100 grams, while the domesticated quail weighs between 100-140 grams, while the weight of the females ranges between 120-160 grams. However, the weight between domesticated lines varies greatly, as commercial breeds for meat production can weigh up to 300 grams (Minvielle, 2004).

The study aimed to demonstrate the effect of pure and hybrid genotype and sex on some reproductive and productive traits in Japanese quail, allowing for early selection.

Materials and Methods

This study was conducted in the quail farm, Department of Animal Production, College of Agriculture, Tikrit University for the period from 21/11/2019 to 25/1/2020. The hatching eggs were obtained by collecting eggs from females of pure genotype (♂ White × White ♀), pure genotype (♂ Black × Black ♀) and hybrid genotype (♂ Black × White ♀) bred as hosts with a ratio of (1: 1).) in rooms with dimensions of 40 x 40 x 40 cm, as shown in pictures (1, 2, and 3) and according to the genotype for a period of 6 days, and stored at a temperature of 18-20 °C and a humidity of 60-65%. The eggs were hatched in an Italian-origin Fiem type incubator, and the eggs were laid in Trays incubator drawers according to the genotype. After hatching, the chicks were reared in three rooms, one for each genotype, and the number of hatched chicks was (40, 39, and 50) chicks of the pure genotype (♂ White × White ♀), (♂ Black × Black ♀) and hybrid genotype (♂ Black × White ♀), Each room had dimensions of (1 x 1) meter and a height of 90 cm. The floor was covered with sawdust. A gas incubator was used to maintain a temperature of 35 °C in the first week, then the temperature was gradually reduced by 2 degrees per week to reach the optimum temperature (Abu El-Ela, 2005). Feed and water were provided to the chicks freely, and the lighting was continuous during the first 7 days, after which the lighting hours were reduced to 16 hours of illumination throughout the duration of the experiment using 60-watt lamps to ensure that the intensity of lighting reaches everyone as required.

The Japanese quail birds were fed on a diet with an energy content of 2976 kilocalories/kg of feed and 24% of crude protein from the age of one day until the age of 30 days. Then they were fed on a diet with an energy content of 2850 kilocalories/kg of feed and 20% of crude protein. Until the end of the experiment and according to information provided by the
US National Research Council (NRC, 1994).

Photograph (1) ♂ White × White ♀

Photograph (2) ♂ Black × Black ♀

Photograph (3) ♂ Black × White ♀

Data collection:

Hatching eggs weight (gram): Weighing the eggs daily and individually for each female, the length of the egg collection period is 6 days, according to each genotype, using a sensitive scale, Citizen model Fr - H1200, with an accuracy of 0.01 grams, then placed in an Italian-origin FEM incubator, and placed the eggs in incubating Trays drawers, according to the genotype.

Fertility percentage (%): After the completion of the hatching period, the unhatched eggs were broken for each genotype, the number of unfertilized eggs was recorded, and the percentage was calculated according to equation Abu El-Ela (2005):

$$\text{Fertility percentage(\%)} = \frac{\text{The number of fertilized eggs}}{\text{Total number of eggs}} \times 100$$

Hatchling percentage of total eggs (%): After the end of the hatching period, the chicks were removed from the hatchery and their numbers were recorded on the basis of each genotype. The percentage of hatching was calculated according to the equation of Diab (1988):

$$\text{Hatchling percentage of total eggs (\%)} = \frac{\text{The number of hatched chicks}}{\text{Total number of eggs}} \times 100$$

Body weight at 1, 7, 14, 21 and 28 days of age (gram): The chicks were weighed at the age of 1, 7, 14, 21 and 28 days, according to each genotype individually, using a sensitive balance type Citizen, model Fr - H1200, with an accuracy of 0.01 grams.

Body weight at 35 and 42 days of age (gram): The birds were weighed at the age of 35 and 42 days for both females and males, according to each genotype and individually, using a Sensitive Balance, Model Fr - H1200, with an accuracy of 0.01 grams. The sex was known through a secretory gland called the Cloacal gland, and this gland is located above the opening of the complex and its size is about 1-1.5 cm3. One of the traits of this gland is that it is found in the male only and that it secretes foamy substances similar to soap foam, and therefore it is also called the Foam gland. (Al Sabeel and Al Badri, 2008).

Statistical Analysis:

Statistical Model 1: The data were analyzed using a complete randomized design to study the effect of genotype for some of the studied traits. Significant differences between the averages were compared using Duncan's polynomial test (Duncan, 1955) and below a significant level (0.05), and the statistical program SAS (2010) was used in the statistical analysis according to the following mathematical model.

$Y_{ij} = \mu + T_i + e_{ij}$

Since:

Y_{ij} = value of the studied view.

μ = general average of the traits studied

T_i = genotype effect

e_{ij} = the normally and independently distributed random error with a mean of zero and an equal variance of S^2e.

Statistical Model 2: The data were analyzed using the Factory Experiment Design to study the effect of genotype and sex and the interaction between them. Significant differences between the averages were compared using Duncan's polynomial test (Duncan, 1955) and under a significant level (0.05), and the statistical program SAS (2010) was used in the statistical analysis according to the following mathematical model.

$Y_{ijk}=\mu+A_i+B_j+AB_{ij}+e_{ijk}$

Since:

Y_{ij} = value of the studied view.

μ = General average of the traits studied

A_i = Effect of the first factor (genotype), where i = 1, 2, 3.

B_j = The effect of the second factor (sex), as j = 1, 2.

AB_{ij} = Effect of interaction between factors (A,B)

e_{ijk} = the normally and independently distributed random error with a mean of zero and an equal variance of S^2e.

Results and Discussion

1- The effect of genotype:

1-1: Weight of hatching eggs (grams): The results of Table (1) indicate that there are significant differences at the level ($p \leq 0.05$), if a significant superiority of the pure genotype (♂ White × White ♀) and the hybrid genotype (♂ Black × White ♀) was observed over the pure genotype (♂ Black × Black

♀). in the description of the weight of the hatching eggs and their values were (11.87, 11.50 and 10.25) **grams respectively.**

The reason for this is that there is a high genetic correlation between live body weight and egg weight (Zayed et al., 2000 and Attia, 2006).

The data of the study agreed with Nwachukwu and others (2015) in their study on two lines of Japanese quail in Nigeria, as they showed significant differences in the weight of eggs between white and brown, and recorded (11.08 and 10.46) grams respectively.

1-2: Fertility percentage (%): The data of Table (1) showed that there were significant differences at the level (p≤0.05) between the genotypes in the trait of fertility rate, as the hybrid genotype (♂ Black × White ♀) was superior to the pure genotype (♂ Black × Black ♀), and no difference appeared. Significant between the hybrid genotype (♂ Black × White♀) and the pure genotype (♂ White × White ♀), as well as no significant difference between the pure genotype (♂ White × White ♀) and (♂ Black × Black ♀) and their values reached (92.67, 83.67 and 85.67) % respectively.

Janes (2007) showed that the shape and colour of plumage have an impact on reproductive success and mating frequency. Thornberry (2016) also found that plumage colour correlates with some reproductive traits. And it agreed with the study of Ahmed and Al-Barznji (2020) on three lines of Japanese quail, as they found a significant difference in the fertility rate trait between the brown, white and desert colour of the plumage.

1 - 3: Hatching percentage of total eggs (%): The statistical analysis of Table (1) indicated that there were significant differences at the level (p≤0.05) between the genotypes in the trait of the percentage of hatching from total eggs, as the hybrid genotype (♂ Black × White ♀) was superior to the pure genotype (♂ White × White ♀) and (♂ Black × Black ♀) and no significant difference appeared between the pure genotypes (♂ White × White ♀) and (♂ Black × Black ♀) and their values were (84.33, 74.17 and 73.00) % respectively.

The reason is due to the existence of a direct relationship between the hatching rate and the weight of the eggs (Al-Kaisi, 2014). The results of the study agreed with Al-Tikriti et al. (2019) in their study on the Japanese quail bird found in Nigeria, as they found significant differences between the colour of the white plumage and the colour of the brown plumage in the trait of the hatching percentage of the total eggs. The results of the study of Faruque et al. (2016) showed a significant superiority of the Japanese line found in Bangladesh compared to the line with white, brown and black plumage in the trait of the hatching percentage of total eggs.

The results did not agree with Hassan and Abd Alsattar (2015), as they did not notice significant differences in their study of three colours of Japanese quail plumage (white, brown and black) in the percentage of hatching based on total eggs.

Table (1) The effect of genotype on the weight of hatching eggs (grams), fertility percentage (%) and hatching percentage of total eggs (%) of Japanese quail (means ± standard error)

Body weight	Genotype		
	♂ White × ♀White	♂ Black × ♀ Black	♂ Black × ♀White
	N = 10	N = 10	N = 10
hatching egg weight	11.87 ± 0.20 a	10.25 ± 0.18 b	11.50 ± 0.14 a
Fertility percentage	85.67 ± 2.44 ab	83.67 ± 2.86 b	92.67 ± 3.01 a
Hatch percentage of total eggs	73.00 ± 2.65 b	74.17 ± 2.36 b	84.33 ± 3.06 a

* Different lowercase letters within one row indicate significant differences (p ≤ 0.05) between genotypes.

1-4: Body weight at 1, 7, 14, 21 and 28 days of age (grams): The results of Table (2) showed that there were significant differences at the level (p≤0.05) if the hybrid genotype (♂ Black × White ♀) and the pure genotype (♂ White × White ♀) were superior to the pure genotype (♂ Black × Black ♀). In terms of body weight at the age of 1 and 14 days, its values were (8.32, 8.18 and 7.18) and (62.59, 59.43 and 52.19) grams, respectively. While the hybrid genotype (♂ Black × White ♀) outperformed the pure genotype (♂ White × White ♀) and (♂ Black × Black ♀) while the pure genotype (♂ White × White ♀) outperformed the pure genotype (♂ White × White ♀) ♂ Black × Black ♀) in the trait of body weight at the age of 7 days, and their values were (25.84, 23.80 and 21.75) grams, respectively.

As for the trait of body weight at the ages of 21 and 28, a significant superiority was observed for the hybrid genotype (♂ Black × White ♀) over the pure genotype (♂ Black × Black ♀) and no significant difference was observed between the hybrid genotype (♂ Black × White ♀) and The pure genotype (♂ White × White ♀) as well as between the pure genotype (♂ White × White ♀) and the pure genotype (♂ Black × Black ♀) with values of (97.67, 89.92 and 91.30) and (137.22, 127.46 and 130.88). grams respectively.

The reason is due to the increase in the size of the eggs, which reflects positively on the body weight at hatching, and the existence of a positive and highly significant correlation between the weight of the egg and the weight of the one-day-old chick (Razuki, 2005 and Al-Assady, 2005).

These results agreed with the study of Bed hom et al. (2012), as it was found that the genotype has a relationship with some productive traits, including body weight. It also agreed with the study of Bagh et al. (2016) on three lines of Japanese quail, as they found significant differences in body weight at the age of 7, 14, 21 and 28 days between the color of gray, white and brown plumage, while they did not find significant differences in body weight at the age of 1 day.

The results did not agree with the findings of Al-Kafajy et al. (2018), as they did not notice significant differences in body weight at 21 and 28 days of age between three lines of Japanese quail (brown, white and black).

Table (2) Effect of genotype on body weight at 1, 7, 14, 21 and 28 days of age (grams) of Japanese quail (means ± standard error)

Body weight	Genotype		
	♂ White × ♀White	♂ Black × ♀ Black	♂ Black × ♀White
	N = 10	N = 10	N = 10
1 day	8.18 ± 0.19 a	7.18 ± 0.10 b	8.32 ± 0.23 a
7 day	23.80 ± 0.74 b	21.75 ± 0.55 c	25.84 ± 0.41 a
14 day	59.43 ± 1.14 a	52.19 ± 1.57 b	62.59 ± 1.80 a
21 day	91.30 ± 1.53 ab	89.92 ± 2.76 b	97.67 ± 2.27 a
28 day	130.88 ± 2.51 ab	127.46 ± 2.90 b	137.22 ± 2.28 a

* Different lowercase letters within one row indicate significant differences (p ≤ 0.05) between genotypes.

1-5: Body weight at the age of 35 and 42 days (grams): The statistical analysis in Table (3) indicated that there were significant differences at the level (p≤0.05) in the trait of body weight at the age of 35 days, if the hybrid genotype (♂ Black × White ♀) was superior to the pure genotype (♂ Black × Black ♀) in When there was no significant difference between the hybrid genotype (♂ Black × White ♀) and the pure genotype (♂ White × White ♀), as well as between the pure genotype (♂ White × White ♀) and the pure genotype (♂ Black × Black ♀).) and their values were (167.62, 162.19 and 155.80) grams, respectively. As for the trait of body weight at the age of 42 days, it was found that the hybrid genotype (♂ Black × White ♀) and the pure genotype (♂ White × White ♀) over the pure genotype (♂ Black × Black ♀) were found to be (190.39, 184.83 and 170.54) grams respectively.

The reason for this is due to the difference in the genetic susceptibility between them, including the weight at hatching, where there is a positive and highly significant correlation between the weight at hatching and the body weight with age (Ozbey and Ozcelik, 2004). The reason is also due to the presence of a positive relationship between the color of the plumage and the weight of the body (Rabie, 2019). It agreed with the findings of Al-Kafajy et al. (2018), as they noticed significant differences in body weight at 5 and 6 weeks of age between three lines of Japanese quail (brown, white and black).

Table (3) Effect of genotype on body weight at 35 and 42 days of age (grams) of Japanese quail (means ± standard error)

Effect Genotype	N	Body weight	
		35 day	42 day
♂ White × ♀ White	20	162.19 ± 3.50 ab	184.83 ± 5.79 a
♂ Black × ♀ Black	20	155.80 ± 3.72 b	170.54 ± 5.18 b
♂ Black × ♀ White	20	167.62 ± 3.62 a	190.39 ± 5.86 a

* Different lowercase letters within one column indicate significant differences (p ≤ 0.05) between genotypes.

2- The effect of sex on body weight at the ages of 35 and 42 days (grams): The results of the statistical analysis in Table (4) showed that there were significant differences at the level (p≤0.05) between the sexes in the trait of body weight at the age of 35 and 42 days, if the females outperformed the males and their values reached (172.03 and 151.71) and (202.04 and 161.80) grams Straight.

The reason is due to differences in the growth hormone secretion systems in females on the one hand, and on the other hand, the ability of females to deposit higher amounts of fat than males (Al-Tikriti, 2018). The reason may also be attributed to the fact that the female reproductive system is heavier than the male reproductive system (Nwachukwu et al , 2015 and Al-Aedani, 2014).

These results agreed with the results of Al-Asadi (2005) in his study on white and coloured Japanese quail, if it was found that females outperformed males for the colour of white plumage compared to colored ones in body weight at the age of 4 and 6 weeks. It also agreed with the study of Alkan et al. (2013) and Al- Aedani (2014) as they found that the body weight of females was superior to that of males during their study of the colour of plumage of Japanese quail.

Table (4) Effect of sex on body weight at 35 and 42 days of age (grams) of Japanese quail (means ± standard error)

Effect Sex	N	Body weight	
		35 day	42 day
Females	30	172.03 ± 2.70 a	202.04 ± 3.54 a
Males	30	151.71 ± 2.08 b	161.80 ± 2.40 b

* Different lowercase letters within one column indicate significant differences (p ≤ 0.05) between sex

3- The effect of the interaction between genotype and sex on body weight at the ages of 35 and 42 days (g): The results of Table (5) indicated that there were significant differences at the level (p≤0.05) if the females of the hybrid genotype (♂ Black × White ♀) and the females of the pure genotype (♂ White × White ♀) recorded the highest body weight at the ages of 35 and 42 days in While males of pure genotype (♂ Black × Black ♀) recorded the lowest body weight, the values of body weight at the age of 35 and 42 days were (171.47, 152.91, 168.97, 142.63, 175.66 and 159.59) and (204.56, 165.10, 189.57, 151.52, 211.98 and 168.79) grams for females and males of the pure genotype (♂ White × White ♀), the pure genotype (♂ Black × Black ♀) and the hybrid genotype (♂ Black × White ♀), respectively.

This study agreed with the results of Inci et al. (2015) in their study on the effect of plumage colour (wild, golden, white and brown) and sex of Japanese quail if they found significant differences between plumage colour and sex in body weight at 35 and 42 days of age.

Table (5) Effect of the interaction between genotype and sex on body weight at 35 and 42 days of age (grams) of Japanese quail (means ± standard error)

Effect Interaction		N	Body weight	
Genotype	Sex		35 day	42 day
♂ White × ♀White	Females	10	171.47 ± 5.05 a	204.56 ± 6.41 a
	Males	10	152.91 ± 2.68 cd	165.10 ± 3.73 c
♂ Black × ♀ Black	Females	10	168.97 ± 4.03 ab	189.57 ± 5.30 b
	Males	10	142.63 ± 1.95 d	151.52 ± 2.15 d
♂ Black × ♀White	Females	10	175.66 ± 5.13 a	211.98 ± 4.77 a
	Males	10	159.59 ± 3.82 bc	168.79 ± 4.32 c

*Different lowercase letters within one column indicate significant differences (p ≤ 0.05) between the interaction

4- **Phenotypic correlations**: The results of Table (6) show that there is a significant and positive phenotypic correlation between the weight of the hatching eggs and the fertility rate on the one hand, and with the body weight at the age of 7 days on the other hand. While the phenotypic correlation coefficient was positive and significant between body weight at the age of 1 with 7 days on the one hand, and the body weight at the age of 1 with 28 days on the other hand, with a value of 0.32 and 0.35. There was also a significant and positive correlation between the two trait of body weight at the age of 7. with 28 days and its value was 0.32, While the phenotypic correlation coefficient was positive and highly significant between the two traits of body weight at the age of 1 day and the body weight at the age of 14 days on the one hand, and on the other hand, between the body weight at the age of 14 days and the body weight at the age of 21 days, and the value of the correlation coefficient was 0.50 and 0.31 .

These results agreed with Adeogun and Adeoye (2004), Zezer et al. (2006), Al-Tikriti (2010) and Ahmed et al. (2019), as they found a positive and significant correlation between different body weights in their study on Japanese quail.

Table (6) Phenotypic correlations between some studied traits of Japanese quail

Traits	Correlation of phenotype
Weight of hatching eggs with fertility percentage	0.32 *
The weight of hatching eggs with body weight at the age of 7 days	0.34 *
Body weight at the age of 1 day with the body weight at the age of 7 days	0.32 *
Body weight at the age of 1 day with the body weight at the age of 14 days	0.50 **
Body weight at the age of 1 day with body weight at the age of 28 days	0.35 *
Body weight at the age of 7 days with body weight at the age of 28 days	0.32 *
Body weight at the age of 14 days with body weight at the age of 21 days	0.31 **

** Highly significant differences at the level ($p \leq 0.01$).

* The differences are significant at the level ($p \leq 0.05$).

Conclusion

We conclude from the results of this study the superiority of the hybrid genotype in the traits of the hatching percentage of total eggs and body weight at the age of 7 days. 28, 35 and 42 days. A positive and highly significant phenotypic correlation was found with body weight at the age of 7 with 28 days on the one hand, and between body weight at the age of 14 with 21 days on the other hand.

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