

Effect of Genotype and Genotype – Environment Interaction on Productive Performance of Japanese Quail Varieties

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To cite this article:

Khalid Hamid Hassan, Ali Rafea Abd–Alsattar. Effect of Genotype and Genotype – Environment Interaction on Productive Performance of Japanese Quail Varieties. *American Journal of BioScience*. Vol. 4, No. 4, 2016, pp. 49-52. doi: 10.11648/j.ajbio.20160404.12

Received: July 25, 2016; **Accepted:** August 9, 2016; **Published:** August 25, 2016

Abstract: Two experiments were conducted at the poultry farm of Department of Animal Production – College of Agriculture – University of Diyala / Iraq, the first experiment performed in Autumn season using 324 birds and the second experiment performed in Spring season using 397 birds reared for ten weeks, the study aimed to detect the productive performance of three varieties of Japanese quail (White, Black and Brown plumage color) in the natural conditions of Iraq during Spring and Autumn seasons and the effect of genotype \times environment interaction ($G \times E$) on meat and egg production. The statistical analysis done according to factorial experiment in Completely Randomized Design (3×2) with three replicates. The results showed, significant superiority of the Black variety in the body weight measurements during the first 5 weeks of age, while there were no significant differences found in body weight between Black and Brown varieties during 6 and 7 weeks of age. There were significant differences due to $G \times E$ in body weight measurements of all weeks of rearing. The results showed significant superiority of the Black variety compared with White variety in feed consumption and weight gain traits, and also there were a significant superiority of measurements during Spring season rearing compared with Autumn season rearing in respect of weight gain and feed conversion traits, also there were significant $G \times E$ effect in feed conversion. There was a significant superiority of measurements during Autumn season rears in the age of sexual maturity of females, hen day egg production (%), and the number of eggs per hen.

Keywords: Japanese Quail, Variety, Season Effect, $G \times E$ Interaction

1. Introduction

In the last decades, the Japanese quail (*Coturnix coturnix*) became within the commercial poultry industry for producing good quality flavored meat for human consumers with the inexpensive price compared with most poultry species. The rearing of quail can be practiced by many families because of the simple requirements and rearing area of the flock [1], in another hand, the rearing of quail represents attractive economic activity because of its rapid growth, early age of sexual maturity and high reproduction rate.

In spite of the lack of understanding about the living conditions and limitations that face family procedures [2], the family poultry production is an important activity in Asia, Africa, and Latin America [3].

The wild-type plumage color of the quail is predominantly dark cinnamon Brown, and male and female have some differences in plumage color, hence adult males have uniform dark rust-red feathers on the breast and Cheek, while adult females have pale breast feathers that are speckled with dark

colored spots and these differences can be recognized at three weeks of age [4]. The difference between bird groups in plumage color can classify these groups to varieties [5].

Minvielle et al. [6] studied the effect of Roux plumage color on growth, carcass traits and egg production compared with wild-type plumage, the results referred that Roux color associated with significantly lower in the body weight, less abdominal fat and lower in egg weight. Islam et al. [7] found that there was significant superiority of White plumage in live body weight compared with Black variety.

Environmental conditions are playing important role in gene expression and as a result affect in quantitative traits. Conner and Hartl [8] referred to phenotypic plasticity, which means that the same genotype may produce different phenotypes in different environments and there are two types of genotype- environment interaction, the first has reaction norms cross and referred to as crossing $G \times E$, and the second type often called variance $G \times E$ because there are different genetic variance between environments. Breeder flocks that exposure to environmental challenges may introduce changes in behavior, physiology, and gene expression under both

chronic and temporal conditions, and may be heritable changes in the parent and transmitted to their offspring [9].

Ozbey and Ozcelik [10] recorded a significant decline in live body weight, feed consumption and feed efficiency of Japanese quails in high environmental temperature (35°C) compared with control group reared in 18–24°C.

Iraq is located in the southwest of the continent of Asia extended from 29–37 North latitudes and longitudes 38–48 East, there are wide variations among the four seasons in Iraq with respect to temperature, moisture and day length. The monthly average temperatures in Iraq range from higher than 48°C (120 Fahrenheit) in July and August to below zero in January. The maximum environment temperature in Autumn ranged 17–30°C and in Spring 32–41°C, while the minimum temperature ranged 14–28°C and 21–30°C for Autumn and Spring seasons respectively, and these variations affect the performance and viability of birds reared in the natural environment.

Hassan [11] studied the effect of rearing Brown variety quail in the natural environment during summer in Iraq on meat and egg production performance, using quails flock adapted to Iraqi conditions and the results recorded live body weight 158.07 g at 6 weeks of age and the uniformity among birds was 41.94%, while the mean age of sexual maturity was 40.63 days. Hassan et al. [12] studied the effect of some non-genetic factors (including age and sex) and its effect on production traits, his results showed highly significant effect of bird age on the body weight, carcass weight, and significant effect of age on thigh weight, and a significant effect of sex on body weight, dress percentage, intestine length, liver weight percentage.

Hassan et al. [13] compared two varieties of Japanese quail (White plumage quail and Gray plumage quail) for their production performance and their results recorded highly significant differences between males and females in body weight, dress percentage, gizzard weight, liver weight and intestine length, and the significant effect of age × variety interaction on gizzard weight, beside the significant effect of age × sex interaction on liver weight. This experiment aimed to determine the effect of plumage color genotypes of quails

on productive performance which recorded in the natural condition of Autumn and Spring seasons of Iraq, also determine the genotype-environment interaction effects on productive traits.

2. Materials and Methods

The experiments of the study conducted at the poultry farm of Dept. of Animal production –College of Agriculture–University of Diyala / Iraq, the first experiment performed in Autumn season using 324 birds and the second experiment performed in Spring season using 397 birds reared for ten weeks of age, the study aimed to detect the performance of three varieties of Japanese quail (White, Black and Brown plumage color) in the natural condition of Spring and Autumn seasons in Iraq and determine the effect of genotype × environment interaction (G × E) on meat and egg production.

The statistical analysis of the data performed according to factorial experiment 3×2 in a Completely Randomized Design (CRD) and each treatment combination has three replicates, the significance of differences between means was determined by Duncan multiple range test [14] at 0.05 significant level.

3. Results and Discussion

The results recorded highly significant superiority ($P < 0.01$) of Black plumage variety compared with other varieties in body weight during the period from one week to five weeks, while there was no significant difference between Black and Brown varieties in body weight at one day age, 6 and 7 weeks of age (Table 1), this result disagree with Islam et al [7].

The results showed highly significant differences in body weight between measurements of Autumn and measurements of Spring seasons. Hence, there was superiority in the body weight trait during Autumn season at one day age and the weeks 1, 2, 3, 4 of age, while there were superiority in body weight during Spring season at weeks 5, 6 and 7 of age. The multiple comparisons among group means revealed significant differences due to genotype × environment interaction in body weight of all periods of the study (Table 1).

Table 1. Means of body weight at different ages for a main effect and interaction between genotypes and environment in Japanese quail varieties.

Traits	Weight (g) at various ages (wk)							
	One day	1 wk	2 wk	3 wk	4 wk	5 wk	6 wk	7 wk
Genotypes (G)								
White (W)	7.50b	20.79b	42.58b	81.72b	116.56b	152.71c	175.03b	184.27b
Black (B)	7.74a	24.24a	50.17a	90.29a	125.85a	161.51a	187.62a	197.58a
Brown (N)	7.69ab	21.17b	44.64b	82.15b	120.02b	156.47b	182.91a	193.83a
Seasons (E)								
Autumn (A)	7.81a	24.10a	51.47a	89.48a	123.83a	154.13b	175.74b	180.60b
Spring (S)	7.48b	20.03b	40.12b	79.96b	117.79b	159.67a	187.97a	203.19a
G × E								
WA	7.74ab	21.39bc	45.76bc	85.10b	120.10bc	151.66d	171.65b	180.83b
WS	7.26c	20.19cd	39.40cd	78.34c	113.01d	153.76cd	178.41b	187.71b
BA	7.93a	28.97a	60.29a	98.27a	128.31a	157.26bc	179.69b	180.52b
BS	7.56b	19.50d	40.04d	82.31bc	123.40ab	165.76a	195.56a	214.64a
NA	7.76ab	21.94b	48.35b	85.10b	123.08ab	153.46cd	175.88b	180.44b
NS	7.62b	20.40cd	40.92cd	79.23c	116.95cd	156.48b	189.94a	207.22a

*Means have different superscript refer to a significant difference at ($P < 0.05$) within each effect.

The G×E interaction can appear in genetics studies in two forms, the first represents a change in variance between the performance of two genotypes as a result of a change of environment and the second type of interaction represents a cross-interaction included a change in the arrangement order of the performance of genotypes [8], hence, the results recorded no significant difference between measurements of White and Black varieties during Autumn season, while the results showed significant differences between measurements of these varieties during Spring season, which refer that Spring environment increased the variance between the

measurements of these varieties (Table 1), also there was reverse situation in the second week of age, hence the results recorded a significant difference between White and Black varieties during Autumn season and appeared no significant differences between them during Spring season (Table 1). According to the results in Table 2, there were significant differences among all varieties in feed consumption while there were no significant differences in weight gain and mortality percentage between Black and Brown varieties. The results recorded lower feed conversion of Black variety compared with White and Brown varieties.

Table 2. Means of feed consumption, weight gain, feed conversion and mortality percentage of main effects and genotype × environment in Japanese quail varieties.

Traits	Feed consumption (g / 6 weeks)	Weight gain (g / 6 weeks)	Feed conversion (g feed / g gain)	Mortality (%)
Genotypes (G)				
White (W)	566.58c	167.53b	3.38a	0.00a
Black (B)	660.29a	179.88a	3.68b	2.58ab
Brown (N)	609.58b	175.22a	3.49a	5.72b
Seasons (E)				
Autumn (A)	614.93a	167.93b	3.66a	4.01a
Spring (S)	609.37a	180.49a	3.37b	1.52a
G × E				
WA	547.08d	163.91b	3.34a	0.00a
WS	586.08c	171.15b	3.42a	0.00a
BA	680.55a	171.76b	3.96c	2.87a
BS	640.04b	188.00a	3.40a	2.30a
NA	617.16bc	168.11b	3.68b	9.17b
NS	602.00c	182.32a	3.30c	2.27a

*Means have different superscript refer to a significant difference at ($P < 0.05$) within each effect.

The statistical analysis revealed no significant difference between the measurements of Autumn and Spring seasons in feed consumption and mortality percentage, while there were significant differences between measurements of Autumn and Spring seasons in weight gain (167.93 and 180.49 g / week) and feed conversion (3.66 and 3.37 g feed/ g weight gain). Also, the statistical analysis showed there were no significant effects of genotype × environment interaction on weight gain and mortality percentage, while there were significant differences in the G×E interaction mean of the feed

consumption, hence, there were significant differences between White and Brown varieties in feed consumption during Autumn season and became no significant differences during Spring season.

Also, the results appeared significant differences between the G×E interaction means in feed conversion, hence, there were significant differences between White and Black varieties in Autumn and the differences between these varieties became no significance in the Spring season (Table 2).

Table 3. Means of sexual maturity, hen-day egg production, the number of eggs per hen and egg weight of the main effect and genotype × environment interaction in Japanese quail varieties.

Traits	Sexual maturity (Day)	Hen-day Egg (%)	Egg / Hen (Egg)	Egg weight (g.)
Genotypes (G)				
White (W)	39.67a	68.22a	36.83a	9.93a
Black (B)	40.67ab	77.09a	42.00a	9.83a
Brown (N)	41.00b	74.82a	40.50a	9.85a
Seasons (E)				
Autumn (A)	38.22a	78.68a	43.89a	9.60b
Spring (S)	42.67b	68.07b	35.67b	10.14a
G × E				
WA	38.33a	67.34b	37.33bc	9.76bc
WS	41.00b	69.10b	36.33bc	10.11ab
BA	38.00a	90.29a	50.67a	9.47c
BS	43.33c	63.88b	33.33c	10.18a
NA	38.33a	78.42ab	43.67ab	9.56c
NS	43.67c	71.23b	37.33bc	10.14a

*Means have different superscript refer to a significant difference at ($P < 0.05$) within each effect.

The statistical analysis showed significant differences between measurements of White and Brown varieties in the age of sexual maturity (39.67 and 41.0 days) while there were no significant differences among measurements of varieties in other traits of egg production included hen day egg production, number of egg / hen and egg weight (Table 3) Statistical analysis appeared significant differences due to $G \times E$ interaction at the age of sexual maturity, hen day production and number of eggs per hen, the results recorded no significant differences between measurements of White and Black varieties during Autumn and the differences became significant during Spring season, while the differences still no significant between measurements of Black and Brown varieties during both Autumn and Spring seasons (Table 3).

In respect of hen day production, the results recorded significantly differences between measurements of White and Black varieties during Autumn season and the differences became no significant during Spring season.

4. Conclusions

The results appeared the suitable market body weight at six weeks of age during Spring season. There were a superiority of the Black and Brown varieties in body weight and weight gain during the first six weeks of rearing compared with White variety. In respect of hen day egg production, there were no significant differences between White and Black varieties during Spring season, while there were significant superiority of Black variety in egg production during Autumn season, and that referred to $G \times E$ interaction between these varieties and the environment of Autumn and Spring seasons.

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