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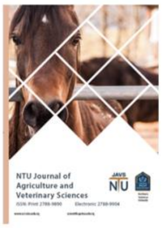

EstimatingGenetic Parameters for Productive Qualities in Local and Ukrainian Quail and their Various Crossbreeds

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A B S T R A C T

Between the 1st of March and 1st June 2023 an experiment was conducted in the field of the Livestock Division/Nineveh Research Department to assess the heterosis, reciprocal and maternal effects as well as general combining ability (GCA) and specific combining ability (SCA) of Ukrainian (U) and local (L) white (W) and brown (Br) plumage quail and their hybrids crosses for the following traits: age at sexual maturity (ASM day), female body weight at sexual maturity (FBWS g), first egg weight (FEW g), hen day production (HDP%), egg weight (EW g) and Feed Conversion Ratio (FCR g food/g egg mass) . The results showed that for all traits under study, there are significant differences ($P < 0.05$) in heterosis between the hybrids. The GCA of FBWS, HDP%, EM and FCR were significantly different ($P < 0.05$) between the pure genetic groups. All traits were significantly different ($P < 0.05$) across the hybrids in the SCA, except for the ASM FBWS. All traits except the EW showed statistically significant variation in the reciprocal effect. The maternal factor had no significant effect on any trait

Introduction

The rapid growth and reproduction of quail, short generation period, quick return on investment with profitabilitydue to resistance to diseases and capacity to survive and produce under various environmental conditions are some of the traits that have made it one of the most important poultry approved after broilers to meet nutritional needs in some countries of the world. [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11], have conducted studies for the reasons listed above, it is also utilized in genetic investigations [12].

According to [13, 14] heterosis is the enhancement of animal performance and output, caused by mating two genetically different parents. The importance of heterosis comes from the fact that it is a product of one of the mating systems, which is the second stage of genetic improvement processes after selection, and depends on boosting mixed genetic compositions through mating of unrelated distances [15]. The effects of hybrid vigor on quail growth and production traits were examined at different levels of significance. Some studies did not find any appreciable variations in heterosis in term of the weekly weight of quails, FC, FCR, or egg weight [16, 17, 18, 19], whereas others have discovered a considerable variation in hybrid vigor based on age and weight at sexual maturity, egg production, hatching rates, and fertility (17, 20, 21], weekly weight and weight gain (18, 22), and the number of eggs [21, 23].

Combining Ability compares how different internally bred lines perform when crossed, and it does so in two directions:

1. General Combining Ability refers to how well a breed or type's progeny perform in combinatorial or reciprocal crossings [13, 24].GCA describes the genetic influence of parents in combination with their prognosis. According to [25], this is a gauge of a parent's capacity to pass on good features to their offspring. General combining ability aids in sire selection based on the enhancement of the productive performance of their progeny [26], as sires with the greatest compatibility ability are chosen. Thus, growth traits and egg production can be increased. According to previous studies, there were significant differences in the sires' general combining abilities for body weight at 6 weeks of age, number of eggs produced per female, egg weight, egg mass, feed consumption, and feed conversion efficiency [18, 27].

2. Specific combining ability, according to [13], is the deviation from the average resulting from pollination between individuals of one clan or species and another. Additionally, it describes one pair of lines in a particular pattern where a certain combination appears better or worse than anticipated based on the average of two internally raised lines. [25] demonstrated the existence of non-aggregate effects that represent dominance variance and superiority variance. Breeders choose combinations based on their highest SCA; research has shown that this factor is significant for body weight (18, 27), as well as egg weight [27].

Materials and Methods

Between 1 March and 1 June 2023, a study was conducted in the poultry fields of the Livestock Division/ Nineveh Research Department to determine the hybrid vigor, GCA, and SCA of local quail (which obtained from the same Livestock Division) and Ukrainian quail (originated from the University of Duhok) colored brown and white, as well as their crosses. There were four large rooms and sixteen little rooms, each measuring (2 × 1.2) m. The lighting and ventilation in each large room was designed to be the same. The raising proceeded on the ground. The chicks were grown and dispersed based on the pure line, the consequent cross, and reciprocal cross breeding. The chicks were fed a growth diet containing 22% crude protein and 2903 metabolic calories up until the age of four weeks, after which the production diet containing 18% crude protein and 2908 metabolic calories was gradually introduced. The hybrid vigor, general combining ability, specific combining ability, reciprocal effect and maternal effect of the following attributes were estimated:

1. First egg weight (FEW).
2. Female body weight at sexual maturity (FBWS).
3. Age at sexual maturity (ASM).
4. Hen day production (HDP%)=No. of egg product/No. of female×100
5. Egg weight (EW)
6. Feed Conversion Ratio (FCR)=egg mass/feed consumption.
7. Heterosis = (hybrid production - parent production) / parent production × 100 [28].

8. General Combining Ability (GCA)= Σyi / n, where is Yi=a trait investigated in relation to offspring from a specific genetic group; N=total number of all offspring [29].
9. Specific Combining Ability (SCA)= [(AB)±(BA)/2]−[(GCA) (A)±GCA (B)/2] , Where: AB= the cross; BA= reciprocal cross [24].
10. Reciprocal effect (RE)= (yji – yij) / 2 , where is yji = reciprocal cross; yij = the cross.
11. Maternal effect (ME)= (ȳ.i – ȳi) , where is ȳ.i = particular dam mean; ȳi = particular sire mean. [29].

Statistical Analysis:

A complete randomized design (CRD) was used for a simple experiment. The Duncan multiple range test was used to identify the significance of the differences between the pure lines and their damages [30].

Results and Discussion

1- Heterosis:

Age at sexual maturity (ASM): According to Table (1) findings, there are substantial differences ($P \leq 0.05$) in the values of heterosis for the two groups of crossing and reciprocal crossing. (LBr♂ × LW♀) had the highest positive value (64.02%) in the reciprocal crossing category, this indicates that in this hybrid female (ASM) was 64% higher than the age of the females in the parents. The crossing group (LW♂ × LBr♀) came in second place with a heterosis (54.15%). This indicates that the age of the hybrid females at the time of their first egg laying increased by about 54% in comparison to their parents. While the heterosis values for the remaining genetic groups were negative, meaning that the first egg was laid by the females produced by crossing and reciprocal crossing at a younger age than their parents. The cause is attributed to [16], which stated that negative values of heterosis are caused by the potential presence of major genes that reduce the values of the trait. These results agreed with those reached by [17, 20; 21, 22].

Female body weight at sexual maturity (FBWS): The results in Table (1) show a significant increase ($P \leq 0.05$) in the FBWS heterosis for the crossing group (LW♂ × LBr♀) (98.18%), followed by the reciprocal group (LBr♂ × LW♀) with (84.97%), which also had a significant superiority ($P \leq 0.05$) over the rest of the crossing and reciprocal crossing groups. This indicates an increase in the weight of the females of these two hybrids by 98% and 84.97% of the weight of their parents at (FBWS). Meanwhile, the lowest significant negative heterosis was (- 7.19) for the crossing group (UW♂ × LW♀), this value means that the (FBWS) this hybrid had decreased by 7% from the weights of their parents. The results of the current study are consistent with [21].

First egg weight (FEW): Table 1 demonstrates a significant increase ($p \leq 0.05$) in FEW heterosis for the crossbred group (UBr♂ × LBr♀), estimated at (17.91%), which outperformed the all groups with the exception of (UBr♂ × LW♀), with an average of (8.56%), and the reciprocal crossbred groups (LW♂ × UBr♀) and (LBr♂ × UBr♀) with heterosis estimated at (1.77 and 11.29) %, respectively. Positive heterosis values indicate an improvement in the FEW of hybrids compared to their parents. While the heterosis for the rest of hybrids were negative, which means a decrease the FEW in hybrids. These results agreed with those of [21].

Hen Day Production (HDP): Table 1 demonstrates a significant increase ($P \leq 0.05$) in HDP Heterosis in two reciprocal crossbred (LW♂ × UW♀) and (LBr♂ × UBr♀), with positive heterosis (72.72 and 77.74)%, respectively. This means that the HDP in these two hybrids has increased over the HDP in the pure lines resulting from them, compared to the rest of genetics groups. The averages of the other genetic groupings ranged from (-28.42 to -43.06). However, the HDP was lowest for the cross bred(UBr♂ × LBr♀), coming in at (-87.59). These findings were in agreement with [17, 21, 23] findings.

Egg weight (EW): Table 1 shows that the crossbred populations of LWM and LBr♀ and the reciprocal crossbred populations of LBrM and UW♀ both had the greatest positive values of EW heterosis, at 5.65 and 5.91%, respectively. This indicates that the EW of the hybrids is better than the EW of their parents. However, the crossbred group (males UBr♀ LBr) got a negative value of heterosis (-4.15), which indicates that the EW of this hybrid declined from the EW of the pure lines originating from it by approximately (4.15%).

Feed Conversion Ratio (FCR): The reciprocal crossbred (LBr♂ × LW♀) obtained the highest positive FCR hybrid vigor (76.39%), which significantly outperformed ($P \leq 0.05$) the other genetic groups except (UW♂ × LW♀). This indicates that the FCR in these hybrids is higher than the FCR of their pure parents, indicating that these hybrids consumed more feed than the pure parents. The reciprocal crossbred (LBr♂ × UW♀) produced a negative hybrid vigor rating of

(-41.88%), which indicates that the feed consumption of the resulting hybrid has increased by about 42% compared to the pure lines. These outcomes complemented [28] findings.

2- General Combining Ability (GCA):
Age at sexual maturity (ASM): The information in Table (2) showed that there were no significant differences between Ukrainian and local quail in the GCA of ASM. The averages for white and brown birds in Ukraine and the surrounding region were determined as (37.95, 38.29, 37.95, and 39.48), respectively.
Female body weight at sexual maturity (FBWS): Table 2 demonstrates a significant (P ≤0.05) FBWS advantage for the UBr quail over the other groups. With averages of (212.04, 217.64, 203.43, and 210.57) for Ukrainian, LW, and brown quail, respectively, the UW and LBr quail considerably (P≤ 0.05) exceeded the LW group in the GCA.
First Egg Weight (FEW): The GCA for FEW did not significantly differ between the Ukrainian and LW and brown genetic groups. The calculated average weights for each were 9.41, 8.54, 8.82, and 9.29 g (Table 2).

Hen Day Production (HDP): The both colors of Ukrainian genetic groups as well as the white local group considerably (P ≤ 0.05) exceeded the LBr quail in the GCA of the HD, with averages of (63.68, 67.81, 60.58, and 49.51)%, respectively (Table 3). These findings were consistent with those of [27, 31].
Egg weight (EW): With averages of (11.71, 11.72, 11.55, and 11.76) g for the Ukrainian and local genetic groups in both colors of feather, the results in Table (2) did not reveal any statistically significant variations in EW. These findings corroborated [31] findings.
Feed Conversion Ratio (FCR): Table 2 demonstrated significant differences (P ≤ 0.05) between the UW group (4.88) g feed/g egg mass and the LW group (6.98) g feed/g egg mass in GCA of FCR. These differences were significant only between the two groups.

Table 2. shows GCA for some productive traits in Ukrainian and LW and brown feathered (mean + SD).

	UW	UBr	LW	LBr
ASM	37.95±0.59 a	38.29±1.38 a	37.95±1.29 a	39.48±0.93 a
FBWS	212.04±0.48 b	217.64±2.22 a	203.43±1.00 c	210.57±1.72 b
FEW	9.41±0.41 a	8.54±0.56 a	8.82±0.53 a	9.29±0.58 a
HDP	63.68±12.96 a	67.81±10.33 a	60.58±7.22 a	49.51±4.24 b
EW	11.71±0.49 a	11.72±0.58 a	11.55±0.57 a	11.76±0.61 a
FCR	4.88±1.79 b	5.21±2.10 ab	6.98±2.23 a	6.51±1.15 ab

Horizontal different letters refer to the significant differences between genetic groups at (P ≤ 0.05).

According to [29] the GCA generally reflects the additive influence of genes over generations, indicating that the levels of the examined traits may be higher in subsequent generations.

3-Specific Combining Ability
Age at sexual maturity (ASM): SCA of ASM in the hybrid (UW LBr) was significantly lower (P ≤ 0.05) than in the other hybrids, which were not statistically different from one another. The averages of the different hybrids UW × UBr, UW × LW, UW × LBr, UBr × LW, and LW × LBr , were estimated to be (0.05, 0.29, 1.55, -0.45, -0.05, and -0.55, respectively.
Female body weight at sexual maturity (FBWS): According to Table 3's findings, the hybrid (UBr × LBr) had the highest SCA of FBWS (9.89), making it statistically superior to the other hybrids (P ≤ 0.05), while the hybrids (UW × LW) and (LW × LBr) had the lowest significant SCA for FBWS, assessed at (-6.50 and -6.73, respectively).
First Egg Weight (FEW): As the averages were estimated at (0.77, -0.59, 0.30, -0.07, 0.36, and 0.25, respectively) (Table 3), no significant differences were found between the hybrids in SCA for the FEW. This is due to the absence of significant differences in the weight of the egg between the hybrids in the study.
Hen Day Production (HDP): The hybrids (UW × LW) and (UBr × LW) had SCA of HDP values that were significantly higher (P ≤ 0.05) than those of the other hybrids, averaging 8.60 and 11.32, respectively. However, with an average of (-10.98), the hybrid (LW × LBr) received the least significant value (P ≤ 0.05) in the SCA of this traits. The other hybrids (Table 3) did not differ significantly from one another. The current study's findings were in agreement with those of [23].
Egg weight (EW): According to Table 3, the hybrids (UBr × LBr) with an average of (0.14) and (UW × LBr) with an average of (-0.19) were the only ones with a significant difference (P ≤ 0.05) in EW's SCA, as opposed to the other hybrids. These findings were in line with those of [23], who concluded that the large weights of the females were to blame for the major disparities in the egg weight rate.
Feed Conversion Ratio (FCR): In comparison to the hybrids (UW × UBr and (UW × LBr), which had average SCA for FCR values of (-1.22 and -0.82), respectively, Table 3 reveals a significant increase (P ≤ 0.05) in the SCA for

the (LW × LBr) hybrid. None of the other hybrids notably differed from the aforementioned hybrids or from one another.

Negative values signify a negative interaction between the genes of the two lines, and the presence of epistasis between their genes may be the cause of the unusual combinatorial ability outcomes [29].

4- Reciprocal Effect (RE):

Age at sexual maturity (ASM): White quail Ukrainian female laid eggs more quickly than the other lines, according to Table (4), which showed a significant decrease ($P \leq 0.05$) in the reciprocal effect of female UW quail on ASM. As a result, the current study advises employing female UW quail for producing hybrid eggs, which lengthens the egg-producing period.

Female body weight at sexual maturity (FBWS): According to the findings in Table 4, the reciprocal effect of FBWS of UW quails increased significantly ($P \leq 0.05$). These females are heavier when they reach sexual maturity than females from other lines, and this characteristic can be utilized to create meat hybrids.

First Egg Weight (FEW): When compared to the other lines, the LW female demonstrated the strongest reciprocal effect ($P \leq 0.05$) for FEW (Table 4).

Hen Day Production (HDP): The findings showed that the reciprocal effect of UW female in HDP was significantly higher than other lines ($P \leq 0.05$) (Table 4). The use of female UW quails to produce egg hybrids was previously noted and is supported by this outcome [23].

Egg weight (EW): According to Table (4), there is no significant difference in the reciprocal effect between the females of the investigated lines.

Feed Conversion Ratio (FCR): The best FCR was found in the neighborhood white quail, which was significantly lower (a 0.05) than the other genetic subgroups.

5- Maternal Effect (ME): According to Table (4) findings, the qualities were not significantly impacted by the maternal effect.

CONCLUSION

The genetic parameters of White and Brown Plumage Quail (Ukrainian and local varieties) and their crosses for ASM, FBWS, FEW, HDP%, EW, and FCR were examined in this experiment. The findings indicated that there are substantial differences ($P < 0.05$) in heterosis between the hybrids for every trait. This shows that these hybrids have a substantial heterotic effect that can be used to boost quail production efficiency. Between the pure genetic groups, there were significant differences ($P < 0.05$) in the GCA of FBWS, HDP%, EW, and FCR. This suggests that there is a considerable genetic variance for these attributes within the pure genetic groups, which can be used to enhance quail production through selection. With the exception of the ASM FBWS, all features were significantly different ($P < 0.05$) across the hybrids in the SCA. This implies that there is a notable effect of unique combining abilities for certain qualities which can be utilized to create hybrids that perform better. There was statistically significant variation in the reciprocal effect for all traits except the EW. This shows that the hybrids' performance can be greatly influenced by the direction in which the pure genetic groups cross. No trait was significantly impacted by the maternal influence. This implies that the performance of the hybrids for the attributes under study is not significantly impacted by the maternal environment.

Overall, the experiment's findings point to a significant possibility for enhancing quail production performance by utilizing heterosis, general and particular combining ability, and reciprocal effects.

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CONFLICT OF INTEREST

The authors state that there are no conflicts of interest with the publication of this work.

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Table (1). Showed the Heterosis of ASM, FBWS, FEW, HDP EW, EM and FCR of Ukrainian and LW and brown-plumage quails and their crossbreds (mean ± SD).

	Genotype	ASM	FBWS	FEW	HDP	EW	FCR
Cross	UW♂ × UBr♀	0.41±4.53 c	0.31±2.49 cd	-21.97±8.55 e	-21.08±29.42 e	-2.82±1.45 d	-16.18±41.90 ef
	UW♂ × LW♀	-1.30±2.25 cde	-7.19±0.92 cd	-13.79±5.26 de	9.67±47.46 d	2.45±1.88 a-d	43.34±106.93 def
	UW♂ × LBr♀	-14.81±3.94 cd	-2.62±2.93 d	-11.82±12.96 cde	-28.05±33.04 d	-1.18±4.76 bcd	34.8±146.65 ab
	UBR♂ × LW♀	-5.20±2.60 c-f	2.07±2.79 cd	8.56±21.72 e	43.17±43.24 b	1.69±4.92 a-d	0.16±68.75 b-e
	UBR♂ × LBr♀	-9.25±4.07 fg	5.98±5.57 cd	17.91±21.24 cde	53.8±56.30 6e	1.90±-4.15 d	-65.42±16.79 bc
	LW♂ × LBr♀	54.15±7.30 g	98.18±15.74 cd	-65.26±1.94 b-e	57.48±98.69 cd	5.65±2.05 a	-17.65±76.37 fg
Reciprocal Cross	UBR♂ × UKW♀	-5.51±1.83 cde	0.30±1.57 cd	-19.69±2.01 abc	10.96±27.17 bc	-2.08±6.72 cd	-7.19±91.45 cde
	LW♂ × UKW♀	-6.36±2.14 c	-1.49±0.53 cd	-31.13±2.01 a-d	72.72±118.62 cd	5.33±2.21 ab	16.8±107.55 bcd
	LW♂ × UBr♀	-15.55±3.46 d-g	5.48±2.74 cd	-10.09±15.30 a	27.47±44.29 bc	0.93±4.80 a-d	-41.88±32.84 g
	LBr♂ × UKW♀	0.02±2.53 efg	-1.30±0.81 c	1.77±14.80 ab	38.05±84.32 a	5.91±3.07 a	29.35±140.48 g
	LBr♂ × UBr♀	-11.54±2.33 b	8.85±5.18 a	11.29±9.90 6 f	191.12±140.59bc	-2.17±7.40 cd	-66.15±29.08 ef
	LBr♂ × LoW♀	64.02±11.26 a	84.97±17.46 b	-56.84±7.45 f	-28.42±67.48 e	4.05±2.22 abc	76.39±128.24 a

Vertical different letters refer to the significant differences between genetic groups at ($P \leq 0.05$).

Table (3). It shows the values of SCA of some productive traits in Ukrainian and LW and brown-feathered quails (mean + SD).

Genotype	ASM	FBWS	FEW	HDP	EW	FCR
UKW × UBr	0.05±0.43 a	4.16±1.34 b	-0.77±0.28 a	-1.22±7.11 b	0.08±0.28 ab	-1.22±1.34 b
UKW × LW	-0.29±0.26 ab	-6.73±0.76 c	-0.59±0.57 a	8.60±6.92 a	0.01±0.11 ab	0.43±2.22 ab
UKW × LBr	-1.55±0.34 c	1.19±0.88 b	0.30±1.14 a	-3.7±3.67 b	-0.19±0.19 b	-0.82±1.41 b
UBR × LW	-0.45±0.23a	3.00±0.86 b	-0.07±0.54 a	11.32±4.90 a	-0.02±0.10 ab	0.04±2.17 ab
UBR × LBr	-0.05±0.53a	9.89±4.25 a	0.36±0.87 a	-3.59±5.78 b	0.14±0.24 a	-0.63±1.37 ab
LW × LBr	-0.55±0.65a	-6.50±0.36 c	0.25±0.66 a	-10.98±8.28 c	-0.12±0.10 ab	1.10±1.14 a

Vertical different letters refer to the significant differences between genetic groups at ($P \leq 0.05$).

Table (4). shows the values of the reciprocal effect and maternal effect of some productive traits in Ukrainian and LW and brown-feathered quails (mean + SD).

	Genotype	ASM	FBWS	FEW	HDP	EW	FCR
Reciprocal Effect	UW	-0.78±1.00 b	4.83±3.83 a	-0.25±0.59 b	9.64±9.26 a	0.13±0.45 a	1.36±1.63 a
	UBr	0.56±1.10 a	-0.17±3.04 b	-0.22±0.52 b	-1.22±5.31 b	0.02±0.56 a	0.16±0.80 b
	LW	0.39±1.39 ab	-3.17±5.18 b	0.74±0.56 a	-8.56±10.01 b	-0.09±0.48 a	-1.41±1.38 c
	LBr	-0.17±1.17 ab	-1.50±6.86 b	-0.28±0.82 b	-4.83±16.94 b	-0.07±0.45a	0.06±1.81 b
Maternal Effect	UW	-1.56±1.07 a	9.67±8.74 a	-0.49±1.22 b	19.29±12.66a	0.26±0.28 a	2.72±3.25 a
	UBr	1.11±1.84 a	-0.33±6.51 a	-0.44±0.17 b	7.48±20.67 a	0.06±0.15 a	-0.03±0.85 a
	LW	0.78±2.41 a	-6.33±11.59 a	1.49±0.82 a	4.33±16.90 a	-0.17±0.26 a	-0.62±2.35 a
	LBr	-0.33±1.76 a	-3.00±15.72 a	-0.56±1.31 b	-9.65±36.04 a	-0.14±0.41 a	0.13±3.88 a

Vertical different letters (in Reciprocal Effect or Maternal effect) refer to the significant differences between genetic groups at ($P \leq 0.05$).