Effect of the diallel cross line and generation on some productive traits in two lines of quail bird (brown and gold)

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Abstract. The aim of this study was to determine the effect of the diallel cross between the two lines on some productive traits, depending on plumage color, to get a genetic combination that is distinguished in productive performance and superior in its performance on pure lines, to demonstrate 79 chicks of quail with brown plumage and 72 chicks of golden plumage color one-day old, mating resulting from two lines of quail, were used in the study. 10 males from the golden plumage colour line and 10 females from the brown plumage colour line to perform crosses as for reciprocal crosses 10 males from the brown plumage colour line and 10 females from the golden plumage colour line. These birds selected and raised in rooms with dimensions of 40 x 40 x 40 cm were numbered and distributed Randomly placed to rooms in the form of families and each one by (1: 1), the productive traits of the parents and the first generation were measured. The experiment was designed according to the design of the Factorial Experiment Design to study the effect of the diallel cross, generation and the overlap between them. The results of the study showed the superiority of crosses over reciprocal crosses regardless of the effect of the generation on the average body weight trait at sexual maturity, and the first generation also outperformed the parents regardless of the effect of the mutilation of the same trait, while no significant differences were found between crosses and reciprocal crosses as well between parents. and the first generation in the trait of the average age at sexual maturity, the average weight of the first egg, the average number of eggs, the weight of the eggs, and the mass of eggs during 56 days of production. Sexual maturity, the average weight of the first egg, the average number of eggs, egg weight, and egg mass during 56 days of production. The results also indicated that the first generation of reciprocal crosses achieved the highest heterosis in the trait of average body weight at sexual maturity and the average weight of the first egg while crosses and reciprocal crosses parents achieved the highest heterosis in the trait of average egg number, average egg weight and average egg mass, as for the trait of average age at sexual maturity the crosses and reciprocal crosses parents of and achieved the highest negative heterosis for early life at sexual maturity.

1. Introduction

Studies relating to the strength of the hybrid in domestic birds began early with the use of cross-species speciation [28], which prompted some companies to use inter-species speculation after relying on pure species only, 1940 [29]. That the aims of modern breeding methods is to establish high-performance lines, which are of major importance to breeders [17]. Therefore, breeding and genetic improvement programs are among the most important sciences that have been promoted, the poultry industry as international companies have achieved great and tangible excellence in producing superior commercial types and strains. In a productive performance by following the continuous periodic selection and adopting different mating systems [13]. Achieving the genetic improvement program in poultry is through selection, breeding, or a combination of both. Therefore, the creation of commercial hybrid quail lines is by selecting individuals or groups on the basis of the independent performance of each strain by mating the improved strain in every possible combination (via interbreeding) to determine the superior hybrid for commercial exploitation [8]. The main objective...
of poultry breeding is to produce superior crosses to improve carcass and fertility traits and to combine different traits of economic importance [24]. This system is considered one of the modern breeding systems and the aim of it is to obtain a genetic synthesis that is distinguished by productive performance and outperforms pure lines and the rest of the other combinations due to the phenomenon of heterosis [14]. The idea of this selection is to create pure homogeneous lines in which it takes place. Selection for specific traits and then specifying between pure lines in order to know the performance of the hybrids resulting from each smacking, including the reciprocal crosses of the lines (using the female from the first line and the male from the second line and vice versa, i.e. using the male from the first line and the female from the second line) This method aims to select a force The hybrid that results from striking specific lines [13]. Therefore, hybridization uses pure breeding or streaking to improve economically important traits using the power of the hybrid and to achieve better performance for individuals or the clan. Mating is arranged to take advantage of all forms of speciation in addition to the correct selection of lines for use as parents and evaluation of line performance and the efficiency of speculation between parents within the same species (Pure breeding) or between Crossbreeding parents, choosing the strains or lines to be used in the periodic cross-selection program, and also understanding the nature of gene action and its role in quantitative traits [15, 27]. Study showed [4] that the confusion between the cross-breed new Hampshire local and brown chicken crossing led to a significant improvement in body weight at sexual maturity of hybrids.

The quail bird was used in many selection experiments due to its low breeding costs as it requires small areas that are related to its small body size (80 - 300 grams), as well as the short generation period (3-4 generations) per year, early puberty, disease resistance and high egg production. They make it an excellent laboratory bird [26, 9, 16, 21]. The aim of using diallel cross is to obtain a genetic synthesis that is distinguished by productive performance and outperforms pure lines due to the phenomenon of heterosis.

2. Materials and Methods

2.1. Animals and collocation sample

This study was conducted in the poultry farm of the Department of Animal Production - College of Agriculture - Tikrit University for a period from 2/27/2019 to 3/31/2020. In the study 79 chicks of brown plumage colour quail and 72 golden plumage colour chicks of one-day old were used in the study. Resulting from two lines (brown plumage colour line and golden plumage colour line) from quail bird, the chicks were placed each line in a room with a dimension of (1 x 1) meter and the height of the room was 90 cm from the floor and the floor was covered with sawdust and gas incubators were used to maintain the temperature of 35 °C during the first week, then the temperature was gradually reduced At a rate of 2 degrees per week to reach the optimum temperature [1]. Free water and fodder were prepared for the birds and the lighting was continuous in the first week after which the lighting hours were reduced to 16 hours of lighting throughout the duration of the experiment by using lamps with a intensity of 60 watts to ensure that the intensity of lighting reaches all The cages were as required, and the quail birds were fed on a diet with a crude protein level of 24.37% and a representative energy of 2976 kilograms of calories / kilogram of fodder from the age of one day to the age of 30 days, and then fed on a diet with a crude protein level of 20.00% and an energy represented 2850 kilo Price / kilograms of feed until the end of the experiment According to the National research council [20].

Birds were naturalized at the age of 21 days by the colour of the chest plumage, which is reddish brown in males and mottled gray in females in relation to the colour of brown feathers [3]. To orange, and the ring around the neck is a dark brown, as for the females, the back is light golden and the ring around the neck is black brown [12]. after which 10 males from the golden plumage colour line and 10 females from the brown plumage colour line were selected to perform crosses as for reciprocal crosses 10 males from the brown plumage colour line and 10 females from the golden plumage colour line were selected and transferred to a hall dedicated to raising quail, as it contains homemade cages consisting of three floors and divided into rooms with dimensions of 40 x 40 x 40 cm and numbered, and the birds were distributed randomly to the rooms as families and each family by (1: 1), the production traits of each line were measured. To produce the first generation, eggs were collected from the parents from each beating line for 7 days and stored at 18-20 °C and 60-65% humidity. The
eggs were placed in the trays of brooding and each line in a drawer as it was given Numbers according to the parents so that they can be easily known. After hatching the chicks, the chicks were placed in two rooms, one room for the crosses line and the other for the reciprocal crosses line, and the same management, feeding, and preventive program and the steps that were taken on the parents were followed.

2.2. Studied Traits:
2.2.1. Average body weight at sexual maturity (grams):
Each female was weighed individually at the first egg-laying of each generation with a Citizen Model Fr - H1200 sensor scale, with an accuracy of 0.01 grams.

2.2.2. Average age at sexual maturity (days):
The laying of the first egg was adopted as evidence that every female has reached the age of sexual maturity and for each generation [25].

2.2.3. Average weight of the first egg (grams):
Weighing the first egg laid by each female for each generation using a Citizen Model Fr - H1200 sensor scale, with an accuracy of 0.01 grams.

2.2.4. Average number of eggs (egg):
The daily production was collected at one o'clock in the afternoon for each female and the number of eggs produced during 56 days of the onset of life at sexual maturity for each female and each generation was calculated according to the formula [25].

2.2.5. Average egg weight (grams):
Weighing eggs daily and individually for each female. The length of egg production is 56 days at one o'clock in the afternoon for each generation. Its average was calculated through the weight of eggs produced during the experiment period divided by the number of eggs produced according to the mathematical equation formula [7].

\[ \text{Average Egg Weight} = \frac{\text{Weigh the total eggs produced during the first 56 days of production}}{\text{The number of eggs produced during the first 56 days of production}} \]

2.2.6. Average eggs mass (grams/bird):
The mass of eggs produced for each generation was calculated according to the formula [22].

The mass of eggs produced = the number of eggs produced during a certain period of time x the average egg weight (grams).

2.3. Statistical Analysis:
The data were analysis using the Factorial Experiment Design to study the effect of the diallel cross, generation, and the overlap between them. The significant differences between the means were compared using the Duncan polynomial test [10] and under the significance level (0.05). The statistical program [23] was used in the analysis Statistical according to the following mathematical model.

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

Where:
\( Y_{ijk} \) = the value of viewing studied.
\( \mu \) = the general mean of the studied trait.
\( A_i \) = the effect of the first factor (diallel cross), since \( i = 1, 2 \).
\( B_j \) = the effect of the second factor (generations), as \( j = 1, 2 \).
\( AB_{ij} \) = the effect of overlap between the two factors (A, B)
\( e_{ijk} \) = random error that is normally and independently distributed with mean equal to zero and equal variance of \( s^2e \).
3. Results and Discussion

3.1. Average body weight at sexual maturity:
The results in Table (1) indicated that there were significant differences at the level of \((p \leq 0.05)\) between crosses and reciprocal crosses in the trait of average body weight at sexual maturity, as crosses outperformed reciprocal crosses and its values were (206.90 and 198.42) grams respectively. The data of the same table indicates that there are significant differences between generations in the trait of the average body weight at sexual maturity, as the first generation surpassed the parents, and its values were (198.31 and 207.02) grams for each of the parents and their first generation outcome, respectively.
The results of the table also show that there are significant differences in the effect of the interaction between diallel cross and generation on the trait of average body weight at sexual maturity, and its values reached (203.44, 210.37) and (193.19, 203.66) grams for each of the parents and the first generation of crosses and reciprocal crosses, respectively. The first generation of crosses surpassed the generation of the parents of reciprocal crosses, while no significant difference was observed between the first generation and the parents of crosses and the first generation of reciprocal crosses. The reason is due to the difference in the breed between the color of brown and golden plumage.

3.2. Average age at sexual maturity:
It is evident from the data shown in Table (1) that there were no significant differences at the level \((p > 0.05)\) between crosses and reciprocal crosses in the average age trait of sexual maturity, and their values were (41.65 and 41.70) days, respectively. The results of the table also showed that there were no significant differences between generations in the trait of average age at sexual maturity, and its values reached (41.10 and 42.25) days for each of the parents and the first generation, respectively. From the results of the same table, it appears that there were no significant differences for the effect of the interaction between crosses, reciprocal crosses and generation on the average age at sexual maturity, and its values were (41.50, 41.80) and (40.70, 42.70) days for each of the parents and the first generation of crosses and reciprocal crosses, respectively. The reason for the absence of significant differences in the age trait at sexual maturity is due to the negative relationship between the decrease in the average age at sexual maturity and the average number of eggs produced [19, 6]. Therefore, there were no significant differences in the average age trait of sexual maturity during this study, whether between the diallel cross, generation, or the overlap between them.

3.3. Average weight of the first egg:
Table (1) data indicate that there were no significant differences at the level of \((p > 0.05)\) for the effect of diallel cross on the average weight of the first egg, and its values were (8.57 and 8.61) grams for each of the crosses and reciprocal crosses, respectively. The table also showed that there were no significant differences between generations in the trait of the average weight of the first egg, and its values were (8.45 and 8.73) days for each of the parents and the first generation, respectively. From the results of the same table, it appears that there were no significant differences for the effect of the interaction between diallel cross and generation on the trait of the average weight of the first egg, with values of (8.65, 8.49) and (8.25, 8.97) days for each of the parents and the first generation of crosses and reciprocal crosses, respectively. The reason for the absence of significant differences in the trait of the average egg weight is due to the presence of a positive correlation coefficient between the weight of the first egg and the weight of the eggs produced [2]. Therefore, there was no significant difference in the weight of the first eggs of between the diallel cross or generation or the overlap between them.
**Table 1. The effect of diallel cross, generation and the overlap between them on average body weight at sexual maturity (grams), average age at sexual maturity (day) and average weight of the first egg (grams) of quail (means ± standard error)**

| Traits                                | Observations number | Crosses     | Reciprocal crosses | Generation effect | Overlap effect |
|----------------------------------------|---------------------|-------------|--------------------|-------------------|---------------|
|                                        |                     | 20          | 20                 | 20                | 10            |
| Average body weight at sexual maturity (grams) |         | 206.90 ± 2.17A | 198.42 ± 3.05 B   | 198.31 ± 2.11 b   | 193.19 ± 2.93 B |
| Average age at sexual maturity (day)    |         | 41.65 ± 0.83 A | 41.70 ± 0.65 A    | 41.10 ± 0.64 a    | 40.70 ± 0.86 A |
| Average weight of the first egg (grams) |         | 8.57 ± 0.23 A  | 8.61 ± 0.40 A     | 8.45 ± 0.22 a     | 8.25 ± 0.31 A  |
|                                        |         | 216.91 ± 2.17 A| 198.42 ± 3.05 B   | 207.02 ± 3.08 a   | 203.66 ± 4.95 AB|
|                                        |         | A            | B                  | a                 | AB            |
|                                        |         | A            | B                  | a                 | AB            |

*The different capital letters within one column indicate significant differences (p ≤ 0.05) between diallel cross
*The different small letters within one column indicate significant (p ≤ 0.05) differences between generations
*The different capital letters within one column indicate significant differences (p ≤ 0.05) between the overlap

3.4. Average number of eggs:

Table (2) shows that there were no significant differences at the level of (p > 0.05) in the trait of the average number of eggs during 56 days between crosses, reciprocal crosses and its values were (49.75 and 49.50) eggs / female, respectively.

The same table also shows that there were no significant differences between generations in the trait of the average number of eggs, and its values were (49.85 and 49.40) eggs / female / 56 days for each of the parents and the first generation, respectively.

The results of the table also showed that there were no significant differences for the effect of the interaction between diallel cross and generation on the trait of the average number of eggs. Its values were (50.40 and 49.10) eggs / female / 56 days for each parent and the first generation of crosses, respectively. The reciprocal crosses values (49.30 and 49.70) eggs / female / were 56 days for each parent and first generation, respectively.
The reason is that males are the result of females with distinct eggs production. The reason is also due to the existence of a negative relationship with the trait of average age at sexual maturity, which did not show any significant differences during this study [5].

3.5. Average egg weight:
Table (2) data indicate that there were no significant differences at the level ($p > 0.05$) between crosses and reciprocal crosses in the average egg weight trait, and its values were (11.55 and 11.25) grams / female / 56 days, respectively.
The results of the same table also show that there were no significant differences between generations in the trait of average egg weight, and its values were (11.47 and 11.33) grams / female / 56 days for each of the parents and the first generation, respectively.
The table data showed that there were no significant differences for the effect of the interaction between dihalle cross and generation on the trait of average egg weight during 56 days of production, and its values for crosses were (11.49 and 11.61) eggs / female for each of the fathers and the first generation, respectively. Whereas, its reciprocal crosses values were (11.45 and 11.05) grams / female for each of the parents and the first generation, respectively.
The reason is that there are no significant differences in the trait of the number of eggs produced because there is a negative association between egg weight and egg production [5]. Therefore, there was no significant difference in the trait of the average egg weight, whether between the dihalle cross, generation, or overlap between them.

3.6. Average egg mass:
The results shown in Table (2) show that there were no significant differences at the level of ($p > 0.05$) between crosses and reciprocal crosses in the trait of Average egg mass, and its values were (574.53 and 557.90) g / female / 56 days, respectively.
The table data showed that there were no significant differences between generations in the trait of average egg mass during 56 days of production, and its values were (572.17 and 560.26) grams / female / 56 days for each of the parents and the first generation, respectively.
The results of the table also indicated that there were no significant differences for the effect of the interaction between dihalle cross and generation on the trait of average egg mass, and their crosses values were (579.31 and 569.74) grams / female / 56 days for each parent and first generation, respectively. Whereas, its reciprocal crosses values were (565.02 and 550.78) grams / female / 56 days for each parent and first generation, respectively.
The reason for the absence of significant differences in the trait of both the average of the number of eggs and the average of egg weight is due to the presence of a positive and highly significant phenotypic and genetic correlation between the trait average of egg mass and each of the number of eggs and the weight of the eggs produced [6]. Therefore, there was no significant difference between the dihalle cross or generation, or the overlap between them in the trait average of egg mass.
Table 2. The effect of diallel cross, generation and the overlap between them on average number of eggs (egg / female / 56 days), average egg weight (grams / female / 56 days), and average egg mass (gram / female / 56 days) for quail females (averages ± Standard error)

|                     | Observation number | Average number of egg (egg/females/56 days) | Average egg weight (grams females/56 days) | Average mass of eggs (grams females/56 days) |
|---------------------|--------------------|---------------------------------------------|--------------------------------------------|---------------------------------------------|
| **Diallel cross effect** |                    |                                             |                                            |                                            |
| Crosses             | 20                 | 49.75 ± 0.60 A                              | 11.55 ± 0.09 A                             | 574.53 ± 6.95 A                             |
| Reciprocal crosses  | 20                 | 49.50 ± 0.90 A                              | 11.25 ± 0.20 A                             | 557.90 ± 15.66 A                            |
| **Generation effect** |                    |                                             |                                            |                                            |
| Parents             | 20                 | 49.85 ± 0.66 a                              | 11.47 ± 0.15 a                             | 572.17 ± 11.55 a                            |
| First generation    | 20                 | 49.40 ± 0.85 a                              | 11.33 ± 0.16 a                             | 560.26 ± 12.80 a                            |
| **Overlap effect**  |                    |                                             |                                            |                                            |
| Crosses             | 10                 | 50.40 ± 0.95 A                              | 11.49 ± 0.10 A                             | 579.31 ± 12.85 A                            |
| First generation    | 10                 | 49.10 ± 0.72 A                              | 11.61 ± 0.15 A                             | 569.74 ± 5.80 A                             |
| Reciprocal crosses  | 10                 | 49.30 ± 0.94 A                              | 11.45 ± 0.30 A                             | 565.02 ± 19.66 A                            |
| First generation    | 10                 | 49.70 ± 1.59 A                              | 11.05 ± 0.27 A                             | 550.78 ± 25.27 A                            |

* The different capital letters within one column indicate significant differences (p ≤ 0.05) between diallel cross
* The different small letters within one column indicate significant (p ≤ 0.05) differences between generations
* The different capital letters within one column indicate significant differences (p ≤ 0.05) between the overlap

3.6.1. Heterosis for average body weight at sexual maturity:
The statistical data in Table (3) indicated that the first generation of reciprocal crosses and crosses achieved the highest heterosis and their values were (5.42 , 3.41) % respectively. Whereas, the crosses parents recorded less heterosis, while the reciprocal crosses parents recorded negative heterosis, whose values were (0.54 , -4.53) % respectively.

3.6.2. Heterosis for average age at sexual maturity:
The results of Table (3) showed that the parents of crosses and reciprocal crosses achieved negative heterosis and its values reached (-4.96 , -6.79) % respectively, while the first generation of crosses and reciprocal crosses achieved positive heterosis and their values were (0.72 , 4.91) % respectively. It is evident from this that the parents of reciprocal crosses achieved the highest heterosis towards an early age at sexual maturity, followed by the parents of the bashing compared to the first generation of the diallel cross.
3.6.3. Heterosis for average weight of first egg:
Table (3) showed that the first generation of reciprocal crosses recorded the highest heterosis compared with the first generation of crosses, which achieved negative heterosis and its values were (8.73 , -1.83) % respectively. Whereas, the crosses parents recorded a positive heterosis compared with the reciprocal crosses parents, who achieved negative heterosis and their values were (-2.00 , -2.71) % respectively.

| cross Traits | Diallel | Heterosis | | | | |
|---|---|---|---|---|---|---|
| Traits | Dials | Crosses | Reciprocal crosses | | | |
| Average body weight at sexual maturity (grams) | 0.54 | 3.41 | - 4.53 | 5.42 | | |
| Average age at sexual maturity (day) | - 4.96 | 0.72 | - 6.79 | 4.91 | | |
| Average weight of the first egg (grams) | 2.00 | - 1.85 | - 2.71 | 8.73 | | |

3.6.4. Heterosis for average egg number:
The results of Table (4) showed that the crosses parents achieved the highest heterosis compared to the reciprocal crosses parents, whose values were (2.65 , 0.41) %, respectively, while the first generation of crosses recorded a negative heterosis compared to the first generation of reciprocal crosses, which achieved a positive heterosis and it was (-2.58 , 0.81) % respectively.

3.6.5. Heterosis for average egg weight:
Table (4) shows that the parents of crosses and reciprocal crosses achieved the highest heterosis compared with the first generation of crosses and the first generation of reciprocal crosses, which recorded negative heterosis and its values were (7.08 , 6.71) and (1.04 , -3.49) % respectively.

| cross Traits | Diallel | Heterosis | | | | |
|---|---|---|---|---|---|---|
| Traits | Dials | Crosses | Reciprocal crosses | | | |
| Average number of eggs (egg/ females/56 days) | 2.65 | - 2.58 | 0.41 | 0.81 | | |
| Average egg weight (grams females/56 days) | 7.08 | 1.04 | 6.71 | - 3.49 | | |
| Average mass of eggs (grams females/56 days) | 9.87 | - 1.65 | 7.16 | - 2.52 | | |

3.6.6. Heterosis for average egg mass:
The results of Table (4) showed that the parents of crosses and reciprocal crosses recorded the highest heterosis and their values were (9.87 , 7.16) % respectively. Whereas, the first generation of crosses and reciprocal crosses achieved negative heterosis and its values reached (-1.65 , -2.52) % respectively.
The reason for the difference in the achieved heterosis between the diallel cross and generation is due to the presence of a partial relationship to sex that affects the inheritance of the genes responsible for these studied traits [18]. While the reason for the decrease in the hybrid power in the first generation in some of the studied traits is due to the fact that the parentage gives half of the heterosis in the first generation [11].

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