EFFECT OF DIALLEL CROSS BETWEEN VARIETIES OF JAPANES QUAIL ON MEAT PRODUCTION TRAITS

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ABSTRACT

This study was conducted in poultry house - Animal production Department- College of Agriculture/ University of Diyala, for the period from 3/7 until 30/10/2015. The aim of the study was to determine the effect of diallel cross (3×3) between japanese quail varieties (*Coturnix coturnix japonica*), white (W), black (B) and brown (N) on meat production traits, estimation the main effects of sire and dam, effect of interaction between sire and dam, general combining ability (GCA), specific combining ability (SCA), reciprocal effect (RES), heterosis and maternal effect on body weight, weight gain, food consumption and feed conversion. The results showed significant effect of sire main effect on body weight during six and seven weeks of age, the superiority of black variety sire main effect compared with the white variety sire main effect, and nonsignificant of dam variety main effect on body weight at all weeks of age. The interaction between variety of sire and dam showed a superiority of cross (B×N) on cross of white purebred and some crossbred and reciprocal on body weight at 3 and 7 week .The results showed the important of additive genes effects in black and brown varieties, the important of dominant effect in the hybrid (white× brown) compared with the other hybrids in body weight traits when cross male white variety with female brown variety, reciprocal effect showed nonsignificant differences in body weight at all weeks. The result of cumulative traits showed nonsignificant differences between all crosses in cumulative food consumption, cumulative feed conversation and significant differences in cumulative weight gain. Hence the cross (B×N) had high weight gain compared with white purebred and some reciprocal crosses. Black and brown varieties showed superiority on white variety in GCA in cumulative weight gain. The hybrid (black × brown) had less SCA compared with the other hybrids. Reciprocal crosses showed nonsignificant differences in all cumulative traits.

Key words: Diallel Cross, Combining ability, Maternal effect, Heterosis, Japanese quail.

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INTRODUCTION

The poultry breeding program depends on genetic selection and mating systems (Hassan,2011; Adebambo, 2011). The term Diallel refers to perform all possible crosses between lines, breeds, varieties or genotypes. Hayman (1954) defined the term to refer to all possible matings between genotypes, and represent one of the mating systems that used to test the combining ability of the line or breed and the genetic components of quantitative traits. So, the diallel cross used to provide information about the available lines or breeds for construction the breeding program. Siwendu *et al.*, (2012) reported that diallel cross represents out breeding system led to increase heterozygous genotype frequencies and decrease the homozygous genotype frequencies. Many studies reported that diallel cross can be used to build a wide genetic foundation for the poultry industry to rise new lines or superior hybrids by crossing between different breeds (Lalev *et al.*, 2014; Saadey *et al.*, 2008; Amin, 2007). The reciprocal crosses that used in a diallel cross provide the chance to estimate the deviations between the offspring of different crosses which result from sex-linked traits, maternal effects and the heterosis (Siwendu *et al.*, 2013; Youssef *et al.*, 2008). The major source for poultry meat production in Iraq and most countries in the world is the chicken, but in the last decades, there is more attention considered for other poultry species especially Japanese quail to contribute in meat and egg production. Although Japanese quail (*Coturnix coturnix japonica*) is the smallest poultry species, but adopted and reared as a source of animal protein in many countries, hence they are reared primarily for meat production in European and American Countries (Minvielle, 2004).

MATERIALS AND METHODS

This study was conducted at the poultry house of Animal production Dept., College of Agriculture– Univ. Of Diyala in Iraq, during Summer season (3rd July to October 30, 2015), which represent the hottest period in the year. The diallel cross of three varieties was performed, namely White (W), Black (B), and Brown (N) including nine crosses of W×W, B×B, N×N, B×W, N×W, N×B, W×B, W×N and B×N and the data were recorded for the studied traits in the groups of progeny which result from the crosses during the first seven weeks including: Body weight, Food consumption, weight gain, food conversion. All the groups reared in the same conditions of management and hygienic care. During the brooding and rearing periods, the birds were fed *ad libitum* using starter ration (24 % crude protein and 2896 kcal metabolic energy from hatching

to 42 days of age, and following by grower diet (20 % crude protein and 2876 kcal metabolic energy from 43 days until the end of the seven weeks).

The data were analyzed using the general linear model procedure according to the following linear model:

$$Y_{ijk} = \mu + P_k + S_i + D_j + (SD)_{ij} + \varepsilon_{ijk}$$

Where, Y_{ijk} = the kth observation of the bird which result from ith sire and jth dam. μ = overall mean,
P_k = the effect of kth block, S_i = the fixed effect of ith sire, D_j = the fixed effect of jth dam, $(SD)_{ij}$ = the fixed effect of interaction between ith sire and jth dam, and ε_{ijk} = the random error.
The differences among means considered to be significant at probability level 0.05 according to Duncans multiple range test (Duncan, 1955).
The values of general combining ability (GCA) for pure varieties W, B and N were calculated as means (Griffing, 1956), and the specific combining ability was calculated according to the following formula:

$$Sij = (1/2)\ (Yij. + Yji.) – (1/2p)\ (Yi..+Y.j.+Yj..+Y.j.) + (1/p2)Y…$$

And the reciprocal effect, according to the following formula:

$$rij = 1/2(Yij - Yji)$$

Heterosis was calculated according to William *et al.*, (2002) by the formula:

$$H(\%)=F1- (P1+P2)/(P1+P2)/2\times100$$

The maternal effect calculated according to Amin (2015).

RESULTS AND DISCUSSION

The means ± standard error which are presented in Table 1 showed significant differences among progeny means of different variety sires in body weight during second, six and seven weeks of age, hence the black variety has significantly heaveier body weight compared with white variety, while there were no significant differences among brown variety and other varieties. There were no significant differences among progeny means of different varieties used as a dam in all experimental periods.

Table 1. Means of body weight (g) in main effect of sire and dam in diallel cross between quail varieties

Main effect of Sire	Age of birds (week)							
	One day	1	2	3	4	5	6	7
White	8.34	25.81	57.18b	103.51	142.72	177.57	193.03 b	200.66 b
Black	8.63	26.16	59.36a	106.39	144.02	182.89	197.25 a	205.30 a
Brown	8.52	26.20	60.11a	102.87	143.98	180.83	193.79ab	204.01ab
Significance	N.S	N.S	**	N.S	N.S	N.S	*	*
Main effect of Dam	Age of birds (week)							
	One day	1	2	3	4	5	6	7
White	8.41	25.05	58.87	102.50	139.41	176.95	192.30	200.90
Black	8.59	26.49	58.74	104.71	145.40	182.01	195.64	204.70
Brown	8.49	26.63	59.19	105.60	145.91	182.34	196.12	204.38
Significance	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Means with different letters significantly differ from each other at P<0.05.
*Refer to significant effect (P<0.05) in ANOVA Table.
** Refer to highly significant effect (P<0.01) in ANOVA Table.

The Table 2 shows the means of interaction between sire and dam effects on body weight, the results recorded heavier body weights of black and brown purebreds than white purebred during the periods 3 and 7 weeks of age, and there was significant superiorty of body weight of purebred black variety compared with reciprocal cross (N × B) during three weeks of age, while the superiorty of purebred black variety recorded on (W × B), (B × N), (N × W) and (N × B) crosses at seven week of age, these results did not agree with Musa *et al.* (2015) who reported superiorty of reciprocal crosses on hybrid crosses in his diallel cross in chicken, and also did not agree with Rezvannejad *et al.* (2013) who reported superiorty of reciprocal crosses on purebred crosses and hybrid crosses during all age periods in his crosses between high body weight and low body weight lines in Japanese quail, while the results agreed with the results which reported by Abou Khadiga (2014).

Table 2. Means of body weight (g) of pure lines, hybrid crosses and reciprocal at various ages in diallele cross of three Japanese varieties

Genotypes Pure Lines	Age of birds (week)							
	One day	1	2	3	4	5	6	7
W × W	8.26	24.86	56.11 b	99.04 bc	138.65	172.96 b	189.91	197.34 c
B × B	8.78	26.80	59.34 ab	110.61 a	150.27	186.78 a	200.75	211.39 a
N × N	8.57	26.90	60.51 a	107.61ab	149.42	185.25 a	199.04	208.26 ab
Crosses								
W × B	8.32	25.96	57.91 ab	106.61 ab	143.04	178.54 ab	194.39	200.86 bc
W × N	8.43	26.63	57.53 ab	104.89abc	146.46	181.20 ab	195.08	203.79abc
B × N	8.46	26.39	59.52 ab	104.19abc	141.85	180.56 ab	194.54	201.94 bc
Reciprocal								
B × W	8.66	25.30	59.23 ab	104.37 abc	139.95	181.34 ab	196.45	203.41abc
N × W	8.29	25.00	61.28 a	104.80 abc	139.62	176.52ab	190.56	201.94 bc
N × B	8.69	26.70	58.55 ab	96.91 c	142.90	180.72 ab	194.39	201.82 bc
Significance	N.S	N.S	N.S	*	N.S	N.S	N.S	*

Estimates of GCA, SCA and reciprocal effects (REs) are presented in the Table 3, the results show positive and significant GCA of black and brown varieties at all weeks during 6 and 7 weeks of age, while the white variety recorded negative GCA measurements in all week. In the same Table the results show significant SCA on body weight measurements during the third week of age, and there were no significant effects of reciprocal crosses during all week of experiment, the results agree with Saadey *et al.* (2008) about the significant GCA which result of the diallel cross of chicken breeds on body weight at different ages, while not agree with Nofal (2006) who recorded non significant GCA from crosses between two lines of quail. And the results did not agree with Khalil *et al.* (1999) whom recorded significant sex-linked effects on body weight appeared from reciprocal crosses between two breeds of chicken.

Table 3: General combining ability (GCA), Specific combining ability(SCA) and Reciprocal effect of body weight in diallel cross of quail varieties

Combining Ability GCA	Age of birds (week)							
	One day	1	2	3	4	5	6	7
White	0.126-	0.626-	0.906-	1.253-	2.51-	3.175-	2.003 -	2.542 -
Black	0.117	0.265	0.119	1.293	1.139	2.023	1.721	1.67
Brown	0.009	0.361	0.787	0.04-	1.371	1.153	0.282	0.871
LSD	N.S	N.S	N.S	N.S	N.S	N.S	1.56	1.778
Crosses								
W × B	0.005-	0.068-	0.423	1.193	0.704-	0.667	0.984	0.317-
W × N	0.015-	0.02	0.59	1.523	0.605	0.453	0.183-	1.212
B × N	0.046	0.14-	0.59-	4.959-	3.712-	2.968-	3.574-	4.406-
LSD	N.S	N.S	N.S	3.209	N.S	N.S	2.467	2.813
Reciprocal								
B × W	0.152	0.327-	0.658	1.122-	1.545-	1.408	1.03	1.275
N × W	0.072-	0.817-	1.873	0.405-	3.42-	2.338-	2.26-	0.925-
N × B	0.112	0.158	0.272-	3.642-	0.525	0.082	1.387-	0.362
LSD	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Heterosis estimates for body weight is found in Table 4, the results show non-significant heterosis on body weight at all week measurements axcept measurements of sixth week which recorded significant superiority of reciprocal cross (B × W) on (B × N) and (N× B), these results not agree with Vali *et al.* (2005), and agree with Shit *et al.* (2010) whom found significant superiority of hybrid crosses on reciprocal crosses in heterosis in diallel cross of three lines of Japanese quail. The maternal effects presented in Table 4, the results revealed significant differences among varieties in maternal effects at second week of age, hence there are significant superiorty of black and brown varieties on white variety, while during sixth week of age there are superiority of white and black varieties on brown variety, the results agree with Saadey *et al.* (2008) whom recorded significant maternal effects on body weight during all ages of diallel cross combinations, but the results not agree with Sezer (2007) who reported

that differences in body weight may be related to maternal effects but loss its significance after the second week of age.

Table 4. Heterosis and Maternal effect on body weight in diallel cross of quail varieties

Heterosis Crosses	Age of birds (week)							
	One day	1	2	3	4	5	6	7
W × B	3.8-	0.56	0.56	31.58	0.92-	0.73 -	3.08 - ab	1.69 -
W × N	0.27	2.82	1.09-	1.52	1.70	1.26	3.77- ab	0.51
B × N	2.29-	2.26-	0.64-	4.48-	4.72-	0.03	7.22 - b	4.10 -
Reciprocal								
B × W	1.62	1.92-	2.93	0.42-	2.97-	0.81	2.12 - a	0.47 -
N × W	1.47-	3.79-	5.07	0.94	1.15	1.27 -	6.01 - ab	0.42 -
N × B	0.37	0.55-	1.50-	11.27-	4.52-	2.89-	8.56 - c	3.84 -
Significance	N.S	N.S	N.S	N.S	N.S	N.S	*	N.S
Maternal Effect								
White	0.04	0.12 -	1.80- b	13.76	24.70 a	0.59	1.72 a	0.48 -
Black	0.06 -	0.44 -	0.33- a	14.31	14.08 b	0.45 -	10.24 a	2.04
Brown	0.10 -	0.48 -	0.58 a	2.63	0.95 c	1.18 -	8.56 - c	0.94
Significance	N.S	N.S	*	N.S	**	N.S	**	N.S

The study of the accumulative traits includes food consumption, weight gain and feed conversion after the six weeks period which is shown in Table 5, represented the means and standard error for these traits, the results show non-significant differences between groups in respect of the sire main effect or dam main effect.

Table 5. Mean ± standard error of food consumption (g), weight gain (g) and feed conversion in main effect of sire and dam in diallel cross between quail varieties

Main effect of Sire	Food Consumption (g)	Weight Gain (g)	Feed Conversion
White	37.17 ± 988.72	1.43 ± 184.96	0.12 ± 5.34
Black	37.87 ± 1010.88	1.56 ± 185.62	0.18 ± 5.36
Brown	29.66 ± 985.72	1.92 ± 188.59	0.17 ± 5.29
Significance	N.S	N.S	N.S
Main effect of Dam			
	Food Consumption(g)	Weight Gain (g)	Feed Conversion
White	42.03 ± 982.01	1.58 ± 183.81	0.23 ± 5.24
Black	36.83 ± 1002.52	1.84 ± 187.03	0.18 ± 5.36
Brown	24.31 ± 1000.13	1.38 ± 188.33	0.18 ± 5.19
Significance	N.S	N.S	N.S

For the interaction effect of sire and dam on the same trait, Table 6 represente the means and standard error for these traits, the results revealed non significant differences between groups on accumulative food consumption and feed conversion during first six weeks of age, this results did not agree with Inci *et al.* (2015) whom recorded feed conversion 3.5, food consumption 727.3 g and weight gain 205.6 g in white variety of quail. Also, the results record significant differences among crosses in weight gain after six week period, hence there was significant superiority of black and brown purebred on white purebred, (N × W) and (N × B), this results agree with Khalid and Ali (2016) whom recorded superiority of black and brown varieties on white variety in weight gain after six weeks period.

Table 6. Mean ± standard error of food consumption (g), weight gain (g) and feed conversion in different combinations of diallel cross of quail varieties

Genotypes Pure Lines	Food Consumption (g)	Weight Gain (g)	Feed Conversion
W × W	86.86 ± 929.86	181.63 ± 2.64 b	0.46 ± 5.12
B × B	77.03 ± 1041.99	191.94 ± 2.75 a	0.42 ± 5.43
N × N	34.57 ± 1028.85	191.75 ± 3.24 a	0.39 ± 5.34
Crosses			
W × B	56.67 ± 1007.38	186.06 ± 2.82 ab	0.32 ± 5.42
W × N	56.64 ± 1027.93	187.18 ± 0.99 ab	0.33 ± 5.49
B × N	17.44 ± 943.53	186.07 ± 1.51 ab	0.13 ± 5.08
Reciprocal			
B × W	87.88 ± 1044.97	187.76 ± 3.17 ab	0.38 ± 5.55
N × W	50.72 ± 970.19	182.02 ± 0.97 b	0.30 ± 5.33
N × B	73.22 ± 958.19	183.08 ± 2.14 b	0.34 ± 5.22
Significance	N.S	*	N.S

Means with different letters significantly differ from each other at $P<0.05$.
*Refer to significant effect ($P<0.05$) in ANOVA Table.

Estimates of GCA, SCA and reciprocal effects (REs) for the accumulative traits of food consumption, weight gain and feed conversion after six weeks period are presented in the Table 7, the results show nonsignificant effects of GCA, SCA and REs on food consumption and feed conversion, this results not agree with Adebambo (2011) who reported a significant effect of additive genes and dominant genes on feed conversion result from diallel cross in four breeds of chicken. While there are significant effects of GCA on weight gain which refer to the important role of additive genes in black and brown varieties for this trait.

Table 7. General combining ability (GCA), Specific combining ability (SCA) and Receprocal effect of Food consumption (g), weight gain (g) and Feed conversion in diallel cross of quail varieties

C.A. GCA	Food Consumption (g)	Weight Gain (g)	Feed Conversion
White (W)	6.46 -	2.01 -	0.01
Black(B)	14.87	1.42	0.03
Brown(N)	8.40 -	0.59	0.03 -
LSD	N.S	1.56	N.S
SCA			
W × B	25.98	1.111	0.12
W × N	22.08	0.37 -	0.11
B × N	46.38 -	3.82 -	0.17 -
LSD	N.S	2.46	N.S
Reciprocal			
B × W	18.85	0.85	0.07
N × W	28.87 -	2.58 -	0.08 -
N × B	6.26	1.50 -	0.07
LSD	N.S	3.31	N.S

Means with different letters significantly differ from each other at P<0.05.
*Refer to significant effect (P<0.05) in ANOVA Table.

Heterosis estimates for the accumulative traits of food consumption, weight gain and feed conversion after six weeks period are presented in the Table 8, the results showed nonsignificant differences in heterosis among hybrid crosses and reciprocal crosses in food consumption and feed conversion, while there were significant differences among crosses in weight gain, hence there was significant superiorty of hybrid cross (W×N) compared with reciprocal cross (N×B), this result did not agree with Abou El–Ghar (2006) who reported significant differences among hybrid and reciprocal crosses in weight gain.

Table 8: Heterosis and maternal effect on food consumption (g), weight gain (g) and feed conversion in diallel cross of quail varieties

Heterosis Crosses	Food Consumption(g)	Weight Gain (g)	Feed Conversion
W × B	5.28	0.33- ab	5.80
W × N	12.91	0.27 a	12.56
B × N	4.52-	2.93 - ab	1.36-
Reciprocal			
B × W	10.73	0.52 a	10.16
N × W	7.70	2.45 - ab	10.75
N × B	2.94-	4.54 - ab	1.76
Significance	N.S	N.S	N.S
Maternal Effect			
White	1.28	1.16	0.04
Black	37.07	1.19	0.01
Brown	35.79	0.02	0.06
Significance	N.S	N.S	*

Means with different letters significantly differ from each other at P<0.05.
*Refer to significant effect (P<0.05) in ANOVA Table.

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تأثير التضريب التبادلي بين عروق السمان الياباني في صفات انتاج اللحم

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المستخلص

اجريت الدراسة في حقل الطيور الداجنة التابع الى قسم الانتاج الحيواني/ كلية الزراعة/ جامعة ديالى للمدة من 7/3 ولغاية 30 /10 /2015، واستهدفت التجربة دراسة تأثير التضريب التبادلي الكامل Diallel Cross (3×3) بين عروق السمان الياباني *Coturnix coturnix japonica* الابيض W، والاسود B والبني N في الصفات الانتاجية وتقدير التأثيرات الرئيسية لعرق الاب وعرق الام، وتأثير التداخل بين عرق الاب وعرق الام، والقدرة التوافقية العامة، والقدرة التوافقية الخاصة، والتأثير العكسي، وقوة الهجين والتأثيرات الامية في صفات وزن الجسم، ومعدل الزيادة الوزنية، ومعدل إستهلاك العلف، وكفاءة التحويل الغذائي التراكمية. أظهرت النتائج وجود تأثير معنوي لعرق الاب في وزن الجسم للتضريبات عند أعمار 6،7،8 أسابيع ، إذ تفوق عرق الاب الاسود معنوياً على العرق الابيض، ويلاحظ عدم وجود تأثيرمعنوي لعرق الام في جميع الاعمار، وأظهر تأثير التداخل بين عرق الاب وعرق الام تفوق التضريب النقي للعرق الاسود والبني على التضريب النقي للعرق الابيض وبعض التضريبات الهجينة والعكسية في وزن الجسم عند أعمار 3 و 7 أسابيع، وأظهرت نتائج القدرة التوافقية أهمية الجينات

التجميعية للعرق الاسود والبني في وزن الجسم لجميع الاعمار، وأهمية الجينات السيادية للتضريب (الابيض×البني) مقارنة مع بقية التضريبات في صفة وزن الجسم عند تضريب ذكور العرق الابيض مع إناث العرق البني. ولم يلاحظ وجود تأثير معنوي للتأثير العكسي في جميع الاعمار. وبينت نتائج الصفات التراكمية لمعدل استهلاك العلف، معدل الزيادة الوزنية وكفاءة التحويل الغذائي، عدم وجود فروق معنوية بين التضريبات في صفات معدل استهلاك العلف التراكمي وكفاءة التحويل الغذائي التراكمية ووجود فروق معنوية بين التضريبات، ويلاحظ تفوق التضريبين (الاسود×الاسود) (البني×البني) معنوياً على (الابيض × الابيض) وبعض التضريبات العكسية في معدل زيادة وزنية تراكمية. وتفوق العرقين الاسود والبني على العرق الابيض في القدرة التوافقية العامة لمعدل الزيادة الوزنية، وأظهرت النتائج أهمية الجينات التجميعية للعرقين الاسود والبني في وزن الجسم ومعدل الزيادة الوزنية مقارنة مع العرق الابيض. وسجل التضريب الهجين (الاسود×البني)أقل قدرة توافقية خاصة مقارنة مع بقية التضريبات، ولم يكن للتاثيرات المرتبطة بالجنس تأثير معنوي في الصفات التراكمية.

الكلمات المفتاحية: التضريب التبادلي، القدرة التوافقية، التأثيرات الامية، قوة الهجين.