# Effect of crossing two selected lines for early and lately age at sexual maturity on some growth and carcass traits in Japanese quail

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## ABSTRACT

A crossbreeding experiment was carried out using two selected lines of Japanese quail,( Early and Lately age at Sexual Maturity) (EASM&LASM lines were established for early and lately age at sexual maturity). A total number of 1310 crossbred birds of quail produced from two mating groups among three hatches were used for the present study to estimate direct heterosis, direct additive and maternal effects on the following traits: growth traits: body weight recorded at 0, 2, 4, 6 weeks of age ($BW_0$, $BW_2$, $BW_4$, $BW_6$) and average daily gain between the different growth period studied 0 - 2, 2 - 4, 4 - 6, 0 - 6 weeks of age ($ADG_{0-2}$, $ADG_{2-4}$, $ADG_{4-6}$, $ADG_{0-6}$).Carcass traits: Slaughter weight, meat, bone, giblets and dressing percentages (SW, M%, B%, G%, D%).

The results obtained can be summarized as follow: Crossing sires of EASM with LASM dams had the highest body weights and body weight gains recorded from hatch to 6 weeks of age followed by reciprocal crossing between sires of LASM with EASM dams., Highly significant positive direct heterosis effect for most body weights recorded at different ages was observed except $BW_4$ and body weight gains calculated between different growths periods studied. , Crossing sires of EASM with LASM dams had the highest carcass performance followed by reciprocal crossing between sires of LASM with EASM dams., positive direct heterosis effect for most carcass traits studied was observed except M% and G% direct heterosis was non-significant

**Keywords**: Crossing, early and lately age at sexual maturity, Japanese quail.

## INTRODUCTION

Quails have the advantages of rapid growth rate, good reproductive potential, short life cycle, low feed requirements, good meat taste, better laying ability and shorter time for hatching as compared with different species of poultry, so it is considered as a pilot animal for poultry breeding investigations.

Crossing procedures usually lead to better economic performance due to the hybrid vigor, however crossbreeding is a very effective method for obtaining different recombination of genetic materials where it results in increased heterozygosis and tends to cover up recessive genes, decreases breeding purity and eliminates families in one generation. Breeding usually improve the performance of the different characters by selection and or crossing, to obtain different degrees of heterosis. That is to say, by directing the additive and non-additive genes to better performance of the different traits. The additive nature of genetic variation for growth has resulted in dramatic body weight improvement in Japanese quail (Marks, 1978 & 1990 and Nestor *et al.*, 1982). Non additive genetic effect is important in meat and laying stocks because of the opportunities to combine stocks that complement each other. This allows development of mating combinations for rapid growth, yield and other important economic traits (Marks, 1995). Most available estimates of heterosis for body weight in Japanese quail were observed in reciprocal crosses of two quail lines, both selected for high body weight (Biak and Marks, 1993 and Marks, 1995) or crossing lines of high and low body weight (Gerken *et al.*, 1988; Barden and Marks, 1989 and Marks, 1993).

The main purpose of the present study was to evaluate the importance of heterosis, maternal and direct additive effects arising from crossing two selected lines of Japanese quail for early and lately age at sexual maturity on some growth and carcass traits.

## MATERIALS AND METHODS

Data used in the present study were collected on the flock of two lines of Japanese quail EASM&LASM(early and lately age at sexual maturity) were selected for early and lately age at sexual maturity maintained by the Department of Animal Production, Faculty of Agriculture, Al-Azhar University. Cairo, Egypt. Crossbreeding experiment was carried out using two selected lines of Japanese quail EASM x LASM, its reciprocal cross LASM x EASM.

Distribution of birds produced in each hatch and breed group are presented in Table (1).

Eggs were collected for hatch when the females were 10 to 12 weeks of age, marked, incubated for 15 days, after incubation the eggs were transferred to the hatcher and 3 days later all chicks were removed from the hatcher. Immediately after hatch individual quail birds were permanently identified by wing - bands and placed in quail battery brooders, where they remained for 4 week-period. All birds were housed in the same room for temperature, humidity, light intensity and other variables would be as similar as possible. However, environment and management practices were at conventional levels through the whole study. At 5 weeks of age the males were separated from the females and at 6 weeks of age, birds were divided into four groups. (EASM , LASM, EASM X LASM and LASM X EASM)

All birds were sexed according to plumage color and pattern at the same time, all chicks were taken and moved to individual laying cages and stud mating started about two weeks later. Feed and water were provided ad libitum. The experimental diet contained 28% protein and 2920 k cal. - ME/ Kg until two weeks of age and 25% protein with 2850 k cal. - ME/Kg during 3-6 weeks of age, then changed to a ration contained 20% protein with 2820 K cal. - ME / Kg during the egg production period.

Temperature started with 38°c for the first week after hatching, then decreased 2-3°c weekly to 26-28°c at the fourth week of age till the end of brooding period.

**Statistical analysis:**

Data of individual body weight, daily gains and carcass traits were analyzed using Henderson's Method III (Henderson, 1984) by using the following mixed model (Harvey 1990).

$Y_{ikpmq} = \mu + G_i + S_k + SE_p + H_m + e_{ikpmq}$ Where:

$Y_{ikpmq}$ = the observation on the kpmq $^{th}$ trait;

$\mu$ = overall mean, common element to observations,

$G_i$ = fixed effect of the $i^{th}$ mating groups,

$S_k$ = random effect of $k^{th}$ sire,

$SE_p$ = fixed effect of the $p^{th}$ sex;

$H_m$ =fixed effect of the $m^{th}$ hatch,

$e_{ikpmq}$ = random deviation of the $q^{th}$ growth and carcass traits distributed, i.e., N.D (0, $\sigma^2$e).

Crossbreeding components for growth and carcass traits were estimated according to Dickerson (1992),it was used to analyze the crossbreeding data as:

**Pure lines differences:**

PU $_{EASM\ x\ LASM}$ = [(EASMxEASM) - (LASMxLASM)].

**Direct heterosis effect:**

$H^I$ $_{EASM\ x\ LASM}$ = [(EASM x LASM) + (LASM x EASM) – (EASM x EASM) - (LASM x LASM)].

$H^I$% = $H^I$ in units/0.5[(EASM x EASM) + (LASM x LASM)] x100.

**Direct additive effect:**

($G^I_{EASM}$ – $G^I_{LASM}$) = [(EASM x LASM) + (EASM x LASM)]–[(LASM x LASM) + (LASM x EASM)].

**Maternal additive effect:**

($G^M$ $_{EASM}$ – $G^M$ $_{LASM}$) = (EASM x EASM) - (LASM x EASM) , where:

$G^I$ and $G^M$ represent direct additive and maternal additive effects, of the subscript breed (genetic) group.

## RESULTS AND DISCUSSION

**Crossbreeding effects:**

***Growth traits:***

Least-square means and standard errors (SE) for body weights recorded at different ages and daily weight gain calculated among different growth periods studied are given in (Tables, 2 & 3). Crossing sires of EASM with LASM dams had the higher body weights and body weight gains recorded from hatch to 6 weeks of age followed by reciprocal crossing between sires of LASM with EASM dams. However, significant differences due to mating group on growth traits were observed.

Results of significant effect of MG on growth traits of Japanese quail strains were also confirmed by different authors (Larson *et al.*, 1986; El-Naggar *et al.*, 1992; Barbour and Liibum, 1995; Mandour *et al.*, 1996; Bahie El-Deen *et al.*, 1998; Sherif *et al.*, 1998; Aboul-Hassan, 2001; Abdel-Ghany *et al.*, 2004 and Nofal, 2006).

***Direct heterosis:***

Estimates of direct heterosis calculated in units (g) and percentages (%) for body weights recorded at different ages and body weight gains calculated among different growth periods studied are presented in (Tables, 2&3) However, these traits showed highly significant positive direct heterosis effect for most body weights recorded at different ages was except $BW_4$ and body weight gains calculated among different growth periods studied. Estimates of heterosis percentage for $BW_0$ and $BW_2$ (32.7 and 27.9%) declined to (19.8 and 18.9%) for $BW_4$ and $BW_6$. However, estimates of heterosis percentage for body weight gains were high at $ADG_{0-2}$, $ADG_{2-4}$ (15.9 and 14.3%) and declined to (9.9 and 6.7%) for $ADG_{0-6}$ and $ADG_{4-6}$.

Such superiority of cross lines quail over their parental lines points to considerable non-additive genetic line effects. In this respect, Bahie El-Deen *et al*. (1998) and Aboul-Hassan (2001) observed that heterosis contrasts were significant for $BW_0$, $BW_2$ and $BW_4$ ($P\leq0.001$) and $BW_6$ ($P\leq0.01$).

Maeda *et al*. (1988) and Sato *et al*. (1990) indicated the presence of heterotic effects in body weights of quail recorded at different ages. Marks (1995) crossing lines of quails selected long-term for increased body weight, but that was dependent on both environments and age as well as the genetic of populations. He crossed medium weight quails (selected for high $BW_4$) and quails of heavy strain and reported that considerable heterosis was present for body weights.

Damme (1994) reported heterosis for $BW_1$ to $BW_6$ ranged between 0.6 and 2.7%, and it was significant for $BW_2$. Bahie El-Deen *et al*. (1998) reported that heterosis percentage estimates for body weight were high at $BW_2$ (30.2%) and declined to (11.8%) at $BW_6$. Heterosis contrast were significant for $BW_2$, $BW_4$ ($P\leq0.001$) and $BW_6$ ($P\leq0.01$) but non for $ADG_{2-6}$. Furthermore, Bahie El-Deen (1994) and Nofal (2006) when crossing two lines of quails, one selected for high $BW_6$ and the other line was selected for high egg production noticed negative heterosis for growth traits.

On contrary, Gerken *et al*. (1988) reported that heterosis was not significant for body weight from 25 to 49 days of age in Diallel crosses among two random bred control lines and a line selected for large body weight.

***Direct additive effect:***

Direct additive effect for all body weights recorded at different ages and all body weight gains calculated between different growth periods studied were significant and they were ranged between 5.66 for $BW_0$ and 30.28 for $BW_4$ and between 5.29 for $ADG_{0-2}$ and 9.75% for $ADG_{4-6}$ (Tables, 2&3).

The same trend was also concluded by Bahie El-Deen *et al*. (1998) and Nofal (2006). They reported that direct additive effect on body weight at market age of M-sired quails was significantly different from quails sired by E-line. Sire-line linear contrasts indicate that E-sired quails were significantly superior in $BW_6$ ($P\leq0.05$) and $ADG_{2-6}$ ($P\leq0.01$). At 4 weeks of age, direct genetic effects were also pronounced in favour of E-sires, while at early ages, M-sires were better than E-sires.

Aboul-Hassan (2001) reported that body weights and body weight gains of B sired quails were significantly different from quails sired by W strain. Sire-line linear contrasts indicate that W-sired quails were significantly superior in most growth traits studied ($P\leq0.01$) except $BW_0$ and $BW_2$ was in favor of sired by B strain.

***Maternal additive effect:***

Maternal additive had a significant negative effect on most body weights recorded at different ages and body weight gains calculated between different growth periods studied, except $BW_0$, $BW_2$, $ADG_{2-4}$ and $ADG_{4-6}$ and they were ranged between -7.34 for $BW_4$ and -8.77 for $BW_6$ and between -4.18 for $ADG_{0-2}$ and -5.23 for $ADG_{4-6}$ (Tables, 2 & 3). However, it may be effective to use EASM quails as a line of dams in crossbreeding programs for producing quails with heavy weights and increased gains. The same trend was observed by Bahie El-Deen *et al*. (1998). An evidence for the significant maternal effects on body weight was obtained by Biak and Marks (1993). They reported significant reciprocal effects between the HW with LW and LW with HW crosses in Diallel crosses of Japanese quail lines divergently selected for BW.

On the contrary, Chahil *et al*. (1975) reported the absence of maternal effects in BW5 in a 3 x 3 Diallel cross of 3 random mating populations of quail. Nofal (2006) crossed M line (selected for meat production) and E line (selected for egg production) and reciprocal crosses reported that maternal additive had a non-significant effect on all growth traits ($BW_0$, $BW_6$ and $ADG_{0-6}$). However, this insignificant influence of maternal additive could be expected since this component is being diminished as birds advance in age.

***Carcass traits:***

Least-square means and standard errors (SE) for carcass traits studied i.e., SW, M%, B%, G% and D% are given in (Table, 4). The crossbreds produced from sired EASM with LASM dams had the highest carcass traits except B% and the crossbreds produced from sired LASM with EASM dams had the lowest carcass traits except B%. However, significant differences due to mating groups (MG) on carcass traits were observed. The same trend was reported by Shalan (1998) and Adel-Mounsif (2005).

On the other hand, Sharaf *et, al* (2006) when they crossed three colored varieties of Japanese quails (Brown, Golden and White) stated that carcass traits did not express any significant values between purebreds, crossbred and reciprocals, while edible percentages were the highest in purebreds (8.99%).

***Direct heterosis:***

Positive direct heterosis effect for most carcass traits studied was observed except M% and G%. Direct heterosis was non-significant effect. Estimates of heterosis percentage for carcass traits were high for B% and SW % (22.9 and 19.6%) and declined to (12.0 and 12.8%) for M% and D% (Table, 4).

***Direct additive effect:***

Direct additive effect on all carcass traits studied were non-significant. Estimates of carcass traits of quails in favor of EASM-sire to those quails sired by LASM line (Table, 4). The same trend was reported by Abdel-Mounsif (2005).

***Maternal additive effect:***

Maternal line effects (expressed as the differences between reciprocal crosses) on all carcass traits studied were non-significant. Estimates of carcass traits of quails in favor of sired by EASM line were to those quails mothered by LASM line (Table, 4).

## CONCLUSION

Crossing of EASM line sires with LASM line dams was associated with an improvement in all growth traits, egg production and reproduction and carcass traits.

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**Table 1.**Distribution of birds produced from crossbreds among different lines and hatches.

| Mating groups | EASM X LASM | | LASM X EASM | | Total | |
|---|---|---|---|---|---|---|
| Hatch | M | F | M | F | M | F |
| 1 | 105 | 127 | 105 | 110 | 210 | 237 |
| 2 | 125 | 118 | 115 | 100 | 240 | 218 |
| 3 | 105 | 100 | 95 | 105 | 200 | 205 |
| Total | 335 | 345 | 315 | 315 | 650 | 660 |

M: Males, F: Females.

**Table 2.** Least-square means of body weight traits between different mating groups ± SE, heterosis ($H^I$), maternal additive effect ($G^M$) and direct additive effect ($G^I$).

| | No. | $BW_0$ | $BW_2$ | $BW_4$ | $BW_6$ |
|---|---|---|---|---|---|
| Mating groups: | | Mean ± SE | Mean ± SE | Mean ± SE | Mean ± SE |
| EASM x LASM | 475 | 9.8 ± 0.32 | 53.5 ± 6.04 | 109.2 ± 6.06 | 191.7 ± 8.76 |
| LASM x EASM | 390 | 9.0 ± 0.51 | 48.4 ± 4.11 | 100.3 ± 7.55 | 181.9 ± 7.80 |
| Pure breed effect | | $10.23 \pm 3.50^{***}$ | $8.91 \pm 2.90^{**}$ | $2.53 \pm 9.83^{ns}$ | $19.24 \pm 1.37^{***}$ |
| Direct heterosis ($H^i$) Unit | | $6.54 \pm 3.14^{*}$ | $15.86 \pm 1.24^{***}$ | $1.78 \pm 3.95^{ns}$ | $22.42 \pm 1.88^{***}$ |
| Percentage | | 32.7 % | 27.9 % | 19.8 % | 18.9% |
| Direct additive effect ($G^i$) | | $5.66 \pm 2.44^{**}$ | $9.98 \pm 1.24^{**}$ | $30.28 \pm 4.54^{***}$ $13.55^{***}$ | $27.37 \pm 1.88^{***}$ |
| Maternal additive effect ($G^m$) | | $2.35 \pm 3.50^{ns}$ | $3.20 \pm 0.86^{ns}$ | $-7.34 \pm 9.33^{*}$ | $-8.77 \pm 1.30^{***} \pm$ 4.54 |

*=P≤ 0.05or **= P≤ 0.01or ***= P≤ 0.001, $^{ns}$=Non- significant.

**Table 3.** Least-square means of daily weight gain traits between the different mating groups ± SE, heterosis ($H^I$), maternal additive effect ($G^M$) and direct additive effect ($G^I$).

| | No. | $ADG_{0-2}$ | $ADG_{2-4}$ | $ADG_{4-6}$ | $ADG_{0-6}$ |
|---|---|---|---|---|---|
| Mating groups: | | Mean ± SE | Mean ± SE | Mean ± SE | Mean ± SE |
| EASM x LASM | 475 | 2.8 ± 0.89 | 4.4 ± 0.47 | 6.9 ± 0.71 | 4.8 ± 0.04 |
| LASM x EASM | 390 | 2.5 ± 1.09 | 4.1 ± 0.99 | 6.4 ± 0.90 | 4.0 ± 0.04 |
| Pure breed effect | | 9.36 ± 0.08*** | 10.35 ± 0.71*** | 6.01 ± 0.09* | 9.48 ± 0.04*** |
| Direct heterosis ($H^i$) Unit | | 10.15 ± 0.10*** | 8.40 ± 0.53** | 1.81 ± 0.13*** | 10.24 ± 0.06*** |
| Percentage | | 15.9 % | 14.3 % | 9.9 % | 6.7% |
| Direct additive effect ($G^i$) | | 5.79 ± 0.15** | 6.66 ± 0.17** | 9.75 ± 0.45** | 7.51 ± 0.06** |
| Maternal additive effect ($G^m$) | | -4.18 ± 0.27* | -0.15 ± 0.13ns | -5.23± 0.39* | -0.16 ± 0.27 n.s |

*=P≤ 0.05or **= P≤ 0.01or ***= P≤ 0.001, ns=Non- significant.

**Table 4.** Least-square means of carcass traits among the different mating groups ± SE, heterosis ($H^I$), maternal additive effect ($G^M$) and direct additive effect ($G^I$).

| Traits | No. | SW | M% | B% | G% | D% |
|---|---|---|---|---|---|---|
| Mating groups: | | Mean ± SE | Mean ± SE | Mean ± SE | Mean ± SE | Mean ± SE |
| EASM x LASM | 6 | 192.7 ± 3.45 | 65.3 ± 6.47 | 13.0 ± 9.20 | 8.9 ± 3.12 | 74.0 ± 6.08 |
| LASM x EASM | 6 | 183.5 ± 3.77 | 63.8 ± 7.22 | 13.9 ± 7.86 | 7.6 ± 4.70 | 72.8 ± 7.38 |
| Pure breed effect | | -24.5 ± 5.43*** | -10.5 ± 8.65** | -0.8 ± 6.02ns | -1.2 ± 0.45ns | -1.3± 1.31ns |
| Direct heterosis ($H^i$) Unit | | 28.8 ± 7.69*** | 2.7 ± 6.99ns | 6.8 ± 8.52** | 1.9 ± 0.63ns | 8.5 ± 1.85** |
| Percentage | | 19.6 | 12.0 | 22.9 | 13.5 | 12.8 |
| Direct additive effect ($G^i$) | | -31.7 ±11.69*** | -20.0 ± 7.96*** | -9.2 ± 3.82** | -6.7 ± 0.63* | -2.0 ± 4.80ns |
| Maternal additive effect ($G^m$) | | 21.0 ± 10.46*** | 10.5 ± 5.63*** | 6.3 ± 5.72** | 2.2 ± 0.45ns | 1.2 ± 3.39ns |

*=P≤ 0.05or **= P≤ 0.01or ***= P≤ 0.001, ns=Non- significant.

# تأثيرالخلط بين خطين منتخبين لصفة النضج الجنسى المبكر والمتأخرعلى بعض صفات النمو وصفات الذبيحة فى السمان اليابانى

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**الملخص العربي:**

تم إجراء تجربة خلط بإستخدام خطين منتخبين من السمان اليابانى لمدة أربعة أجيال : الخط الأول منتخب لصفة النضج الجنسى المبكر(EASM). الخط الثانى منتخب لصفة النضج الجنسى المتأخر(LASM). تم خلط ذكور الخط (EASM) مع إناث الخط (LASM) والتلقيح العكسى بين الخطين. تم أخذ عدد 1310 طائر خليط تم إنتاجها خلال ثلاث فقسات متتالية وذلك لتقييم الأداء الإنتاجى وصفات الذبيحة فى الطيور الخليطة وقياس تأثير كل من الخلط والتأثيرات المضيفة المباشرة والأمية على الخلطان للصفات الآتية: صفات النمو وتشمل: أوزان الجسم عند عمر الفقس و 2 و 4 و 6 أسابيع ومعدلات النمو اليومية خلال الفترات الآتية : صفر-2 و 2-4 و 4-6 و صفر-6 أسبوع . وصفات الذبيحة وتشمل: وزن الذبح والنسب المئوية لكل من اللحم – العظم – الأجزاء المأكولة – التصافي في ذبائح السمان اليابانى .وقد أوضحت الدراسة النتائج الآتية : بالنسبة لصفات النمو :صاحب الخلط بين ذكور (EASM) وإناث (LASM) تفوق فى صفات أوزان الجسم عند الأعمار المختلفة وكذلك فى صفات معدلات النمو اليومية خلال فترات النمو المختلفة تلاها الخلط العكسى بين ذكور (LASM) وإناث (EASM). وكانت قوة الخلط المباشرة عالية المعنوية فى معظم صفات وزن الجسم المدروسة من عمر الفقس حتى عمر 6 أسابيع ما عدا صفة وزن الجسم عند عمر 4 أسبوع وكانت قوة الخلط المباشرة عالية المعنوية فى صفات معدلات النمو اليومية خلال فترات النمو المختلفة وكانت نسبة الخلط لهذه الصفات مرتفعة فى فترتى النمو من الفقس حتى عمر 2 أسبوع ومن 2- 4 أسابيع وإنخفضت إلى فى فترتى النمو من 4-6 أسبوع ومن الفقس - 6 أسابيع.

و بالنسبة لصفات الذبيحة : صاحب الخلط بين ذكور (EASM) وإناث (LASM) تفوق فى كل صفات الذبيحة المدروسة تلاها الخلط العكسى بين ذكور (LASM) وإناث (EASM). وكانت قوة الخلط المباشرة عالية المعنوية فى معظم صفات الذبيحة ماعدا صفتى النسبة المئوية للحم والأجزاء المأكولة من الذبيحة ولم يكن لقوة الخلط المباشرة تأثيرا معنويا عليها وكانت نسبة الخلط لهذه الصفات مرتفعة بالنسبة لصفتى النسبة المئوية للعظام ووزن الذبيحة وإنخفضت إلى بالنسبة لصفتى النسبة المئوية للحم والنسبة المئوية للتصافى.

**الكلمات الاسترشادية** : الخلط, عمر النضج الجنسى المبكر والمتأخر ,السمان اليابانى