TI Journals
**Agriculture Science Developments**
www.waprogramming.com

ISSN
2306-7527

# Effects of Cage Type and Mating Ratio on Fertility in Japanese Quails (Coturnix Coturnix Japonica) Eggs

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ARTICLE INFO

*Keywords:*
Fertility
mating ratio
cage type
Japanese quail

ABSTRACT

In this study, the effects of mating ratio and cage type on the percentage of fertility in Japanese quail were investigated. For this aim, 124 breeder quails were housed in individual cages and 164 breeder quails were housed in colony cages. In total, 1646 eggs were used to determine the percentage of fertility. Families were formed to consist of 1, 2, 3, 4 or 5 female per male in both individual and colony type cages. The percentage of fertility was found to be 87.43% for the quails housed in individual cages and 84.26% for the quails housed in colony cages. The effect of cage type on the fertility was found to be significant ($P<0.05$). In general, the highest percentage of fertility were found in 1:1 (92.21%) and 1:2 (91.18%) male-female mating ratio ($P<0.05$). The highest percentage of fertility (92.21%) for the quails housed in colony cages was obtained from 1:1 male-female mating ratio, whereas the highest percentage of fertility (93.21%) for the quails housed in individual cages was observed in 1:2 male-female mating ratio ($P<0.05$). In conclusion, it can be concluded that the number of female per male must not exceed 3 in order to obtain sufficient number of chicks from the quails housed in individual cages for genetic improvement studies. Moreover, 1:4 male-female mating ratio may be the choice that results in reasonable number of chicks in breeder flocks for commercial production.



## 1. Introduction

The Japanese quail (Coturnix coturnix Japonica) is the smallest avian species being farmed and has been considered as a source of animal protein recently. Quails are generally kept for egg production in Far East and Asian Countries, while they are reared primarily for meat production in European and American Countries (Minvielle, 2004). In Turkey, quails are kept as a dual purpose breed for meat and egg production. Quails are reared for production generally at family type small-scale enterprises in villages. In a study carried out in the Antalya province of Turkey, it was determined that no breeding activities were performed in the breeder flocks the villagers used in production and that these flocks consisted of randombred birds (Yapici et al., 2006).

In certain countries like Turkey, quails are raised for meat production and sold by being priced per animal (Narinc and Aksoy, 2012). Therefore, producers aim to obtain the maximum number of chicks to achieve a desired level of total income. Reproduction traits such as fertility, hatchability and embryonic mortality are important factors effecting the number of chicks that can be obtained from a breeding flock. Fertility is defined as the number of fertile eggs per chicken and determined by both the genetic and environmental factors such as genetic structure, mating ratio, parental age, rate of laying, climatic conditions (Kulenkamp et al., 1973). Fertility is a low heritable trait and requires a complex genetic improvement program (Wolc et al., 2009). Therefore, for small-scaled enterprises, it is primarily of interest to perform remedial actions for the environmental effects that have an influence on the fertility.

The effects of some management methods on fertility in Japanese quail, such as, stocking density, mating ratio, rearing type investigated by Wilson et al. (1974), Woodard and Abplanalp (1971), Kumar et al. (1990), Vilchez et al. (1991), Altan and Oguz (1993) and Kirmizibayrak and Altinel (2001). Investigations indicate that grouping a single male with two to five females in colony cage will generally give high fertility. But the increase of the group size may influence bird welfare. In colony cages, aggressive behaviors are the most problem to rearing quails, typically numerous male birds cause stress and aggressive pecking (Ophir and Galef, 2003). But the excessive male to female ratios can stress both sexes. On the contrary, cutting the proportion of males allows savings in space and feed and also results in more uniformity of progeny by increased selection intensity. When quails are kept in individual cage, a single male with one to three females is sufficient and reduces fighting among birds. Pair mating in individual cages also gives good fertility. Quail rearing in individual cages is applied rather in the genetic improvement studies. The producers that apply commercial production prefer colony type cages to individual cages. The aim of this study is to examine the effects of the different male-female mating ratios (1:1, 1:2, 1:3, 1:4, 1:5) of the Japanese quail breeders in both individual and colony cages on the fertility. Within this scope, the most suitable rate in both individual and colony cage is aimed for an economical production.

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## 2. Materials and Methods

Experiment was carried out in the Research and Application Unit in Department of Animal Science, Faculty of Agricultural, Akdeniz University. At sixteen weeks of age, a total of 348 birds from a randombred breeder flock were randomly divided into two experimental groups according to two cage type and different mating ratio. Quails were placed in individual cages, and colony cages. In colony cages, we used a total of 188 birds, and divided them among five mating groups. Group 1 comprised 32 quails (16 males and 16 females); 8 birds of each colony cage (one male and one female), housed with a mating ratio of 1:1. Group 2 comprised 36 quails (12 males and 24 females); 9 birds of each colony cage (3 male and 6 female), housed with a mating ratio of 1:2. Group 3 comprised 32 quails (8 males and 24 females); 8 birds of each colony cage (2 male and 6 female), housed with a mating ratio of 1:3. Group 4 comprised 40 quails (8 males and 32 females); 10 birds of each colony cage (2 male and 8 female), housed with a mating ratio of 1:4. Group 5 comprised 48 quails (8 males and 40 females); 12 birds of each colony cage (2 male and 10 female), housed with a mating ratio of 1:5. In individual cages, a total of 160 quails were randomly divided into five experimental groups of eight replicates each and were assigned to one of the following male to female ratio: 1:1, 1:2, 1:3, 1:4, and 1:5. All birds were kept under similar environmental conditions (all quails of the experiment were distributed to the different cages according to similar stocking densities) during the whole experimental period. Both feed contained 20 % CP, 2800 kcal of ME/kg and water were provided ad libitum to all the experimental groups. All birds were subjected to 18 h lighting program a day.

The birds were allowed to adapt to cages for 2 weeks prior to experimental mating period. In each of mating ratio groups, the birds were visually examined for physical condition and any missing birds due to mortality, damaged or unhealthy birds were replaced by one of the separately held extra birds. In individual cages, male birds were relocated every day in the families composed of various number of females to obtain high fertility. The eggs used in the study were started to be collected 2 weeks after the quails started laying eggs in the mating cages of experiment. Fertility was determined by collecting the eggs of each mating groups during five consecutive days and was measured on two occasions during the experiment (18 and 20 weeks of age). Eggs were stored in a cold storage room at 18 °C having relative humidity 75-80 %, and turned twice a day for one week. After one week storage, eggs were placed in a commercial incubator for preheating, where the hot air was circulated and warmed gradually. These eggs were warmed from storage temperature up to room and then incubation temperature. A total of 1646 eggs collected from mating groups were incubated for 16 d at 37.5°C 55% relative humidity. At the sixteenth day of the incubation period, unhatched eggs were broken and classified according to the macroscopic diagnosis as fertile or infertile. Fertility was determined as the proportion of fertile eggs to the number of eggs set.

Under the data set for the evaluation of fertility, fertile eggs were coded as “1”, and infertile eggs were coded as “0”. These data were analyzed using generalized linear mixed models with a logit link and binomial variance function using PROC GLIMMIX of SAS (Schabenberger, 2005). Pairwise comparisons were performed using LSMEANS with the Tukey–Kramer method (Westfall *et al*., 1999).

## 3. Results

The effects of cage type, male to female ratio and their interaction terms (subgroups) on fertility were summarized in Table 1. As it is shown in the results of the present study, Table 1 indicates that main terms had significant ($P<0.05$) effect upon percentages of fertility. Mean values indicating the effect of cage type and mating ratio are summarized in Table 1. In terms of cage type the higher ($P<0.05$) fertility rate was determined in the individual cages (% 87.43) than group cages (84.26%). The means of fertility rate for the 1:1, 1:2, 1:3, 1:4, 1:5 mating groups were 92.21, 91.18, 86.41, 85.15, 77.43 %, respectively. The highest percentages of fertility were obtained in 1:1 and 1:2 mating groups while the lowest value was observed in 1:5 mating ratio laying period ($P<0.05$). There were no significant differences in mating ratio between 1:1 and 1:2. Also, no significant differences were found in mating ratio between 1:3 and 1:4. Analyses within the different cage type-mating ratio combinations also revealed significant differences in fertility (Table 1). Percentages of fertility were significantly higher within the group cage-1:1 mating ratio (92.21 %) and individual cage-1:2 mating ratio (93.21 %) than the other subgroups of quails. Means of fertility for group cage-1:3 and 1:5, individual cage-1:5 had lower fertility rate than the other subgroups of quails ($P<0.05$).

## 4. Discussion

In this study, percentage of fertility was found 84.26 % in group cage and 87.43 % in individual cage. Significant differences for percentage of fertility existed between the two cage type ($P<0.05$). To our knowledge, there are no studies available on the effects of cage type in fertility of Japanese quail eggs. Most previous reports in fertility have focused on the effects of housing systems (cage or floor pen) or the other environmental conditions. Such as, Roshdy et al. (2010) reported that no significant differences were found between colony cage (97.5 %) and floor pens (97.8 %) in mean of fertility. Woodard and Abplanalp (1967) reported that the fertility of caged hen eggs is often lower than floor bird eggs, but the tom maintained in cages produces greater semen volume. The present study demonstrated that the decrease in fertility in group cages can be attributable to non-specific stress that may arise or to the high aggressive activity between birds.

Highest fertility of the groups of 1:1 and 1:2 in terms of male female rates was found 92.21 % and 91.18 %, respectively (Table 1). These results are in good agreement with the findings of Kaymak (1991), where the effects of the male-female ratio and mating period on the fertility were examined. In the study, the author reported that there is no significant difference in the percentage of fertility between 1:1 and 1:2 male-female ratios, while the percentage of fertility for 1:3 male female mating ratio was significantly the lowest among the groups. Similar to our findings, Baumgartner et al. (1979) have reported that the highest fertility was shown by 1:1 mating ratio while the lowest fertility was shown by 1:8 male-female ratio. In the study of Narahari et al. (1988) on defining the highest fertility ages, the mating ratio was set to 1:2 male-female and the incubation results were evaluated through the use of this rate. Wilson and Holland (1974) have reported

that 1:1 male-female mating ratio of the quails reared in the cage yields better results than the other mating ratios. In another study in Japanese quails, Seker et al. (2004) found that optimum male-female mating ratio were 1:1 and 1:2.

The 1:1 mating ratio resulted the highest percentage of fertility (93.32 %) for the quails kept in colony cages while the highest percentage of fertility was obtained with 1:2 male-female mating ratio for individually housed quails (P<0.05). Among the groups, the lowest percentages of fertility were observed to be 74.16% with 1:5 male-female ratio for the quails kept in colony cages. In a study carried out on quails, Kocak and Ozkan (1999) reported that the higher the number of females per sire the lower the fertility. Gebreil (2002), have emphasized that for the optimum fertility ratio of Japanese quails, required male-female ratio must be between 1:1 and 1:3. In the study carried out by Yurdakul (2006), the effect of the male-female mating ratio on the fertility was examined, and similar findings were reported. In the study, percentage of fertility for 1:1 and 1:2 mating ratios were found to be 90% and 93%, respectively. On the other hand, the author has also stated that fertility was decreased below 80% for 1:4 and 1:5 mating ratios.

**Table 1.** Effects of housed type and mating ratio in percentage of fertility (%)

| **Factors** | | **N** | **Mean** | **SE** |
|---|---|---|---|---|
| Cage Type | | | *P*<0.05 | |
| Group | | 781 | 84.26 | 0.01 |
| Individual | | 865 | 87.43 | 0.01 |
| Mating Ratio (♂:♀) | | | *P*<0.05 | |
| 1:1 | | 245 | 92.21a | 0.02 |
| 1:2 | | 260 | 91.18a | 0.02 |
| 1:3 | | 371 | 86.41b | 0.02 |
| 1:4 | | 372 | 85.15b | 0.02 |
| 1:5 | | 396 | 77.43c | 0.02 |
| Subgroups | | | *P*<0.05 | |
| Group | 1:1 | 135 | 93.32a | 0.03 |
| | 1:2 | 150 | 89.34abc | 0.03 |
| | 1:3 | 222 | 81.18cd | 0.02 |
| | 1:4 | 138 | 83.21bc | 0.03 |
| | 1:5 | 136 | 74.16d | 0.03 |
| Individual | 1:1 | 110 | 91.24ab | 0.03 |
| | 1:2 | 110 | 93.21a | 0.03 |
| | 1:3 | 151 | 91.31ab | 0.03 |
| | 1:4 | 234 | 87.18abc | 0.02 |
| | 1:5 | 260 | 81.45cd | 0.02 |

Tukey–Kramer grouping of the main effects and subgroups using least square means option in GLIMMIX procedure (SAS version 9.2). LSMEANS estimates with the same letter are not significantly different.

## 5. Conclusion

As the available output level is considered as adequate for an economical production, genetic improvement studies are performed or short term experimental phenotypic selection studies are conducted. But their use in commercial production has not been become widespread. Another reason for using modern genetic improvement tools for quails is highly heritable characteristics that are selection criteria (for example; live weight depending on a fix age) and for this reason, achieved result is gained even with the short term phenotypic selection for a single trait. For both of these cases, there is no inconvenience of quails being housed in colony cages. But, where characteristics that are selection criterias are more than one or any characteristics that have low heritable reproduction traits, applying phenotypic mass selection can lead breeding values to be estimated wrong. On the genetic improvement programs that breeding value for characteristics as feed efficiency, egg yield, fertility, are detected through modern methods as selection index or BLUP, quails are required to be housed in individual cages.

Quail producers in Turkey are small scaled who generally use their production flock as breeder flock simultaneously. Meat type quail producers should raise their chicks on their own. In this case, the number of chicks to be obtained from the breeder flock directly affects the business profitability. Moreover, from the animal breeding point of view, an animal with high breeding value must have a sufficient number of chicks to better transform its superiority to the following generation. Therefore, high fertility rate of incubation eggs has high importance. Besides, to prevent the possible financial loss of the producers that may be caused by keeping excessive amount of male birds, optimum male female ratio must be used. Yapici *et al.* (2006), who stated that 1:3 male female rate is used by commercial producers. On the contrary, in this study, percentage of fertility resulted by 1:3 male female mating (81.18%) is observed to be lower than 1:4 fertility rate (83.21) in colony cages (P<0.05). On the basis of the results of this research, it can be concluded that in order to obtain a sufficient number

of chicks from the quails housed in individual cages for genetic improvement purposes, female per male must not exceed 3. Furthermore, for a quail flock housed in colony cages, the male to female ratio that results desired number of chicks to be produced is 1:4.

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