Heterosis for Reproductive Traits in Reciprocal Crosses of Highly Inbred Lines of Japanese Quail

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Heterosis for reproductive traits, such as fertility, hatchability, viability and egg production rate was investigated in the reciprocal crosses between the highly inbred lines \( F = 0.925 \) of Japanese quail. High heterosis effect was found for all reproductive traits except fertility. Fertility, hatchability and viability were similar in the reciprocal crosses, however, statistically significant difference was detected in egg production rate.

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Key words: Heterosis, Reproductive trait, Reciprocal cross, Inbred line, Japanese quail

Introduction

Heterosis is known in a variety of species. It is of economical importance in the domestic animals. Heterosis effects have been observed on growth, reproduction, food conversion efficiency, variability and disease resistance. Therefore, heterosis is widely utilized in commercial animal production. Although heterosis in crosses between the inbred lines of Japanese quail was studied by Shinjo et al.\(^1\), Narayan\(^3\) and Maeda et al.\(^4\), there is little information available in the literature for crosses of highly inbred lines of Japanese quail.

This study was conducted to investigate heterosis effect for reproductive traits, such as fertility, hatchability, viability and egg production rate, in reciprocal crosses between highly inbred lines of Japanese quail.

Materials and Methods

Two inbred lines (lines OO and TT), their reciprocal crosses (OT and TO) and a randombred population of Japanese quail were used in this experiment. Inbred line OO originated from the randombred population maintained at the Laboratory of Animal Breeding, Faculty of Agriculture, Okayama University. Inbred line TT was derived from a closed colony created from eggs obtained from six quail breeders in Toyohashi-shi. The two inbred lines were established by consecutive full-sib mating until generation 12 \( (F = 0.925) \). The reciprocal crosses (OT and TO) were performed by pair matings between OO male and TT female and between TT male and OO female. The experiment with the randombred population was also performed with pair

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matings. Crossing was set out at the age of 11 weeks and egg collection was started ten days after caging. Eggs from above mating groups were collected daily and incubated three times at 7-day intervals in an incubator maintained at 38.3 ± 0.2°C. Hatched chicks were taken out at 17th, 18th and 19th days of incubation. The methods for breeding of chicks have been shown in the previous report by Sato et al. 5).

Data were obtained on fertility, hatchability, viability up to 4 weeks of age after hatching egg production rate. Fertility and hatchability were expressed by the ratio of fertile eggs to eggs set and by the ratio of hatched chicks to fertile eggs, respectively. Viability was represented as the percentage of chicks surviving four weeks after hatching. Egg production rate (hen-day) was measured during the period of 6 weeks from 10th to 16th weeks of age.

The data for reproductive traits were statistically analysed by the \( \chi^2 \) test 6) to detect the differences between the groups. Heterosis effect was estimated with potency ratio 7).

Results and Discussion

Table 1 shows the fertility, hatchability, viability and egg production rate in inbred lines, in their reciprocal crosses and in the randombred population. The reciprocal crosses showed lower values in fertility compared with the inbred lines and the randombred population. However, the crosses were found to be superior to both of the parental inbred lines for hatchability, viability and egg production rate. There were significant differences between the reciprocal crosses and inbred lines (P<0.01). It seems interesting to note that viability and egg production rate in both OT and TO crosses were similar to those of the randombred population. Significant differences were not detected between the reciprocal crosses in fertility, hatchability and viability. However, egg production rate differed significantly between the two crosses (P<0.05).

Table 1. Fertility, hatchability, viability up to 4 weeks after hatching and egg production rate in inbred lines, their reciprocal crosses and randombred population of Japanese quail.

<table>
<thead>
<tr>
<th>Mating group</th>
<th>N</th>
<th>Fertility (%)</th>
<th>Hatchability (%)</th>
<th>Viability (%)</th>
<th>N</th>
<th>Egg production (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OO</td>
<td>24</td>
<td>81.1^a(258/312)</td>
<td>38.7^a(98/253)</td>
<td>57.1^a(56/98)</td>
<td>19</td>
<td>61.0^a(487/798)</td>
</tr>
<tr>
<td>TT</td>
<td>25</td>
<td>78.8^ab(271/344)</td>
<td>36.9^a(100/271)</td>
<td>62.0^a(62/100)</td>
<td>24</td>
<td>71.7^b(714/996)</td>
</tr>
<tr>
<td>OT</td>
<td>20</td>
<td>73.8^bc(211/286)</td>
<td>73.5^b(155/211)</td>
<td>92.9^b(144/155)</td>
<td>54</td>
<td>89.6^c(2031/2268)</td>
</tr>
<tr>
<td>TO</td>
<td>18</td>
<td>70.1^c(155/221)</td>
<td>68.4^b(106/155)</td>
<td>91.5^b(97/106)</td>
<td>54</td>
<td>84.9^d(1923/2266)</td>
</tr>
<tr>
<td>RB</td>
<td>38</td>
<td>96.9^d(655/676)</td>
<td>81.8^c(536/655)</td>
<td>93.3^b(500/536)</td>
<td>60</td>
<td>88.6^c(2214/2500)</td>
</tr>
</tbody>
</table>

1) OO: Okayama inbred line; TT: Toyohashi inbred line; OT: Okayama inbred line × Toyohashi inbred line; TO: Toyohashi inbred line × Okayama inbred line; RB: Randombred population.

2) Number of birds.

3) Values with different superscripts are significantly different (P<0.05).

4) Values in parentheses are actual values.
Potence ratios were -5.33 and -8.48 for fertility, 38.74 and 33.23 for hatchability, 13.72 and 13.14 for viability, and 4.35 and 3.47 for egg production rate in the reciprocal crosses, OT and TO, respectively.

SHINJO et al.\textsuperscript{1,2)} found the superiority of crosses between inbred lines (\(F = 0.50\) or 0.425–0.375) in fertility compared with the parental inbred lines of Japanese quail. The presence of heterosis for fertility in a few crosses between the selected lines of quail was observed by MARKS\textsuperscript{8)} and OKAMOTO et al.\textsuperscript{9)}. These results do not coincide with the present ones. The lower values for fertility in the present study may have been influenced by a higher incidence of the pairs showing complete infertility.

SHINJO et al.\textsuperscript{2)} also reported that hatchability and viability of crosses of inbred lines were superior to those of inbred lines. CHAHIL et al.\textsuperscript{10)} also found superiority of inter-line crosses for hatchability. OKAMOTO et al.\textsuperscript{9)} reported the apparent positive heterosis for viability of chicks at 1 week and 6 weeks of age. MARKS\textsuperscript{8)} also observed a considerable amount of heterosis in inter-line crosses for mortality up to 4 weeks of age. In this experiment, hatchability in both of the reciprocal crosses was lower than that of the randombred population. This is considered to be attributable to the inferior egg quality of the parental lines caused by consecutive inbreeding. There is no report on heterosis effect for egg production rate in inter-line crosses of Japanese quail. Heterosis for egg production or production rate has been observed in inter-line crosses of chicken\textsuperscript{11–16)}. Our data are in agreement with those data. In this experiment, a difference between the reciprocal crosses was found in egg production rate. GOTO et al.\textsuperscript{11)}, YAO\textsuperscript{12,13)} and HAGGER\textsuperscript{16)} reported that differences in heterosis effects appeared between reciprocal crosses for egg production or production rate in chickens. This difference in reciprocal crosses is attributable to either paternal or maternal effects, in other words, it seems to be associated with the difference in egg production performance between the parental inbred lines.

The present study showed high heterosis effects in the reciprocal crosses between the highly inbred lines for the reproductive traits that were affected greatly by inbreeding. From these findings, it is considered that heterosis is caused by heterozygosity involving favorable new combinations of genes in the hybrid offspring.

References

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