MULTI TRAIT SELECTION INDICES FOR IMPROVEMENT OF CERTAIN ECONOMIC TRAITS IN JAPANESE QUAIL

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ABSTRACT
A total of 56 selection indices were computed in Black strain of Japanese quails based on the body weights at 1, 2, 3 and 4 weeks of age, with its dams Age at first egg, dams egg production at 16 weeks, dams egg weight at 16 weeks and dams egg mass at 16 weeks. The aggregate genetic gain (?H) expected from the selection indices constructed with dam's performance and individual body weights at different ages ranged from 0.23 to 71.15, 0.30 to 58.58, 0.06 to 24.86 and 0.58 to 9.86 at 1, 2, 3 and 4 weeks age respectively. Among all indices the body weight at 4th week showed the highest RIH of 4.86 (I45) in combination with 2 traits, whereas the highest RIH of 2.93 (I42) was observed with body weight at 3rd week in combination with all traits. The egg mass was repeated in all the indices combinations. The heritability of the indices under the study was observed to be ranging from 0.04 to 0.87. The ideal indices identified were I52 which will increase the body weight (Gi) by 0.20 g, egg production by 0.66 eggs and egg mass by 9.77 g.

Key words : Selection Indices, Accuracy of index, Body weight, Egg mass, Japanese quail

INTRODUCTION
Index selection is reported to be the most efficient method of genetic selection for multi traits with maximum accuracy. Selection indices are of interest to breeders for selection of more than a single character. Index selection is generally used when the information on all the traits is available and to improve genetically antagonistic traits. Hazel and Lush (1942) compared the relative efficiency of different selection methods and indicated that multi-trait index selection is most effective than others when several traits are involved. To get maximum genetic progress simultaneously in all traits, it has been suggested that a desirable proposition would be to combine them into an index. Use of selection indices are expected to result in maximization of aggregate genetic-economic values with the means of genetic values for individual traits moving in positive or negative direction depending upon the type of genetic association among the traits under consideration. Net value of Japanese quails not only depends on specific traits but also on other economic traits, some of which may be negatively correlated. The literature available on the multi trait and multi source index selection in Japanese quails is very limited.

Keeping in view the above, present study was undertaken to compute and evaluate selection indices incorporating different traits in various combinations and to compare various indices.
constructed with its own body weight at different ages and its dam’s performance, for maximum genetic improvement in Japanese quails which are under long-term selection for high 4-weeks body weight.

MATERIALS AND METHODS

Data on 204 number of Japanese quails produced by pair mating families, maintained at Poultry Experimental Station, Hyderabad, Andhra Pradesh and undergone 10 generations of selection for high 4-week body weight were utilized for the present study. The traits studied were the body weights from 1 to 4 weeks age, age at sexual maturity, egg production, egg weight and egg mass at 16 weeks of age, comprising of egg number multiplied by average egg weight at 16 weeks of age. The quails were produced in two generations and multiple hatches, so the data were corrected for significant effect of generation and hatch by least squares techniques as per Harvey (1975), by using the hatch corrected data the variances and covariances of the traits were computed according to Becker (1985) by pair-mating analysis. Equal relative economic weight (1) was assigned to all the traits because several authors have concluded that the efficiency of index was not very sensitive to their economic weights (Santhosh et al., 2007).

Selection indices were constructed incorporating traits in different combinations based on the estimate of genetic (sire component) and phenotypic parameters of traits, individual’s own body weight from 1 to 4 weeks of age, along with its dams AFE, dams EP16, dams EW16 and dams EM16. The indices were constructed as per Becker (1985), Basu (1985) and Singh & Kumar (1994) in the form of

\[ I = b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 \]

Where, \( b_1, b_2, b_3, b_4, b_5 \), and \( b_6 \) are derived optimum weighing factors for the traits \( X_1, X_2, X_3, X_4, X_5 \) and \( X_6 \) respectively. The \( b_i \) values were obtained by solving a set of simultaneous equations represented in matrix notation as \([P] \ [b] = [G] \ [a]\)

Where,

\[
[P] = \text{Phenotypic variance and covariance matrix} \\
[b] = \text{a row vector of index coefficients to be computed} \\
[G] = \text{Genotypic variance and covariance matrix} \\
[a] = \text{a row vector of relative economic values} \\
[b] = \text{a row vector of optimum weighing factors} \\
\]

Relationship between the index and aggregate genotype (RIH) was estimated as

\[ R_{\text{RIH}} = \frac{\sigma_i}{\sigma H} \]

Where,

Variance of index \((\sigma_i^2) = b'Pb\)  \(\sigma_i = \sigma b'Pb\)

Variance of aggregate genotype \((\sigma H) = a'Ga\)  \(\sigma H = \sigma a'Ga\)

The equal (1) relative net economic weights \([a]\) were considered for the traits included in the construction of selection index (Raj Narayan et al., 2000; Lata Sharma et al., 2003). The change produced in each individual trait as a result of selection on the basis of index was also computed.

Heritability of the index \((h^2)\) was estimated as

\[ h^2 = \frac{b'Gb}{b'Pb} \]

Expected response to index selection:

a) Response in aggregate genotype \((\delta H)\) was calculated as

\[ \delta H = i\sigma = a'Gb(i/\sigma) \]

b) Response in the individual trait \((\delta gi)\) was computed as

\[ \delta gi = gib(i/\sigma) \]
Genetic cost of restriction:

The per cent reduction in rate of genetic gain in aggregate genotype, if a particular trait is dropped from the index is called genetic cost of restriction and can be estimated by the following formula (Singh and Kumar, 1994)

\[
\text{Per cent reduction in genetic gain} = 100 \left\{ 1 - \sqrt[100]{\frac{(b'Pb - bi^2/wii)}{b'Pb}} \right\}
\]

Where,

- \( bi \) = Weighting coefficient for the ith trait
- \( wii \) = Corresponding diagonal element of \( P^{-1} \)
- \( b'Pb \) = Variance of the index.

The relative efficacy of an index was computed in percentage by dividing the aggregate genetic gain (\( \delta H \)) of an index with the aggregate genotype of the standard index which included all the 6 traits.

RESULTS AND DISCUSSION

A total of 224 number of selection indices could be successfully constructed based on the genetic parameters computed for various traits in the present study. The bi's, RIH, \( \delta H \), relative efficacy and genetic cost of restriction of different indices constructed based on its dams source of information i.e with dams performance are detailed in Table 1. The usefulness of an index is based on its correlation with aggregate genotype (RIH), the expected gain in aggregate breeding value (\( \delta H \) and the number of traits included in the index.

The aggregate genetic gain (\( \delta H \)) expected from the selection indices with its dams performance ranged from 0.23 to 7.15, 0.30 to 5.88, 0.06 to 24.86 and 0.58 to 14.25 at 1, 2, 3 and 4 weeks age respectively. The \( \delta H \) in the indices I14, I28, I42 and I52 showed 71.15, 58.58, 24.86 and 14.25 at 1, 2, 3 and 4 weeks age.

Among all these indices, the highest aggregate genetic gain based on dams performance (Table 1) was observed in I14 (71.15). At the selection age of 4-weeks in Black strain the index I52 incorporating body weight, egg production and egg mass showed the maximum genetic gain (14.25) and highest relative efficiency (144.49) based on dams performance. The highest RIH (4.86) was observed in index I45 constructed with combination of 2 traits (BW4 and EW16). These values are in good confirmation with the RIH values for the selection indices constructed based on 4th week body weight, ASM, EN18 and EW18 weeks in Japanese quails (Raj Narayan et al., 2000.)

Based on the \( \delta H \) and the relative efficacy the highest genetic gain was observed in the indices I14, I28, I42 and I52. In all these indices apart from the body weight, the egg mass which takes care of the egg production and egg weight was included, thus showing its importance.

In general the heritability estimates of various indices constructed under the study were observed to be low to high. High heritability of the various indices constructed in the present study reflected that the selection on the basis of these indices would improve the aggregate genotype without considering other sources of information for the traits of the index. (Lata Sharma et al., 2003 and Malik et al., 2005). Perusal of the contents of Table 1 revealed that the I14, I28, I42 and I52 indices reduce the AFE, increase the egg mass, which takes care of the egg production and egg weight and keep the body weight constant, reduce or marginally increase which is a favorable trend. The egg mass is repeated in all the indices mentioned above.

In Black strain at 4-weeks age of the selection the ideal indices identified i.e., I52 will increase the body weight by 0.2 g, egg production by 0.66 eggs and egg mass by 9.77 g, whereas the index I49 will improve the body weight by 0.02 g, reduce the AFE by 0.06 days and increase the egg mass by 8.68 g. The genetic cost of restriction of...
Table 1

Partial regression coefficients (bi’s), heritability of the indices (hi2), Correlation of the index with the aggregate genotype (RIH), Genetic improvement in individual traits (Gi’s), Response in aggregate genotype (RH) and % reduction in the genetic gain in aggregate genotype (Genetic cost of restriction) of various selection indices with body weights at different ages in Black strain of Japanese quails

<table>
<thead>
<tr>
<th>Trait</th>
<th>X</th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>X4</th>
<th>X5</th>
<th>X6</th>
<th>X7</th>
<th>X8</th>
<th>X9</th>
<th>X10</th>
<th>X11</th>
<th>X12</th>
<th>X13</th>
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</tr>
</tbody>
</table>

Multi trait selection...
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Duration (weeks)</th>
<th>Weight (kg)</th>
<th>Body Temperature (°C)</th>
<th>Heart Rate (bpm)</th>
<th>Respiration Rate (bpm)</th>
<th>Rectal Temperature (°C)</th>
<th>Treatment Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2.16</td>
<td>2.20</td>
<td>3.20</td>
<td>4.20</td>
<td>5.20</td>
<td>6.20</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2.16</td>
<td>2.20</td>
<td>3.20</td>
<td>4.20</td>
<td>5.20</td>
<td>6.20</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>2.16</td>
<td>2.20</td>
<td>3.20</td>
<td>4.20</td>
<td>5.20</td>
<td>6.20</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>2.16</td>
<td>2.20</td>
<td>3.20</td>
<td>4.20</td>
<td>5.20</td>
<td>6.20</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>2.16</td>
<td>2.20</td>
<td>3.20</td>
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<td>5.20</td>
<td>6.20</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>2.16</td>
<td>2.20</td>
<td>3.20</td>
<td>4.20</td>
<td>5.20</td>
<td>6.20</td>
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</tbody>
</table>
egg mass in these two indices was Rs.1.74 (I52) and Rs.28.07 (I49) respectively, revealing the importance of egg mass. This study recommends based on $H$ and RIH values, that the index I14 constructed with dams performance, including all 5 traits was found to be most efficient.

The findings of the present study indicated the possibility of simultaneous improvement in negatively correlated traits like the body weights, age at first egg, egg production and egg weight in Japanese quails.

REFERENCES


