IDENTIFICATION OF BIVOLTINE BREEDS AND HYBRIDS OF THE MULBERRY SILKWORM, *BOMBYX MORI* L.

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**ABSTRACT:** Identification of promising bivoltine breeds and hybrids of the mulberry silkworm, *Bombyx mori* L. was carried out utilizing three different statistical tools namely, multiple traits evaluation indices, combining ability and hybrid vigour. Out of six bivoltine silkworm breeds, DNB\(_1\) was found promising exhibiting maximum values based on its performance and multiple traits evaluation indices exhibiting maximum values for six characters viz., hatching %, pupation rate, cocoon shell %, filament length, raw silk percentage and neatness followed by DNB\(_6\) which exhibited higher values for three characters viz., cocoon yield/10,000 larvae by weight, cocoon weight and cocoon shell weight. DNB\(_1\) showed its superiority by exhibiting maximum GCA effects for seven characters. Among twenty four hybrids, DNB\(_1\) × CSR\(_2\) recorded maximum rearing performance values for four characters viz., cocoon shell weight, cocoon shell %, filament length and raw silk % followed by two hybrids DNB\(_6\) × CSR\(_2\) and DNB\(_7\) × CSR\(_2\) exhibiting maximum values for two characters each. Different hybrids exhibited higher values for special combining ability (SCA). DNB\(_4\) × CSR\(_4\) manifested higher hybrid vigour for pupation rate, cocoon yield/10,000 larvae by weight and cocoon shell weight.

**KEY WORDS:** *Bombyx mori*, Combining ability, Hybrid vigour, Multiple traits evaluation indices, Performance, Bivoltine silkworm breeds and hybrids.

Attempts to identify promising silkworm breed / hybrids have been carried out based on multiple traits evaluation indices (Vidyunnala et al., 1998; Kariappa & Rajan, 2005; Gangopadhyay et al., 2006; Nazia Choudhary & Ravindra Singh, 2006a) and multiple traits evaluation indices (Ramesh Babu et al., 2002; Rao et al., 2006; Nirupama & Ravindra Singh, 2007; Nirupama et al., 2008a;b) and through analysis of combining ability and hybrid vigour (Datta et al., 2001; Gangopadhyay & Ravindra Singh, 2006; Nazia Choudhary & Ravindra Singh, 2006b; Ravindra Singh et al., 2000; 2001; 2010). It is important to identify breeds/hybrids based on cumulative effect of several characters (Narayanaswamy et al., 2002). Recently, Ravindra Singh and Nirupama (2012) have short-listed promising multivoltine breeds and multivoline × bivoltine hybrids utilizing various statistical tools. The present study has been undertaken to identify promising bivoltine breeds and hybrids based on the performance, other statistical methods like multiple traits evaluation indices method of Mano et al. (1993), analysis of combining ability method of Kempthorne (1957) and hybrid vigour.

**MATERIALS AND METHODS**

Six bivoltine silkworm breeds namely, DNB\(_1\), DNB\(_2\), DNB\(_3\), DNB\(_4\), DNB\(_6\) and DNB\(_7\) and twenty four bivoltine hybrids were utilized in this study. Rearing of both silkworm breeds and hybrids was conducted with three replications in each and 250 larvae were retained after III moult. Data were recorded for eleven economic characters namely, fecundity, hatching %, pupation rate, yield/10,000 larvae by weight, cocoon weight, cocoon shell weight, cocoon shell percentage,
filament length, reelability, raw silk percentage and neatness. Data were analyzed based on rearing performance, multiple traits evaluation index method, combining ability and hybrid vigour.

RESULTS AND DISCUSSION

In order to shortlist promising bivoltine silkworm breeds / hybrids, average rearing performance, values based on multiple traits evaluation indices, general combining ability (GCA) of parents, specific combining ability (SCA) of hybrids and hybrid vigour for 11 economic characters namely, fecundity, hatching, pupation rate, yield/10,000 larvae by weight, cocoon weight, cocoon shell weight, cocoon shell percentage including post cocoon parameters like filament length, reelability, raw silk and neatness have been given in Table 1. DNB₁ showed distinct superiority based on its performance and multiple traits evaluation indices exhibiting maximum values for six characters viz., hatching % (96.28% and 56.91), pupation rate (91.33% and 68.79), cocoon shell % (21.22% and 64.84), filament length (870m and 63.62), raw silk percentage (15.70% and 60.03) and neatness (92p and 59.52) respectively followed by DNB₆ which exhibited higher values for three characters viz., cocoon yield/10,000 larvae by weight (15,630 kg and 61.43), cocoon weight (1.973g and 64.78) and cocoon shell weight (0.380g and 63.01). DNB₂ exhibited maximum GCA effects for seven characters. Three characters namely, cocoon yield/10,000 larvae by weight (15.630 kg and 61.43), cocoon weight (1.973g and 64.78), cocoon shell weight (0.380g and 63.01) were maximum in DNB₆ based on average performance and evaluation index value whereas fecundity in that breed was found highest when the GCA effects for that particular character was compared with other breeds.

Among twenty four hybrids, DNB₁ × CSR₂ was found promising showing highest values for four characters namely, cocoon shell weight, cocoon shell percentage, filament length and raw silk based on average performance. DNB₁ × CSR₂ revealed its superiority for four characters namely, cocoon shell weight (63.96), cocoon shell % (78.33), filament length (65.91) and raw silk % (74.25) based on evaluation index values. Two characters namely, pupation rate (98.80) and cocoon yield/10,000 larvae by weight (17.227 kg) in DNB₆ × CSR₂ and two characters hatching (97.32%) and reelability (86.10%) in DNB₇ × CSR₂ were found comparatively higher performance values. DNB₆ × CSR₂ exhibited higher index values for pupation rate (76.81) and cocoon yield/10,000 larvae by weight (63.99) whereas DNB₇ × CSR₂ exhibited highest values for 2 characters namely, hatching (65.50) and reelability (68.24). Different hybrids expressed higher SCA effects for different characters. DNB₃ × CSR₁₇ for cocoon and cocoon shell weight, DNB₄ × CSR₄ for pupation rate and cocoon yield/10,000 larvae by weight and DNB₄ × NB₄D₄ for fecundity and reelability. On the basis of hybrid vigour studies, DNB₄ × CSR₄ manifested higher hybrid vigour over mid paren values for 3 characters namely, pupation rate (14.08), cocoon yield/10,000 larvae by weight (28.30) and cocoon shell weight (21.46) whereas DNB₃ was poor combiner.

Selection of promising silkworm breeds and hybrids based on cumulative effect of several characters is important in silkworm breeding (Narayanaswamy et al., 2002). Extensive studies have been carried out to select silkworm breeds / hybrids through multiple traits evaluation index method (Ramesh Babu et al., 2002; Gangopadhyay et al., 2006; Nazia Choudhary; Ravindra Singh, 2006a, Rao et al., 2006; Lakshmi and Chandrashekharaiya, 2007; Nirupama and Ravindra Singh, 2007; Nirupama et al., 2008a,b) and through analysis of combining ability and hybrid vigour (Datta et al., 2001; Gangopadhyay and Ravindra Singh, 2006;
Nazia Choudhary and Ravindra Singh, 2006b; Nazia Choudhary and Ravindra Singh, 2006b; Ravindra Singh et al., 2000; 2001; 2010). Ravindra Singh and Nirupama (2012) have short-listed promising silkworm breeds and hybrids utilizing evaluation index, subordinate function values, combining ability and hybrid vigour. The identified breeds DNB1 and DNB6 may be further utilized in future breeding programmes for the development of superior bivoltine silkworm breeds. The promising bivoltine hybrids DNB1 × CSR2  DNB6 × CSR2 may be exploited for commercial exploitation.

LITERATURE CITED


Plate I: 1 - Larvae of DNB₁, 2 - Cocoons of DNB₁, 3 - Larvae of DNB₆ and 4 - Cocoons of DNB₆
Table 1. Short-listing of bivoltine silkworm breeds / hybrids based on various statistical measures.

<table>
<thead>
<tr>
<th>Character</th>
<th>Parents Based on average performance</th>
<th>Hybrids Based on Evaluation Index values</th>
<th>Based on Specific Combining Ability</th>
<th>Based on Hybrid Viability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecundity (B)</td>
<td>DNB1 (944)</td>
<td>DNB2 (64,29)</td>
<td>DNB1 (76.33)</td>
<td>DNB1 × CSR2 (66.09)</td>
</tr>
<tr>
<td>Hatching (%)</td>
<td>DNB1 (84.38)</td>
<td>DNB2 (76.97)</td>
<td>DNB1 (2.69)</td>
<td>DNB1 × CSR2 (70.32)</td>
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<tr>
<td>Parasitism rate</td>
<td>DNB1 (94.33)</td>
<td>DNB2 (68.09)</td>
<td>DNB2 (77.75)</td>
<td>DNB1 × CSR2 (96.84)</td>
</tr>
<tr>
<td>Cocoon yield (9.00)</td>
<td>DNB1 (15.63)</td>
<td>DNB2 (64.54)</td>
<td>DNB1 (1.32)</td>
<td>DNB1 × CSR2 (17.227)</td>
</tr>
<tr>
<td>Cocoon weight (g)</td>
<td>DNB1 (8.972)</td>
<td>DNB2 (64.38)</td>
<td>DNB2 (0.96)</td>
<td>DNB1 × CSR2 (1.942)</td>
</tr>
<tr>
<td>Cocoon shell weight (g)</td>
<td>DNB1 (0.180)</td>
<td>DNB2 (65.01)</td>
<td>DNB2 (0.024)</td>
<td>DNB1 × CSR2 (0.190)</td>
</tr>
<tr>
<td>Cocoon shell %</td>
<td>DNB1 (21.22)</td>
<td>DNB2 (64.84)</td>
<td>DNB2 (9.40)</td>
<td>DNB1 × CSR2 (21.54)</td>
</tr>
<tr>
<td>Fibrinomé stickiness (%)</td>
<td>DNB1 (870)</td>
<td>DNB2 (65.62)</td>
<td>DNB2 (44.54)</td>
<td>DNB1 × CSR2 (91.77)</td>
</tr>
<tr>
<td>Reliability (%)</td>
<td>DNB1 (93.75)</td>
<td>DNB2 (65.84)</td>
<td>DNB2 (3.37)</td>
<td>DNB1 × CSR2 (66.1)</td>
</tr>
<tr>
<td>Raw silk %</td>
<td>DNB1 (97.90)</td>
<td>DNB2 (65.03)</td>
<td>DNB2 (1.14)</td>
<td>DNB1 × CSR2 (74.21)</td>
</tr>
<tr>
<td>Neatness</td>
<td>DNB1 (93)</td>
<td>DNB2 (65.92)</td>
<td>DNB2 (0.68)</td>
<td>DNB1 × CSR2 (93)</td>
</tr>
</tbody>
</table>

Plate II: 1 - Larvae of DNB1 × CSR2, 2 - Cocoons of DNB1 × CSR2, 3 - Larvae of DNB6 × CSR2 and 4 - Cocoons of DNB6 × CSR2.