HYBRID VIGOUR IN HALF DIALLEL CROSSES OF THE SILKWORM, Bombyx mori L.
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ABSTRACT

Four monovoltine lines were utilized in a half diallel crosses in the present study. The six hybrids resulted were coded as (1x2), (1x3), (1x4), (2x3), (2x4) and (3x4).

It was concluded that the hybrid (1x2) was the best for most studied economic traits such as cocoon weight, cocoon shell weight, pupal weight and larval duration. This hybrid was also better for cocoon hatchability percentage. The hybrid (1x3) was better for cocoon weight, cocoon shell ratio and egg fertility. While hybrid (2x3) was the best for egg traits such as fecundity, fertility and hatchability percentage over both the better and mid parents.

INTRODUCTION

The first step for hybrid silkworm egg production is to isolate pure lines from local silkworm race and/or from imported hybrids (Mavvajpour, 2005).

Heterosis breeding has been recognized as the most suitable breeding methodology for augmenting yield and quality parameters in silkworm, selection of suitable parents and assessment of degree of heterosis in the resulted crosses forms as an important step (Ridday et al., 2003). Heterosis at F1 hybrids was calculated either from the better parent or from the mid-parents according to known equations.

Heterosis was expressed as an improvement in the traits shown by a hybrid over its better or mid-parent value. It is a vital measure of the genetic progress made in silkworm selection. It is also a phenomenon in which the performance of an F1 would generate by crossing two genetically different lines and show superiority over the better parent (Talebi et al., 2010).

The present study was carried out to determine the hybrid vigour present in six hybrids with respect to the better and mid-parents and to identify the promising hybrid combination for commercial exploitation, which can be distributed to the farmers for silk production.

MATERIALS AND METHODS

The four monovoltine parents used in this study were : P1: 9F7X is a Chinese X Chinese entry, P2: THBI a Thai hybrid (Japanese X Thai entry), P3: Turkish a Japanese X Turkish entry, P4: THB6.T6.904 a Japanese X Thai entry. These lines were obtained from the Sericulture Research Department of Plant Protection Research Institute, Agricultural Research Center in Giza). The crosses were made and coded as P1xP2, P1xP3,
Kosba, Z. A. et al.

P1xP4, P2xP3, P2xP4 and P3xP4 according to a half diallel crosses mating design.

Silkworm rearing was carried out according to Krishnaswamy (1978). Three replicates from each hybrid were reared during spring season under the laboratory normal conditions at 27±2 °C and 85±5 R.H %. Each replicate contained 100 larva in a wooden trays with the dimensions of 120 x 60 cm. Data were recorded for thirteen economical traits. These traits were male and female cocoon weight, male and female cocoon shell weight (CSW), male and female cocoon shell ratio (SR), male and female pupal weight (PW), fecundity, fertility, hatchability percentage, larval duration and mature larval weight (MLW).

CW, SW, PW and LW were estimated in grams, while SW and hatchability as percentage to fecundity and fertility were recorded by egg and larval duration by day.

- Cocoon shell ratio was estimated according the formula of Tanalca (1964):

\[
\text{Cocoon shell ratio} \% = \frac{\text{Cocoon shell weight}}{\text{Fresh cocoon weight}} \times 100
\]

- Hatchability was calculated using the formula of Lea (1996):

\[
\text{Hatchability percentage} = \frac{\text{Number of hatched eggs}}{\text{Number of fertilized eggs}} \times 100
\]

At the seventh day of montages, cocoon were sexed, weighted and cocoon weight, cocoon shell weight and cocoon shell ratios were recorded for 50 males and females and given a serial numbers. Three females and three males which have high values were selected and mating was carried out between 1x1, 2x2, 3x3 and 4x4. Another 18 females and males were also selected and 3 mating were carried out in all possible combinations between each of 1x2, 1x3, 1x4, 2x3, 2x4 and 3x4 entries.

The data was transformed to percentage by using the formula of heterosis over better and mid-parent value by using the formula of Rao et al., (2002).

\[
\text{F1 - HPV} = \frac{\text{F1} - \text{HPV}}{\text{HPV}} \times 100
\]

\[
\text{F1 - MPV} = \frac{\text{F1} - \text{MPV}}{\text{MPV}} \times 100
\]
Where  
F1: mean of hybrid.
HPV: the better parent involved in the hybridization.
MPV: the average value of the two parents involved in the hybridization.

The best hybrid was the one that has a positive value over better and mid-parent for any trait, while the hybrid which has negative value is better for larval duration.

RESULTS AND DISCUSSION

Data illustrated in Table 1 showed the amounts of hybrid vigour over the better parent. It revealed that the hybrid (1x2) was the best for cocoon weight (4.18 %), cocoon shell weight (11.285 %), cocoon shell ratio (2.796 %), pupal weight (4.456 %), hatchability percentage (10.309 %) and larval duration (-0.467 %). Hybrid 1x3 was also the best for cocoon weight (4.105 %), cocoon shell ratio (2.489 %) and fertility (0.671 %), while the hybrid 1x4 was only better for cocoon weight (7.759 %). As for egg traits, hybrid 2x3 was the best for fecundity (10.539 %), fertility (40.000 %) and better for hatchability percentage (10.263 %). Hybrid 2x4 was better for fecundity (6.618 %) and mature larval weight (16.391 %). Hybrid 3x4 was the best for mature larval weight (19.248 %) and better for larval duration (0.465 %).

Direction and values of heterosis were variable diversified for different traits and also among different hybrids. These results are in agreement with those of Rao and Sahai (1989); Singh et al., (1990); Rahman et al., (1992) and Singh et al., (2002) who studied heterosis in different hybrid combinations for several traits of B. mori L. including cocoon weight, cocoon shell weight, cocoon shell ratio, number of eggs laid per female, larval duration and larval weight.

In all estimates with respect to the better parents there was no single hybrid that exceeded them for all studied traits. Thus, there were no F1 hybrid that was the best and showed heterosis for all traits.

Table 2 presented the (hybrid vigour) over mid-parent value. It is clear that hybrid 1x2 was the best hybrid for cocoon weight (5.375 %), cocoon shell weight (14.597 %), cocoon shell ratio (4.953 %) and pupal weight (3.725 %). The hybrid 1x3 was better for hatchability percentage (10.627 %), while hybrid 1x3 was better for cocoon weight (5.261 %) and fertility (21.177 %). Hybrid 1x4 was better for shell weight (10.666 %) and shell % (4.930 %), while 2x3 was best for eggs fecundity (10.811 %), fertility (58.491 %) and hatchability % (11.023 %). Regarding mature larval weight, 2x4 hybrid was the best and recorded (19.367 %), while hybrid 3x4 was only the best for larval duration (0.233 %).

The results of this study indicated that some hybrids showed positive heterosis for some traits and the others showed negative heterosis. Therefore, the hybrids have positive hybrid vigour (heterosis) can be recommended for increasing silk and egg production and to select suitable parents for breeding.
Generally, it could be concluded that the estimation of heterosis from the mid-parent values showed an increase in most traits of the hybrids 1x2, 2x3 and 3x4. However, the vigour rates of cocoon weight, cocoon shell weight, cocoon shell ratio and pupal weight registered in 1x2 hybrid. This cross exhibited higher heterosis than other crosses for most of the traits because their parents are from different origins (P1) is a Chinese line and (2) is a Japanese one. It is already an established fact that the amount of heterosis obtained from hybrids depends largely on the genetic divergence of the populations from which the parental lines have been extracted (Moll et al., 1962), as diversity among breeds of B. mori, L. causes the opportunity to increase cocoon production efficiency through crossbreeding (Talebi et al., 2010). It is obvious that the estimation of heterosis over respective high and mid-parents revealed significant differences between the six crosses. As varied heterotic effect was observed from different traits for hybrid combinations in all parameters according to high and mid-parent value, it could be concluded that none of the hybrids under study showed the best values for all traits.

The obtained results are in accordance with those obtained by Narayanswami et al., (2002) and Debarage et al., (2011) who reported that traits are not similar and all yield contributing traits are rarely superior in a single hybrid. Therefore, it is necessary to identify the superior hybrids based on cumulative effects of various traits. However, the decrease in various values of heterosis is probably due to the reduction of genetic variation in the source lines as suggested by Grekov (2005).

REFERENCES


Rao, G.S. and Sahai (1989). Combining ability and heterosis studies in bivoltine strains of silkworm, B.


قوة الهجين الناتجة من تهجين نصف دورى لبعض سلالات ديدان الحرير التوتية

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في هذه الدراسة تم اختيار عدد (4) سلالات من ديدان الحرير التوتية وعمل كل التهجينات الممكنة بينها بنظام التهجين نصف الدورى وقد تم تسسيه السلالات الأربعة بأسماء كوديه وهي على التوالي (1) (2) (3) (4). وهذه السلالات من أصول صينية ويدانية وتركية ونيلندية وبذلك تم تتم التهجينات على النحو التالي (1)x(2) (3)x(4) (2)x(1) (3)x(2) (4)x(3).

وقد استمر عمل هذه التهجينات لمدة 3 سنوات هي (2009 - 2010) حيث تهدف هذه الدراسة لقياس قوة الهجين مقارنة الهجين بمنطقه الأبواء وأحس الأباء. ويقييم هذه الهجين تبين تفوق الهجين (1)x(2) في معظم الصفات الكمية والاقتصادية لكل من وزن الشراك الطازجة ووزن الشراك المجفف وال=DBQIPECL المطبق والعمر البشري وكان أفضل في صفة النسبه المئوية للفقس. كما كان الهجين (3)x(1) أفضل في صفة وزن الشراك الطازجة ونسبة الحرير وكذلك نسبة البيض المخصب.

بينما كان البيض (3)x(2) مميزا في الصفات المتعلقة بالبيض مثل عدد الكلي للبيض المنتج وكذلك المخصب والنسبة المئوية للفقس مع الأخذ في الاعتبار أن التقييم على أساس الأم الأول كان أفضل من التقييم على أساس متوسط الأباء. وبصفة عامة نشأ من أنه تأثير قوة الهجين ظاهرة عامة يمكن الاستفادة منها في جميع الكائنات الحية لتحسين صفاتها الاقتصادية.

قام بتحكيم البحث

كلية الزراعة - جامعة المنصورة
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أ.د / على ماهر العدل
أ.د / عادل محمد المصري
Table 1: Hybrid vigour values (%) over better-parent value for six silkworm hybrids.

<table>
<thead>
<tr>
<th>Hybrids</th>
<th>Traits</th>
<th>Pre-mating mean</th>
<th>Mean</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
<th>Mean</th>
<th>Male</th>
<th>Female</th>
<th>Mean</th>
<th>Male</th>
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<tbody>
<tr>
<td></td>
<td>Cocoon weight</td>
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</tr>
<tr>
<td></td>
<td>Male (g)</td>
<td>Female (g)</td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>P1P3</td>
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<td>8.296</td>
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</tr>
<tr>
<td>P1P4</td>
<td>1.480</td>
<td>5.394</td>
<td>0.519</td>
<td>15.000</td>
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<tr>
<td>L.S.D</td>
<td>0.111</td>
<td>0.100</td>
<td>0.105</td>
<td>0.035</td>
<td>0.174</td>
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<td>0.135</td>
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<tr>
<td>L.S.D</td>
<td>0.085</td>
<td>0.076</td>
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<td>----</td>
<td>0.132</td>
<td>----</td>
<td>0.174</td>
<td>----</td>
<td>0.111</td>
<td>0.73</td>
<td>----</td>
<td>23.702</td>
<td>5.295</td>
</tr>
</tbody>
</table>

L.S.D = 0.5% L.S.D = 0.1%
Table 2: Hybrid vigour values (%) over mid-parent value for six silkworm hybrids.

<table>
<thead>
<tr>
<th>Hybrids</th>
<th>Traits</th>
<th>Cocoon weight</th>
<th>Cocoon shell weight</th>
<th>Cocoon shell ratio</th>
<th>Pupal weight</th>
<th>Fecundity</th>
<th>Fertility</th>
<th>Hatchability %</th>
<th>Larval duration LD</th>
<th>Mature larval weight</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Male (g)</td>
<td>Female (g)</td>
<td>Mean</td>
<td>Male (g)</td>
<td>Female (g)</td>
<td>Mean</td>
<td>Male</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>P1P3</td>
<td></td>
<td>5.546</td>
<td>4.976</td>
<td>5.261</td>
<td>33.733</td>
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<td>-3.770</td>
<td>-3.164</td>
<td>21.177</td>
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<tr>
<td>P2P3</td>
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<td>-5.461</td>
<td>11.023</td>
<td>-0.233</td>
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<td>P2P4</td>
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<td>4.117</td>
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<tr>
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<td>2.307</td>
<td>-4.531</td>
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<tr>
<td>L.S.D 0.5%</td>
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<td>0.100</td>
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<td>0.030</td>
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<td>0.086</td>
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<tr>
<td>L.S.D 0.1%</td>
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<td>0.074</td>
<td>0.662</td>
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<td>0.150</td>
<td>----</td>
<td>20.549</td>
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