J.Agric.Chem.and Biotechn., Mansoura Univ.Vol. 3 (12): 439 - 446, 2012

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

Kosba, Z. A.* ; Souad M. Mahmoud and A. I. Abou Ahmed****
*** Fac. Of Agric., Mans. Univ.**
****Seric. Res. Dept., Plant Protec. Res. Inst. Agric. Res. Center**

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 Thae 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, 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 ^{o}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) :

$$\textbf{Cocoon shell ratio \%} = \frac{\textbf{Cocoon shell weight}}{\textbf{Fresh cocoon weight}} \times 100$$

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

$$\textbf{Hatchability percentage} = \frac{\textbf{Number of hatched eggs}}{\textbf{Number of fertilized eggs}} \times 100$$

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).

$$\textbf{Heterosis over better-parent value (HPV)} = \frac{\textbf{F1 - HPV}}{\textbf{HPV}} \times 100$$

$$\textbf{Heterosis over mid-parent value (MPV)} = \frac{\textbf{F1 - MPV}}{\textbf{MPV}} \times 100$$

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.

1

2

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 Chineese 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 non 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

Arnodova, K. and Grekov, D. (2005). Estimation of crossbreeding effects heterosis, general and specific combining ability for some productive traits in silkworm, *Bombyx mori*, L., Proc. of Black, Caspian Seas and Central Asian Silk Association (BACSA), Tashkent, Uzbekstan: 408-414.

Debaraj, Y.; N. Ibotombi Singia; L. Somen Singh and Ravindra Singh (2011). Studies on hybrid vigour in different crosses of the eri silkworm, Samia ricini Donovan and identification of superior hybrids. Sericologia, 5(2): 237-244.

Krishnaswami, S. (1978). New Technology of silkworm rearing. CSR & TI (Bulletin, No.2, Central Silk Board, 1-23).

Mavvajpour, M.I.; S.Z. Mirhosseiny and M. Ghanipour (2005). Genetic identification of economic characters in Iranian native silkworm groups Proc. of the 20th Congr. of the Int. Seric. Comm., 1: 250-256.

Moll, R.H.; Salhuana, W.S. and Robinson, H.F. (1962). Heterosis and genetic diversity in variety crosses of maize. (Crop Sci., 2: 197-288).

Narayanaswami, T.K.; Ananthanarayana, S.R. and Govindan, R. (2002). Studies on heterosis expression among selected multivoltine x bivoltine crosses of silkworm, *Bombyx mori*, L. Bull. Indian Acad. Seric., 6(10): 72-73.

Rahman, S.; K. Mahfuzar; T. Haqie and S.U. Ahmed (1992). Heterosis in breeding depression and correlation coefficient in silkworm, *Bombyx mori*, L. (English summary), (Bangladesh J. 2001. 20(2): 269-278).

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

Rao, P.S.; M. Rekha; N.V. Nishitha; S.N. Pallavi and K.C. Mahalingappa (2002). Hybrid vigour in polyvoltine x bivoltine (sex-limited cocoon colour) hybrid of silkworm *Bombyx mori*, L. (Int. J. Indust. Entomol. 4(1): 37-41).

Riday, H.; Brummer, E.C.; Cambell, T.A. and Luth, D. (2003). Comparison of genetic and morphological distance with heterosis between *Medicago sativa* and subsp. Falcate. Euphytica, 131: 37-45.

Singh, R.; D.R. Rao; B.K. Kariappa; P. Sanyal and V. Premalatha (2002). Studies on parthenogenetic development, hybrid vigour and cocoon shape variability in bivoltine F1 hybrids of silkworm, *Bombyx mori*, L. (Int. J. Indust. Entomol., 5(1): 59-65).

Singh, R.; J. Nagaraju; P.R.M. Rao; V. Premalatha; K. Vijayaraghavan and Sengupta (1990). Heterosis analysis in the silkworm, *Bombyx mori*, L. Sericologia, 38(1): 155-158.

Talebi, E.; G. Subramanya and Shivakumar Bakkappa (2010). An investigation on heterosis and inbreeding depression in the silkworm (*Bombyx mori*, L.) (ARPN J. of Agric. And Biol. Sci., 5(3): 52-55.).

Tanaka, Y. (1964). "Seriology" (Central Silk Board, Bombay, 95-B, Meghdoot, Marine Drive pp. 216-220).

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

زكريا عبد المنعم كسبه1 ، سعاد مرسى محمود2 و أحمد إبراهيم أبو أحمد2
1. قسم الوراثة – كلية الزراعة – جامعة المنصورة – مصر
2. قسم الحرير – معهد بحوث وقاية النبات – مركز البحوث الزراعية

فـي هـذه الدراسـة تـم إختيـار عـدد (4) سـلالات مـن ديـدان الحريـر التوتيـة وعمـل كـل التهجينات الممكنة بينها بنظام التهجين نصف الدوري ولقد تم تسميه السلالات الأربعة بأسماء كوديـه وهى على التوالي (1) (2) (3) (4). وهذه السلالات من أصول صينية ويابانيـة وتركيـة وتايلانديـة وبذلك تمت التهجينات على النحو التالي (2x1) (3x1) (4x1) (3x2) (4x3).

وقد إستمر عمل هذه التهجينات لمدة 3 سنوات هي (2008 – 2009 – 2010) حيث تهدف هذه الدراسة لتقدير قوة الهجين مقارنة الهجن بمتوسط الآباء وأحسن الآباء. وبتقييم هذه الهجن تبين تفوق الهجن (2x1) في معظم الصفات الكمية والإقتصادية لكل من وزن الشرانق الطازجة ووزن الشرانق الجافة ووزن العذارى والعمر اليرقى وكان أفضل في صفة النسبة المئوية للفقس.

كما كان الهجن (3x1) الأفضل في صفة وزن الشرانق الطازجة ونسبة الحرير وكذلك نسبة البيض المخصب.

بينما كان الهجن (3x2) متميزاً في الصفات المتعلقة بالبيض مثل العدد الكلى للبيض المنتج وكذلك المخصب والنسبة المئوية للفقس مع الأخذ في الإعتبار أن التقييم على أساس الأب الأعلى كان أفضل من التقييم على أساس متوسط الآباء. وبصفة عامة إتضح أن ظاهرة قوة الهجن ظاهرة عامة يمكن الإستفادة منها في جميع الكائنات الحية لتحسين صفاتها الإقتصادية.

قام بتحكيم البحث

أ.د / على ماهر العدل	**كلية الزراعة – جامعة المنصورة**
أ.د / عادل محمد المصرى	**كلية الزراعة – جامعة الاسكندريه**

Table 1 : Hybrid vigour values (%) over better-parent value for six silkworm hybrids.

Traits / Hybrids	Cocoon weight		Mean	Cocoon shell weight		Mean	Cocoon shell ratio		Mean	Pupal weight		Mean	Fecundity	Fertility	Hatchability %	Larval duration LD	Mature larval weight
	Male (g)	Female (g)		Male (g)	Female (g)		Male	Female		Male	Female						
P1P2	4.496	3.883	4.189	3.592	18.704	11.285	-1.840	7.432	2.796	6.088	2.825	4.456	1.896	0.671	10.309	-0.467	9.460
P1P3	4.891	3.319	4.105	1.414	-49.317	-47.903	-4.294	9.272	2.489	-18.000	1.407	8.296	-4.265	0.671	1.204	0.000	3.127
P1P4	1.480	5.394	3.437	0.519	15.000	7.759	-1.227	5.405	2.089	-1.508	1.787	-1.647	-1.896	-7.958	1.204	0.000	8.678
P2P3	-1.195	2.050	0.427	-4.283	-52.422	-28.352	-5.660	1.325	-2.167	-22.718	-5.623	-14.170	10.539	40.000	10.263	-0.465	13.486
P2P4	4.402	4.673	3.037	-5.674	19.176	6.751	-7.742	4.054	1.500	-1.353	-5.148	-3.250	6.618	-30.000	7.105	0.647	16.391
P3P4	0.701	5.314	3.002	-1.544	-48.476	-25.010	-5.660	7.947	1.143	-20.201	-5.400	-12.800	6.256	-15.741	8.324	-0.465	9.248
L.S.D 0.5%	0.111	0.100	0.105	0.035	0.174	0.104	0.161	0.229	0.195	0.146	0.125	0.135	31.237	6.970	21.295	0.539	0.333
L.S.D 0.1%	0.085	0.076	-----	0.027	0.132	-----	0.122	0.174	-----	0.111	0.73	-----	23.7027	5.295	20.964	0.409	0.253

Table 2 : Hybrid vigour values (%) over mid-parent value for six silkworm hybrids.

Traits / Hybrids	Cocoon weight		Mean	Cocoon shell weight		Mean	Cocoon shell ratio		Mean	Pupal weight		Mean	Fecundity	Fertility	Hatchability %	Larval duration LD	Mature larval weight
	Male (g)	Female (g)		Male (g)	Female (g)		Male	Female		Male	Female						
P1P2	5.556	5.195	5.375	7.595	21.600	14.597	0.629	9.278	4.953	6.385	1.066	3.725	3.614	8.080	10.627	0.000	15.574
P1P3	5.546	4.976	5.261	4.190	-28.373	-12.091	-3.106	10.368	3.631	-6.983	0.162	-3.410	-2.415	21.177	-0.925	0.703	4.384
P1P4	1.610	6.254	3.932	6.255	15.078	10.666	4.455	5.405	4.930	0.859	3.460	2.159	0.681	3.616	2.355	0.496	11.970
P2P3	-0.719	2.708	0.994	-3.466	-33.733	-18.599	-4.459	4.082	-3.770	-12.547	1.624	-5.461	10.811	58.491	11.023	-0.233	18.449
P2P4	0.279	7.880	4.079	-3.673	22.164	-9.245	-4.667	5.842	1.175	0.741	4.117	2.429	7.620	-26.316	8.015	0.467	19.367
P3P4	1.366	7.862	4.614	4.564	-27.155	-8.795	-1.316	9.030	3.857	-11.369	2.307	-4.531	6.994	-9.000	8.498	-0.233	8.015
L.S.D 0.5%	0.097	0.100	0.098	0.030	0.151	0.090	0.139	0.198	0.168	0.127	0.109	0.118	27.049	6.978	23.898	0.467	0.288
L.S.D 0.1%	0.074	0.662	-----	0.023	0.114	-----	0.106	0.150	-----	0.096	0.082	-----	20.549	5.295	18.155	0.354	0.219