http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 8 (1): 68-72, 2005
ISSN 1028-8880

Combining Ability Estimation in Popular Bivoltine Mulberry Silkworm, *Bombyx mori* L.

[1]M. Iftekher Islam, [1]Ismat Ara Ali and [2]Tajimul Haque
[1]Genetics Research Laboratory, Department of Zoology, Rajshahi University, Rajshahi-6205, Bangladesh
[2]Bangladesh Sericulture Research and Training Institute, Rajshahi, Bangladesh

Abstract: In a line × tester programme, eight existing and four newly developed popular bivoltines were utilized as line and tester to estimate the combining abilities in respect of effective rate of rearing by number and weight, single cocoon weight, shell weight and shell ratio. Among the lines, BSRTI-4, BSRTI-5 and BSRTI-7 were emerged as the best general combiners while CH-BV_2 exhibited significantly higher general combining for effective rate of rearing by weight, single cocoon weight, shell weight and shell ratio (%), among testers. Here silkworm combinations, BSRTI-4 × CH-BV_2, BSRTI-5 × CH-BV_2 and BSRTI-7 × CH-BV_2 exhibited significant positive gca effect for most of the economic characters. Hence these crosses may be recommended for superior quality bivoltine silk production as per international grade in the pre and post winter rearing seasons of Bangladesh.

Key words: *Bombyx mori* L., combining ability, line × tester

INTRODUCTION

Discovery of a marked luxuriance in F_1 hybrids for economic traits in silkworm and their introduction instead of pure strains is completely a new approach. For preparation of highly productive combinations, selection of suitable parents and knowledge on the nature and magnitude of gene action and number of genes controlling the expression of economic traits is of paramount importance to the breeder to have a sound breeding programme. Studies on combining ability provide the information for selection of desirable parents and hybrids for future exploitation. Biometrical methods like diallel crosses and line × tester analysis have been extensively used for determination of combining ability in silkworm, *Bombyx mori*.

The application of diallel analysis for the identification of parents and crosses superior for the desired traits have been reported by different workers in *Bombyx mori*[1-12]. Combining ability in silkworm through line × tester had also been reported[13-18]. However in Bangladesh, heterosis and combining ability was studied by Nahar and Khalequzzaman[19], Rahman and Jahan[20]. But the application of line × texter analysis for determination of combining ability in bivoltine silkworm is very limited. This study was an attempt in that direction by employing a line × tester design for existing and newly developed popular bivoltine silkworm and to identify the best general combiners for cocoon yield and cocoon yield contributing characters.

MATERIALS AND METHODS

Eight existing bivoltine silkworm races viz., Dong-34 (M) × (BSRTI-1), Dong-34 (P) × (BSRTI-2), RB × SB (M)-(BSRTI-3), Ziangsu-12 (J) × (BSRTI-4), Ziangsu-12 (P) × (BSRTI-5), RB-001 × (BSRTI-6), RB-111 × (BSRTI-7), BSRTI-112 × (BSRTI-8) and four newly developed highly productive popular bivoltine races namely, CH-BV_1(T_1), CH-BV_2(T_2), JP-BV(T_3) and S-98(T_4) were collected from the Germplasm Bank of Bangladesh Sericulture Research and Training Institute (BSRTI), Rajshahi. Finally, experimental materials were developed and a total of 32 hybrid combinations were prepared following the approach of Kempthorne[21]. F_1 hybrids along with parental breeds were reared in three replications during October-November, 2000. Improved technology of silkworm rearing[22] was followed during the course of the experiment. Ripen silkworm larvae were mounted on the bamboo mountages. Cocoon harvested on the 6th day after mounting.

Observations were made on five economically important contributing characters namely, effective rate of rearing by number and by weight (ERR/No and ERR/Wt.),

Corresponding Author: Dr. M. Tajimul Haque, Senior Scientific Officer,
Bangladesh Sericulture Research and Training Institute, Rajshahi-6100, Bangladesh
E-mail: iftekher_bsrti_phd@yahoo.com

single cocoon weight, single shell weight, shell ratio percentage were recorded. The collected data were subjected to line × tester analysis [21].

RESULTS AND DISCUSSION

The results of analysis of variance exhibited highly significant differences among the treatments, parents and crosses for all the characters considered (Table 1). Here line × tester interaction showed significant value for all the characters except cocoon yield by number. Highly significant differences were also served for the variance components in parents vs crosses for all the characters except cocoon yield by number. Mean sum of squares due to tester showed the same trend.

The results further revealed that BSRTI-4 and 5 recorded significantly higher general combining ability for all the characters was emerged as the best general combiner among the whole breeding lines (Table 2). Similarly BSRT1-6 and 7 also recorded significantly higher general combining ability (p=0.01) for effective rate of rearing by number, by weight, single cocoon weight and shell ratio percentage. Among the tester, only tester-2 CH (BV_2) exhibited significantly higher general combining ability for effective rate of rearing by weight, single cocoon weight, shell weight and shell ratio. The crosses BSRTI-4 × CH-BV_2, BSRTI-5 × CH-BV_2 and BSRTI-7 × CH-BV_2 showed significantly higher specific combining ability (sca) for most of the economic characters. The crosses BSRTI-1 × S-98 showed significantly higher SCA for shell weight and shell ratio (Table 3). The crosses BSRTI-2 × S-98, BSRTI-3 × CH-BV_2 and BSRTI-8 × S-98 exhibited significantly higher SCA effect for single cocoon weight, shell weight and shall ratio while BSRTI-6 × CH-BV_2 showed significantly higher SCA for ERR by number and ERR by weight.

In the present investigation, BSRTI-4, 5 and 7 exhibited higher positive general combing ability for almost all the economic characters while among the testers, tester-2 (CH-BV_2) showed significantly higher general combining ability for ERR by weight, single cocoon weight, shell weight and shell ratio percentage.

Table 1: Analysis of variance for line × tester analysis for rearing and cocoon characters in bivoltine silkworm, *Bombyx mori* L.

		Mean sum of square				
		Effective rate of rearing				
Source	df	By No.	By wt.	Single cocoon wt.	Single shell wt.	Shell ratio
Replication	2	402103.012NS	2.912 NS	0.005 NS	0.001 NS	0.130 NS
Treatment	43	1079490.001**	14.982**	0.075**	0.005**	5.527**
Parents	11	2014573.151**	13.547**	0.017**	0.004**	2.121**
Parents vs Crosses	1	299915.051 NS	34.642**	0.023**	0.006**	10.612**
Crosses	31	985798.500**	14.521**	0.089**	0.005**	4.512**
Lines	7	3512419.00**	48.521**	0.210**	0.001	8.932**
Testers	3	285872.135 NS	6.992**	0.125**	0.004**	1.001**
Line x Testers	21	407322.415 NS	3.015**	0.021**	0.003**	4.512**
Error	86	251007.091	0.975	0.003	0.001	0.261

Table 2: Effect of general combining ability (gca) of parents for 5 parameters in bivoltine silkworm, *Bombyx mori* L.

		Mean sum of square				
		Effective rate of rearing				
		By No.	By wt.	Single cocoon wt.	Single shell wt.	Shell ratio
Line						
BSRTI	1	597.192**	-2.292**	0.231**	-0.029**	1.051**
	2	-205.100 NS	3.105**	0.182**	-0.021**	-0.812**
	3	-312.072 NS	-0.712**	-0.031*	0.051**	0.917**
	4	570.252**	2.572**	0.162**	0.020**	1.612**
	5	600.121**	1.823**	0.082**	0.028**	0.782**
	6	332.043**	1.947**	0.067**	0.001NS	0.821**
	7	532.433**	1.813**	0.099**	-0.039**	1.921**
	8	492.218**	0.709 NS	-0.0212**	0.019**	-0.674**
Tester						
CH(BV_1)	1	85.927 NS	-0.312 NS	-0.049**	-0.004**	0.251 NS
CH(BV_2)	2	50.421 NS	1.131**	0.121**	0.035**	0.529**
JP(BV)	3	48.212 NS	0.931**	-0.065**	-0.017**	-0.017 NS
S-98	4	198.191 NS	-0.148 NS	-0.010 NS	0.019**	-0.169 NS
SE(I)		149.9813	0.2811	0.0171	0.0027	0.1631
SE(t)		107.2921	0.1895	0.0113	0.0023	0.1182

*p = 0.05, **p = 0.01, NS: Non-significant

Table 3: Estimate values of specific combining ability (sca) effects of line and tester

Line	×	Testers	Mean sum of square				
			Effective rate of rearing				
			By No.	By wt.	Single cocoon wt.	Single shell wt.	Shell ratio
BSRTI-1	×	T_1	167.892	-0.130	0.092	0.008	0.992
		T_2	298.103	0.412	0.041	-0.007	-0.352*
		T_3	-499.119*	-0.185	0.392	0.051	-0.0973*
		T_4	-675.162*	-0.173	-0.057*	0.512**	4.117**
BSRTI-2	×	T_1	273.891	-0.567	-0.059	0.059	0.712
		T_2	590.472	0.782	0.023	-0.006*	0.118
		T_3	138.120	-0.995	-0.292	0.012	0.412
		T_4	-667.513*	1.213*	0.105*	0.015*	4.298**
BSRTI-3	×	T_1	433.913	-0.205	-0.042	-0.018	1.421
		T_2	78.953	1.721	0.172*	0.037	0.192*
		T_3	29.419	-0.991	0.134	0.029	0.432
		T_4	-400.123	-0.897	-0.069	-0.027*	-1.033**
BSRTI-4	×	T_1	-110.413	1.235*	0.129	0.042*	0.628*
		T_2	629.892	1.721**	0.175**	0.037*	1.218**
		T_3	-201.197	-0.991	0.212	-0.031*	0.191
		T_4	-275.891	-0.897	-0.082	0.052	-0.643
BSRTI-5	×	T_1	-87.972	0.046	0.031	-0.006	0.512
		T_2	120.451	-0.512	0.129*	0.019*	1.345**
		T_3	-135.461	0.129	-0.023	0.005	0.113
		T_4	-309.210	-0.732	-0.046	-0.006	0.219
BSRTI-6	×	T_1	-208.812	0.732	0.062	0.004	-0.785
		T_2	803.147*	0.897*	0.059	0.003	1.312
		T_3	-100.823	-1.021**	-0.003	-0.006	0.019
		T_4	-89.913	-1.001**	0.019	-0.005	-0.672
BSRTI-7	×	T_1	112.821	-0.987	0.079	-0.019**	0.0921
		T_2	890.512*	1.003*	0.079*	0.019	1.512**
		T_3	-75.891	-0.853*	-0.042	0.017	0.450
		T_4	-150.210	0.409	-0.071	-0.012	1.391**
BSRTI-8	×	T_1	735.831	0.872	0.015	-0.003	-0.225
		T_2	631.421*	-1.413*	-0.129*	0.029	0.183
		T_3	-199.00	-1.131**	0.097	-0.027**	0.974
		T_4	-89.193	0.550	0.136**	0.042**	1.637**

*p = 0.05, **p = 0.01

Similarly silkworm hybrids BSRTI-4 × CH-BV_2, BSRTI-5 × CH-BV_2 and BSRTI-7 CH-BV_2 showed significantly higher specific combining ability effect most of the economic character. This is due to additive and non-additive gene action for cocoon yield and cocoon yield contributing characters in bivoltine silkworms. Additive and non-additive gene action for yield and yield contributing characters in different plants have been observed by group of workers[23-25]. Similarly this additive and non-additive gene action for cocoon yield and cocoon yield contributing characters in silkworm, *Bombyx mori* have also been observed by so many silkworm breeders[2,26-29] also found and additive gene action in the inheritance of cocoon weight and shell weight in non-mulberry silkworm, *Antheraea mylitta*. Hybrids exhibiting high specific combining effects involving parents of high general combining ability can be used in race improvement programme[25]. The results obtained in this study are in good agreement with that Rahman and Jahan[19], Subba Rao and Sahai[16], Nahar and Khalequzzaman[18], Lea[12], Bhargava *et al.*[30], Rajalakshmi *et al.*[31] and Chauhan *et al.*[32].

The overall results of the present study revealed that the crosses BSRTI-4 × T_2 (CH-BV_2), BSRTI-5 × T_2 (CH-BV_2) and BSRTI-7 × T_2 (CH-BV_2) have got the potentiality with respect to major economic characters.

REFERENCES

1. Krishnawami, S., M.S. Jolly and S. Dubba Rao, 1964. Diallel analysis of quantitative characters in multivoltine races of silkworm. Ind. J. Genet. Plant Breed, 34A.

2. Gamo, T. and Hirabayashi, 1983. Genetic analysis of growth rate, population rate and some quantitative characters by diallel cross in silkworm, *Bombyx mori* L. Japan J. Breed, 33: 178-190.
3. Gamo, T., Y. Otsuka, T. Fujishima, T. Hirobe and Y. Tazima, 1985. Estimation of combining ability and genetic analysis by diallel crosses between regional races of silkworm, I. Rearing performances of cocoon yields. Tech. Bull. Seri. Expt. Sta., 126: 93-120.
4. Gamo, T., Y. Otsuka, T. Fujishima, T. Hirobe and Y. Tazima, 1985. Estimation of combining ability and genetic analysis by diallel crosses between regional races of silkworm, 2. Shape and size of cocoon. Tech. Bull. Seri. Expt. Sta., 126: 121-135.
5. Hirabayashi, T. and Gamo, 1985. Study on the combining ability of Japanese and Chinese silkworm races with different voltinism by diallel cross. III. Shape and Size of cocoon and their genetic analysis. Tech. Bull. Seri. Expt. Sta., 125: 91-104.
6. Siddiqui, A.A., A.K. Sengupta, A. Kumar, D.P.D. Mohapatra and K. Sengupta, 1988. Studies on the genetic architecture and gene actions involving yield components in diallel populations of tropical tasar silkworm, *Anthera mylitta* D. Sericologia, 98: 107-113.
7. Sengupta, K., 1988. Studies on the genetic architecture and gene actions involving yield and yield components in diallel populations of tropical tasar silkworm, *Anthera mylitta* D. Sericologia, 98: 107-113.
8. Subba Rao, G. and V. Sahai, 1989. Combining ability and heterosis in bivoltine strains of silkworm. *Bombyx mori* L. Uttara Pradesh J. Zool., 9: 150-164.
9. Satenalli, S.B., R. Govindar and J.V. Goud, 1989. Genetic analysis of some quantitative traits by diallel cross in silkworm, *Bombyx mori* L. Sericologia, 29: 333-342.
10. Sarkar, A., N.K. Das and B.C. Das, 1991. A diallel cross analysis of the cocoon weight in the silkworm *Bombyx mori* L. Sericologia, 31: 301-306.
11. Bhargava, S.K., V. Thaigarayan, M. Ramesh Babu and B. Nagaraja, 1993. Combining ability and genetic analysis of quantitative traits in silkworm, *Bombyx mori* L. J. Genet. and Breed, 46: 327-330
12. Lea, H.Z., 1998. Combining ability and heritabilty estimation for Sri Lanka stock of mulberry silkworm, *Bombyx mori* L. (half diallel cross) Sericologia, 38: 425-436.
13. Datta, R.K. and G.D. Pershad, 1988. Combining ability among multivoltine × bivoltine silkworm, *Bombyx mori* L. Sericologia, 28: 21-29
14. Gupta, B.K., M. Verma, V.K. Kharoo and K. Sinhh, 1992. Promising Bi × Bi hybrids of silkworm, *Bombyx mori* L. Sericologia, 32: 197-203.
15. Subba Rao, G., 1983. Line × tester analysis of some characters in bivoltine silkworm. National Seminar or Silk Research and Development, 10-13 March, Central Silk Board, Bangalore, Indian, Abstr. No.15, pp: 15.
16. Suba Rao, G. and V. Sahai, 1990. Combining ability and heterosis in bivoltine stains of silkworm, *Bombyx mori* L. U.P.J. Zool., 9: 150-164.
17. Singh, R., D.R. Rao, V. Premalatha, S. Mondal, B.K. Kariappa, K.P. Jayaswal and R.K. Datta, 2001. Evaluation of combining ability in hybrid between low, medium and high cocoon weight of polyvoltine and bivoltine breeds of silkworm. Indian Silk, 39: 5-6.
18. Ravindra, S., V. Premalatha, D. Raghavendra Rao, B.K. Kariappa, K.P. Jayaswal and R.K. Datta, 2001. Line × tester analysis in Sex-limited strains of mulberry silkworm, *Bombyx mori* L. with coloured cocoons. Indian J. Seric., 40: 39-43.
19. Nahar, J. and M. Khalequzzaman, 1994. Studies on the F1 hybrids of silkworm *Bombyx mori* L. I. Combining ability of some characters among multivoltine and bivoltine varieties. Uni. J. Zool. Rajshahi Univ., 13: 49-54.
20. Rahman, S.M. and M.S. Jahan, 1997. Heterosis and combining ability estimates for cocoon breadth in silkworm, *Bombyx mori* L. Bull. Sericult. Res., 8: 7-11.
21. Kempthorne, O., 1957. An introduction to Genetic Statistics. John Wille and Sons, New York.
22. Krishnaswami, S., 1978. New technology of silkworm rearing. CSRTI, Mysore (India) Bulletin No. 2, pp: 1-23.
23. Rajara, M.P. and R.V. Maheshwari, 1996. Combining abilities in wheat using line × tester analysis. Madras Agric. J., 83: 107-110.
24. Kurian, A. and K.V. Peter, 1995. Line × tester analysis for yield and processing characteristics in tomato. J. Trop. Agric., 33: 23-26.
25. Shanmugavalli, N. and I.D. Vigendra Das, 1996. Line × tester analysis of combining ability in cotton. Madras Agric. J., 82: 449-452.
26. Govindan, R., S.B. Magadum and S.B. Satenahalli, 1987. Breeding with some Polyvoltine and bivoltine strains of the silkworm *Bombyx mori* L. Sericologia, 27: 597-604.

27. Strunnikov, V.A., 1986. Nature of heterosis and combing ability in the silkworm. Theor. Applied Genet., 72: 503-512.
28. Pershad, G.D., R.K. Datta, H.V. Vijaya Kumar, S.K. Bhargava and M.S. Jolly, 1986. Performance of some multivoltine races of *Bombyx mori* L. Sericologia, 26: 259-301.
29. Jolly, M.S., V.N. Bardaiyar, S.S. Sinha and Rajdan, 1972. Performance of the four races of Antheraca mylitta D. in relation to triallel crossing system. Ind. J. Seric., 11: 58-62.
30. Bhargava, S.K., E. Rajalakshmi and V. Thiagarajan, 1994. An evaluation index for silk yield contributing traits in *Bombyx mori* L. Indian Textile J., 105: 83-84
31. Rajlakshmi, E., T.P.S. Chauhan, V. Thiagarajan, V. Lakshmanan and C.K. Kamble, 1997. Line × tester analysis of combing ability in new genotypes of bivoltine silkworm, *Bombyx mori* L. Indian J. Agric. Sci., 67: 1- 4.
32. Chauhan, T.P.S., V. Lakshmanan and E. Rajalakshmi, 2000. Combining ability studies in bivoltine silkworm *Bombyx mori* L. Indian J. Seric., 39: 127-130.