Int. J. Indust. Entomol. Vol. 3, No. 2, 2001, pp. 153~155

International Journal of
Industrial Entomology

Studies on the Evaluation of Some Three-Way Cross Hybrids of the Silkworm, *Bombyx mori* L.

Tribhuwan Singh*

Central Silk Board, 6th Floor, BTM Layout, Madiwala, Bangalore 560 068, India.

(Received 29 August 2001; Accepted 27 October 2001)

Eight new three-way cross heterozygotic hybrid genotypes of the mulberry silkworm *Bombyx mori*, resulted from hybridization of multivoltine as female and bivoltine F1 hybrid as male component, have been evaluated for the cumulative effect of nine traits of commercial economic importance with the objective of selecting out the most prospective ones for their exploitation as an intermediate technology during unfavorable season. Five of them namely, G(P5 x NB18) (E.I. = 57.23); S(NB18 x P5) (E.I. = 55.48); S(P5 x NB18) (E.I. = 52.44); S(KB x NB7) (E.I. = 50.42) and S(NB7 x KB) (E.I. = 50.16) have scored higher values of the Evaluation Index (E.I.) and could be selected in the same order for exploitation during unfavorable seasons in tropical climates.

Key words : Evaluation, Three-way cross, Silkworm, *Bombyx mori*

Introduction

Hybrids in general have greater vigor, faster growth, better productivity, higher resistance to diseases and unfavorable climatic conditions besides better adaptability expressed in the form of stability of crops (Ashoka and Govindan, 1990; Singh and Rao, 1993). Evaluation system varies from breeder to breeder with the magnitude of objectives (Singh *et al.*, 1992) but the primary goal of any silkworm breeding is the simultaneous genetic improvement of multiple traits (Mano *et al.*, 1993; Singh and Rao, 1993). In order to judge superiority of hybrid genotypes impartially, a common evaluation index is necessary to be adopted giving equal emphasis to all the commercial economic traits. As during hot and humid season, bivoltine F1 rearing is unsuccessful at field level and rearing of multivoltine indigenous races gives very poor yield (Das *et al.*, 1994), an opportunity was taken in the present study to develop an intermediate technology for commercial use through exploitation of three-way crosses. The advantage of three-way cross hybrid was advocated by many workers (Das *et al.*, 1994; Krishnaswamy, 1987; Rao *et al.*, 1989).

To evaluate the potentiality of three-way crosses unambiguously and to select the prospective ones for the inclusion in the competitive and productive testing, Evaluation Index (E.I.) method derived from variation index value giving equal emphasis to all the traits of commercial importance, used in Japanese Education System to determine students merit was utilized as advocated by Mano *et al.* (1992).

Materials and Methods

The male component of four bivoltine silkworm hybrid (F1) genotypes was crossed with female component of multivoltine genotype 'G' (evolved genotype with yellow elongated oval cocoons) and Sarupat (S) (indigenous genotype with white spindle shaped cocoons) to obtain three-way cross hybrids, which formed the experimental material for the present study (Table 1). These hybrids were reared during unfavorable season (June-July: known for high temperature, 27-36°C and high humidity, 80-96%) with five replications of one Disease Free Laying (DFL) in each in a completely random block following standard schedule of young and late age silkworm rearing techniques. The values of nine traits of economic importance, namely, fecundity, yield/10,000 larvae by number and weight (ERR number and weight), single cocoon and shell weight, absolute silk content, yield/100 DFLs, average filament length and average non-breakable filament length

*To whom correspondence should be addressed.
Central Silk Board, 6th Floor, BTM Layout, Madiwala, Bangalore 560 068, India.

Table 1. Performance of different economic traits in three-way cross hybrids of silkworm (*Bombyx mori*)

Hybrids	Fecundity (eggs)	Yield/10000 larvae by		Single weight (g)		Absolute silk content	Yield/100 dfls (kg)	Filament length [m]	
		number.	weight (g)	Cocoon	Shell			AFL	NBFL
G (NB7 x KB)	398	7070	10914	1.587	0.226	1951	39.38	814	777
G (KB x NB7)	425	7316	12214	1.671	0.279	2041	48.11	838	773
G (P5 x NB18)	439	7307	12193	1.722	0.293	2141	49.88	861	724
G (NB18 x P5)	432	7755	13389	1.764	0.293	2272	53.55	952	871
S (NB7 x KB)	469	9036	13726	1.512	0.257	2322	58.22	750	688
S (KB x NB7)	472	8725	13592	1.561	0.259	2260	59.55	755	698
S (P5 x NB18)	460	7832	12917	1.663	0.279	2185	54.28	899	758
S (NB18 x P5)	471	8914	14257	1.586	0.266	2371	63.03	857	720
Average	446	7,994	12,900	1.633	0.269	2,193	53.25	841	751
S.D.	26.76	786	1078	0.085	0.022	143	7.48	68	59

S : Sarupat ; S.D. : Standard Deviation (n-1); AFL : Average Filament Length; NBFL : Non-breakable filament length

were collected. The experiment was repeated thrice and the average values were subjected for calculation of Evaluation Index (E.I.) (Mano *et al.*, 1993) as follows:

$$E.I. = \frac{10(A-B)}{C} + 50$$

Where

A = Value obtained for a particular trait of the particular hybrid
B = Mean value of a particular trait of all the considered hybrids
C = Standard Deviation (n-1) of a particular trait of all the considered hybrids
10 = Standard unit
50 = Fixed value

The obtained indices for all the traits of a particular hybrid were combined to obtain single value, which is actually the E.I. The average E.I. value fixed to select a hybrid genotype is > 50. Only the hybrids with an E.I. value higher than 50 have been considered of great economic importance.

Results and Discussion

The mean value of each trait, their respective Standard Deviation (Table 1) and Evaluation Index of each individual trait and their sum and average for each hybrid (Table 2) were calculated.

Silkworm hybrids are tested, evaluated and selected for the presence of useful economic characters (Singh and Rao, 1993). In the present study, S (KB x NB7) for fecundity (472 eggs); S (NB7 x KB) for ERR number (9036); S (NB18 x P5) for ERR weight (14,257 g), absolute silk content (2371) and yield/100 DFLs (63.03 kg); G (NB18 x P5) for single cocoon weight (1.764 g), single shell weight (0.293 g), average filament length (952 m) and non-breakable filament length (871 m); G (P5 x NB18)

Table 2. Evaluation Index (E.I.) of different economic traits in three-way cross hybrids of silkworm (*Bombyx mori*)

Hybrids	Fecundity	Yield/10000 larvae by		Single weight		Absolute silk content	Yield/100 dfls	Filament length (m)		Total value	Average value
		number.	weight	Cocoon	Shell			AFL	NBFL		
G (NB7 x KB)	32.06	38.24	31.61	44.59	30.45	33.07	31.46	46.03	54.41*	341.92	37.99
G (KB x NB7)	42.15	41.37	43.64	54.47*	54.55*	39.37	43.11	49.55	53.73*	421.94	46.88
G (P5 x NB18)	47.38	41.26	43.44	60.47*	60.90*	46.36	45.49	52.94*	45.42	443.66	49.29
G (NB18 x P5)	44.76	46.96	54.54*	65.41*	60.90*	55.52*	50.40*	66.32*	70.34*	515.15	57.23*
S (NB7 x KB)	58.59*	63.26*	57.66*	35.76	44.54	59.02*	56.64*	36.62	39.32	451.41	50.16*
S (KB x NB7)	59.72*	59.30*	56.42*	41.41	45.45	54.68*	58.42*	37.35	41.02	453.77	50.42*
S (P5 x NB18)	55.23*	47.94	50.16*	53.53*	54.55*	49.44	51.38*	58.53*	51.19*	471.95	52.44*
S (NB18 x P5)	59.34*	61.70*	62.59*	44.47	48.64	62.45*	63.07*	52.35*	44.75	499.36	55.48*

for single shell weight (0.293 g) performed better in comparison to other hybrids (Table 1). As the varying hybrid genotypes behave differently for different economic traits, it becomes mandatory effort to select a fairly reliable hybrid genotype for exploitation. Therefore, the strategy to increase the efficiency of breeders in short-listing the effective crosses is to set an evaluation index giving equal emphasis to all the traits. Such evaluation index selection strategy is being in practice in plants and live stock breeding (Hazel, 1943; Arunachalam and Bandopadhaya, 1984). However, attempts have been made in the past for an evaluation index and indexing breeds based on one or two economic traits in the silkworm *Bombyx mori* (Udupa and Gowda, 1988; Singh *et al.*, 1990, 1994). But it is of immense importance to select hybrids unambiguously keeping in view the contribution of various economic traits (Minagawa and Otsuka, 1975; Mano *et al.*, 1993; Singh and Rao, 1993). In the present study, average highest value of E.I. (57.23) was obtained in the hybrid G (NB18 x P5), while index value for the other seven hybrids vary from 37.99 to 55.48 (Table 2). Only five hybrid genotypes have scored above 50 index values. The hybrid S (NB18 x P5) with E.I. value of 55.48 was the second only after G (NB18 x P5) (57.23), while S (P5 x NB18) (52.44), S (KB x NB7) (50.42) and S (NB7 x KB) (50.16) progressively followed. Considering the traits individually, the hybrid genotypes G (NB18 x P5) and S (P5 x NB18) exceeded an index value of 50 for seven of the traits, while S (NB18 x P5) for six, S (KB x NB7) and S (NB7 x KB) for five, G (KB x NB7) and G (P5 x NB18) for three and G (NB7 x KB) for single trait.

The above result indicates inconsistency when the E.I. of component traits were considered, reflecting the fact that overall index value may agree for common platform but the component traits may fail. Present study reveals that not even a single hybrid have scored above 50 index value for all the economic traits considered (Table 2), while the goal was achieved by considering all the traits together by five hybrid genotypes, suggesting the fact that for screening the hybrids, all the traits of commercial economic importance should be considered in the formation of aggregate breeding index value. Further, the hybrid S (KB x NB7) (50.42); S (NB7 x KB) (50.16) and S (P5 x NB18) (52.44) having more or less same index value suggests that these hybrids may have equal potentialities. In such cases, they can be differentiated on the basis of individual trait index value, considering the importance for the breeding objectives.

The results obtained clearly demonstrates that during hot and humid season when bivoltine F1 hybrid rearing is unsuccessful at field level and rearing of indigenous races gives very low and poor quality yield (Das *et al.*, 1994), three-way crosses can play a significant role as an intermediate technology for commercial use.

References

Arunachalam, V. and A. Bandopadhaya (1984) A method to make decision jointly on a number of dependent characters. *Indian J. Genetics* **44**, 419.

Ashoka, J. and R. Govindan (1990) Heterosis for pupal and related traits in single and double cross hybrids of bivoltine silkworm *Bombyx mori* L. *Entomon.* **15**, 203-206.

Das, S. K., S. Patnaik, B. Ghosh, T. Singh, B. P. Nair, S. K. Sen and G. Subba Rao (1994) Heterosis analysis in some three-way crosses of *Bombyx mori* (L). *Sericologia* **34**, 51-61.

Hazel, L. N. (1943) The genetic basis for constructing selection indexes. *Genetics* **28**, 476.

Krishnaswamy, S. (1987) A new concept of a three-way cross in place of conventional Mysore x Bivoltine hybrids. *Indian Silk* **27**, 21-26.

Mano, Y., S. Nirmal Kumar, H. K. Basavaraja, N. Mal Reddy and R. K. Datta (1992) An index for combined trait selection for silk yield improvement in *Bombyx mori* L. *Natl. Conf. Mulb. Seric. Res. Mysore*, 10-12 .

Mano, Y., S. Nirmal Kumar, H. K. Basavaraja, N. Mal Reddy and R. K. Datta (1993) A new method to select promising silkworm breeds and combinations. *Indian Silk* **31**, 53.

Minagawa, I. and Y. Otsuka (1975) Relationships of actual performance of double cross hybrids and predicted value based on the mean value of the single crosses concerned in the silkworm, *Bombyx mori* L. *Japan J. Breed.* **25**, 251-257.

Rao, G. S., S. K. Das and B. Ghosh (1989) Heterosis effect on some new silkworm hybrids evolved by three-way cross. *Prosp. Cyto. Gent.* **6**, 373-378.

Singh, T. and G. S. Rao (1993) A multiple traits evaluation index to screen useful silkworm (*Bombyx mori*) hybrid genotypes. *G. It. Ent.* **6**, 379-382.

Singh, T., G. S. Rao and M. D. Senapati (1994) Studies on the heterotic expression in silk productivity in some hybrids of *Bombyx mori*. *Bull. Seric. Res.* **5**, 81-83.

Singh, T., K. Singh and M. D. Senapati (1992) Astounding effect of correlated parameters in silk industry. *Indian Text. J.* **102**, 26-30.

Singh, T., S. N. Sinhadeo and M. D. Senapati (1990) Heterosis in silk productivity as a breeding index in *Bombyx mori* L. *Silkworm Inf. Bull.* **3**, 1-3.

Udupa, S. M. and B. L. V. Gowda (1988) Heterotic expression in silk productivity of different crosses of silkworm, *Bombyx mori* L. *Sericologia* **28**, 395-400.