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Parental Combination and Rearing Season Compatibility for Silk Yield in Tropical Tasar Silkworm, *Antheraea mylitta* Drury

R. Manohar Reddy, A.K. Sinha, Ram Kumar and B.C. Prasad

Breeding and Genetics division, Central Tasar Research and Training Institute,
Central Silk Board, Piskanagri Post, Ranchi-835 303, India

Abstract: Current state of tentative yield by the tropical tasar silkworm of *Antheraea mylitta*, during only commercial crop rearing, needs exploitation of other rearing season(s) for sustainable silk output. In this study, the assorted combinations of Daba ecorace were assessed during five rearing seasons (RS_1=July/Aug' 06; RS_2=Sept/Nov' 06; RS_3=July/Aug' 07; RS_4=Sept/Nov' 07; RS_5=July/Aug' 08) for silk yield and associated trait(s). The high pupal female and high shell male combination (PC_4) has shown enhanced silk yield (+12.1%), fecundity (+8.6%) and shell weight (+22.2%) with reduced egg hatching (-2.4%) and effective rate of rearing (ERR) (-10.8%) over the control (PC_1). The high shell female and high shell male combination (PC_3) has recorded lesser silk yield (-17.8%) but for improved shell weight (+12.7%), fecundity (+1.2%) compared to control. The high pupal female and high pupal male combination (PC_2) has shown least silk yield (-45.4%) with highest fecundity (+12.2%) over the control. The combinations recorded contrasting silk yield and related trait(s) during individual and average of five successive rearing seasons. The study infers the scope of augmenting silk productivity based on the phenotypic magnitude of one or more silk associated trait(s) by applying the compatibility of parental combination with crop rearing season(s).

Key words: *Antheraea mylitta* · Compatibility · Daba ecorace · Selective parent · Vanya silk

INTRODUCTION

The tasar (vanya) silk is produced by *Antheraea mylitta* Drury (Lepidoptera: Saturniidae), a wild polyphagous tropical sericigenous insect, distributed over central India (12-31°N latitude and 72-96°E longitude). The insect feeds primarily on *Shorea robusta* (*Sal*), *Terminalia tomentosa* (*Asan*) and *Terminalia arjuna* (*Arjun*) in addition to secondary and tertiary food plants [1]. The species has wide distribution over diverse ecological niche as forty four ecoraces [2] but only a few are semi-domesticated and applied commercially for seed (egg) and silk production. Other prospective ecoraces are yet to be exploited commercially [3, 4]. The potential phenotypic expression of genotype (endogenic factor) desires compatibility with the rearing environment (exogenic factor viz., like temperature, nutrient availability, feeding duration, larval crowding and environmental stimuli) where it grows [5-9] The race maintenance, selection methods, crossing techniques, perceptive ecological provisions during processing have great influence on genetic improvement of associated trait(s) expression in successive progenies [10-13]. The bigger female parent contributes for higher fecundity and parents with higher shell will put in better shell weight and silk ratios [14-18] making the descendants comprising the silk traits of both quantity and quality. However, the lack of information on impact of different parental combinations and their compatibility with different crop rearing season(s) on the silk yield and its associated trait(s) of semi-domesticated and most commercially exploited Daba ecorace of *A. mylitta* prompted the present study.

MATERIALS AND METHODS

Sorting of Parental Cocoons: The cocoons of Daba ecorace of *A. mylitta* used for study were obtained from the stabilized stocks of Central Tasar Research and Training Institute (CTRandTI), Ranchi. They were assessed and assorted based on pupal and shell weights followed by pupal sexing to get high pupal weight and

Corresponding Author: R. Manohar Reddy, Central Tasar Research and Training Institute, Central Silk Board, Piskanagri Post, Ranchi - 835 303, India, Tel: +919430779893, E-mail: dr.manohar1959@rediffmail.com.

high shell weight (above average weights) groups with both sexes, high pupal female and high shell male group and a mixed group without any selection.

Preparation of Varied Parental Combinations: The assorted seed cocoons of Daba ecorace were maintained separately in tasar grainage house and disease free layings (Dfls) were prepared from varied groups as high pupal female x high pupal male as PC_2 (PxP), high shell female x high shell male as PC_3 (SxS) and high pupal female x high shell male as PC_4 (PxS) along with random female x random male as the control, PC_1 following integrated package of tasar silkworm seed production. The cocoon stocks for subsequent progenies of these combinations were maintained and prepared Dfls during Sep/Nov ’06, Jul/Aug ’07, Sep/Nov ’07 and Jul/Aug ’08 to continue the stocks.

Maintenance of Parental Stocks: The cocoons thus produced as above were utilized to continue their progenies successively from rearing season RS_1 in Jul/Aug ’06 to RS_5 in Jul/Aug ‘08. During the course of progeny maintenance, the parental cocoons were determined based on fecundity and egg hatching, shape and color of cocoons, cocoon weight, silk ratio and silk yields in addition to pupal and shell weights for making different combinations.

Evaluation of Varied Parental Combinations: The Dfls prepared under four combinations were reared following integrated tasar silkworm rearing package successively with complete randomized block design (CRBD) for five generations during Jul/Aug ’06 (RS_1), Sep/Nov ’06 (RS_2), Jul/Aug ’07 (RS_3), Sep/Nov ’07 (RS_4) and Jul/Aug ’08 (RS_5) using the economic plantation of *Terminalia tomentosa* (WandA) maintained at field laboratory of CTRandTI, Ranchi. Three replications were maintained per combination (PC_1 to PC_4) considering larvae of one Dfl as one replication during rearing seasons (RS_1 to RS_5) and the observations were recorded for fecundity, egg hatching, effective rate of rearing (ERR), single shell weight and silk yield.

Statistical Analysis: The observations recorded on fecundity, egg hatching, effective rate of rearing (ERR), shell weight and silk yield were analysed using analysis of variance (ANOVA) to study the variation [19] among parental combinations in the successive seed and commercial crop rearing seasons. The statistical analysis was carried out in Windostat statistical software package (version 8.5, Windostat Services, Hyderabad, India).

RESULTS AND DISSCUSSION

Analysis of Variance among Parental Combinations and Crop Rearing Seasons: The ANOVA for silk yield traits under different parental combinations, successive crop rearing seasons and combinations versus rearing seasons of Daba ecorace (Table 1) indicate mixed levels of significance. The variance among different combinations and rearing seasons has shown significance at 0.1% level except for fecundity among rearing seasons which was non-significant. The variance in parental combinations versus rearing seasons has also shown significance at 0.1% level in respect of egg hatching, shell weight and silk yield and 1% level for ERR, while the fecundity was significant at 5% level.

Performance of Parental Combinations over Crop Rearing Seasons: The performance of different parental combinations during five successive crop rearing seasons as against their respective controls, PC_1 at RS_1 to PC_4 at RS_1 (Table 2), show clear variation for egg, ERR, cocoon and silk traits. The maximum improvement has been recorded in fecundity of high pupal combination, PC_2 ranging between 286 and 309 eggs during different rearing seasons. The high pupal and high shell combination, PC_4 has recorded better fecundity next to PC_2, ranging between 273 and 294, with egg hatching ranging between 64.2 and 73.7%. The egg hatching of 73.7 % at fifth rearing generation recorded in PC_4 was highest among the parental combinations and rearing seasons. However, the shell weight range of 1.4 to 1.9 g and silk yield of 60.6 to 110.0 g of PC_4 are the highest recorded among the combinations. The performance of high shell combination, PC_3 was moderate, though it could out-do the PC_2 combination in egg hatching, ranging between 59.8 and 68.8%, shell weight ranging between 1.4 and 1.6 g and silk yield of ranging between 37.7 and 78.4 g, it has shown less fecundity ranging between 256 and 262. Though the ERR in general has recorded better by control (PC_1) over PC_4, PC_3 and PC_2, the highest of 32.0 % has been recorded by PC_4 at RS_5. The performances of PC_2 and PC_3 combinations are inferior to PC_4 in all traits, except for fecundity of PC_2. The impact of five successive rearing seasons on silk traits of Daba ecorace indicates the enhancement in fifth rearing season (RS_5) over the first (RS_1), except for egg hatching (55.7 %) and silk yield (45.3 g) of PC_2. However, the phenotypic magnitude of silk related traits was better in commercial crop rearing seasons (RS_2 and RS_4) over the seed crop seasons (RS_1, RS_3 and RS_5).

Table 1: ANOVA for silk associated traits of Daba ecorace among different parental combinations (PC_1 to PC_4) and rearing seasons (RS_1 to RS_5)

Source Particulars	DF	Mean Sum of Squares: Fecundity (no)	Egg hatching (%)	Effective rate of rearing (%)	Shell weight (g)	Silk yield (g)
Replicates	2	119	28	23	0.03	46
Parental combinations(PC)	3	3658 ***	530 ***	208 ***	0.54 ***	4282 ***
Rearing generations (RS)	4	327 NS	165 ***	380 ***	0.68 ***	1394 ***
Parental combinations (PC) VS Rearing generations (RS)	12	288 *	38 ***	32 **	0.05 ***	601 ***
Error	38	157	8.6	11	0.01	62
Total	59	372	52	50	0.09	476

*- Significant at 5%; **- Significant at 1%; ***-Significant at 0.1%; NS-Non significant

Table 2: Performance of four Parental combinations (PC_1 to PC_4) of Daba ecorace during five rearing seasons (RS_1 to RS_5) (values are mean and ±SE)

	Factors	Fecundity (no)	Egg hatching (%)	Effective rate of rearing (%)	Shell weight (g)	Silk yield (g)
Parental Combinations	PC_1 at RS_1 to	255 ±4.1	58.3 ±1.7	32.9 ±2.0	1.0 ±0.01	50.0 ±3.0
PC_1 = Control: Parents	PC_4 at RS_1					
randomly mated	PC_1 at RS_2	250 ±7.4	68.6 ±1.1	28.6 ±2.2	1.5 ±0.01	73.5 ±5.2
PC_2 = High pupal female	PC_1 at RS_3	253 ±12.0	68.4 ±0.9	30.6 ±2.6	1.2 ±0.03	65.9 ±6.1
x high pupal male	PC_1 at RS_4	260 ±2.0	71.2 ±1.2	29.1 ±1.6	1.5 ±0.03	81.9 ±4.8
PC_3 = High shell female	PC_1 at RG_5	257 ±4.0	73.4 ±1.3	31.1 ±1.3	1.1 ±0.03	68.2 ±3.5
x high shell male	PC_2 at RS_2	286 ±5.0	54.3 ±2.4	11.7 ±0.9	1.2 ±0.03	23.0 ±0.6
PC_4 = High pupal female	PC_2 at RS_3	309 ±10.0	50.6 ±1.7	19.8 ±0.8	1.1 ±0.06	32.8 ±1.1
x high shell male	PC_2 at RS_4	295 ±6.4	54.5 ±1.1	19.1 ±1.5	1.1 ±0.1	34.6 ±0.9
	PC_2 at RS_5	287 ±8.2	55.7 ±2.0	26.1 ±2.3	1.1 ±0.1	45.3 ±0.2
Rearing Generations	PC_3 at RS_2	257 ±5.5	59.8 ±1.2	14.9 ±0.9	1.6 ±0.01	37.7 ±4.9
RS_1 = July/Aug' 06	PC_3 at RS_3	262 ±9.4	61.7 ±3.9	24.6 ±2.0	1.4 ±0.03	55.8 ±4.9
RS_2 = Sept/Nov' 06	PC_3 at RS_4	256 ±5.9	65.1 ±0.7	20.7 ±0.7	1.6 ±0.07	57.2 ±3.8
RS_3 = July/Aug' 07	PC_3 at RS_5	261 ±3.7	68.8 ±0.9	29.4 ±0.8	1.5 ±0.06	78.4 ±4.5
RS_4 = Sept/Nov' 07	PC_4 at RS_2	278 ±5.8	65.6 ±2.3	16.9 ±0.9	1.9 ±0.06	67.8 ±10.0
RS_5 = July/Aug' 08	PC_4 at RS_3	273 ±4.3	64.2 ±1.1	27.1 ±3.4	1.5 ±0.06	60.6 ±2.0
	PC_4 at RS_4	283 ±4.0	70.4 ±1.2	29.8 ±2.5	1.9 ±0.09	110.0 ±5.1
	PC_4 at RS_5	294 ±4.0	73.7 ±2.6	32.0 ±3.4	1.4 ±0.07	91.8 ±7.2
CD at 5%		20.7	4.9	5.5	0.15	13

Table 3: Performance average of four parental combinations (PC_1 to PC_4) of Daba ecorace of five rearing seasons (RS_1 to RS_5) (values are mean, ±SE and + or - % change over control)

Parentalcombinations	Fecundity (no)	Egg hatching (%)	Effective rate of rearing (%)	Shell weight (g)	Silk yield (g)
PC_1 = Control: Parents randomly mated	255 ±4.1	58.3 ±1.7	30.1 ±2.0	1.3 ±0.0	67.9 ±3.0
PC_2 = High pupal female x high pupal male	287 ±4.9+12.5	54.7 ±0.9-06.2	21.9 ±2.0-27.2	1.1 ±0.04-23.1	37.1 ±2.6-45.4
PC_3 = High shell female x high shell male	259 ±2.9+0.16	62.7 ±1.3+07.5	24.5 ±1.8-18.6	1.4 ±0.06+07.7	55.8 ±3.9-17.8
PC_4 = High pupal female x high shell male	278 ±3.5+09.0	66.5 ±1.6+14.1	27.8 ±1.8-07.6	1.5 ±0.1+15.4	76.2±6.2+12.2
CD at 5%	9.3	2.2	2.5	0.07	5.8

Performance Average of Parental Combinations: The performance average of four parental combinations (PC_1 to PC_4) of Daba ecorace of five rearing seasons (RS_1 to RS_5) presented in Table 3 indicates the variations in silk and associated traits. Among the combinations, the PC_4 has shown improved fecundity (+9.0%), egg hatching (+14.1%), shell weight (+15.4%) and silk yield (+12.2%) in spite of reduced ERR (-7.6%) over the control, PC_1. The PC_3 has recorded improved egg hatching (+7.5%) and shell weight (+7.7%) with very marginally improved fecundity (+0.16%) and reduced ERR and silk yield (-18.6% and -17.8%) over control. However, the PC_2 could show improvement only in fecundity (+12.5%), the highest among all combinations, but for its least average performance in all other associated traits.

The tropical tasar silkworm, *A. mylitta,* with pupal diapause, limited annual life cycles and rearings in outdoor need coherent application of parental variation available among or within the ecorace in exploiting the rearing season's compatibility to augment the silk yield by utilizing the vastly available tasar flora [9, 12]. The rearing of different combinations (PC_1 to PC_4) of Daba ecorace through five successive seasons (RS_1 to RS_5) has improved the magnitude of commercial trait(s), preferred with the parents applied. The maximum fecundity of 309 eggs with average of 286 in PC_2 signifies the role of high pupal parents in improving the fecundity through parental recombine to regain the potential as reported earlier [7-9]. Also, the low performance in other traits in all generations irrespective of rearing season further supports the selective parental role in preferred trait enrichment as was also reported earlier [15-18], which has resulted to low silk yield, suppressing the fecundity enhancement. Same way, the PC_3 has shown higher shell weight average (1.4 g) and consistency (1.4 to 1.6 g) irrespective of season, furthermore supports the role of selected parents in improving their associated trait is coinciding with earlier reports [13, 18]. But, the PC_3 could surpass only PC_2 in the silk yield, in spite of better shell weight and fecundity, due to reduced egg hatching and ERR. Interestingly, both PC_2 and PC_3 have exhibited same trend of enhanced performance in the trait on which the parent selected, irrespective of seasons. The varied levels of the silk yield among the different parental combinations, though, correlated with the performance levels of other associated traits like fecundity, egg hatching and shell weight, the ERR and crop rearing season could influence more. This indicates the compatibility of parental combination with rearing environment, which can compensate the silk yield over different rearing seasons by regulating the levels of one or more silk associated trait(s) to maintain the vigour of the race as was reported [11, 12].

But, the PC_4 could perform better in fecundity as well as in shell weight yielding higher silk, in spite of reduced egg hatching and ERR. Though, the magnitude of trait(s) has closely associated and influenced by rearing seasons in PC_1 (control), the PC_2, PC_3 and PC_4 have tend based on the trait(s) selected, irrespective of the season. However, all combinations have shown less impact of rearing seasons on fecundity and egg hatching than shell weight indicates the seasonal impact on shell and silk content as was reported [14, 15] and might be due to varied feed, climate and larval duration during the rearing seasons and the preparation of insect for diapause. Yet, the ERR has shown higher impact on silk yield with or without the collective role of yield associated traits and crop rearing seasons. As the cocoon or silk yields (commercial parameters) are dependent of interaction among fecundity, egg hatching, shell weight and ERR [5, 7], the parental combinations can serve the needs of commercial viability by compensating the lesser performance in any of the trait(s) with better performance in other(s), which can be evidenced in PC_4, with improved silk yield at RS_5 in spite being seed crop season. The varied performance in silk related traits among different combinations (PC_1 to PC_4) but for their same origin, indicates the role of compatibility of parental combinations and rearing seasons in improving the silk through its associated trait(s) as evidenced from earlier findings [8, 9].

The study infers that the tasar raw silk productivity can be augmented with the phenotypic magnitude of silk associated trait(s) by applying the appropriate compatibility of parental combination(s) with seed or commercial crop rearing season(s) and among the studied parental combinations, the PC_4 has proved best in enhancing the silk yield.

REFERENCES

1. Suryanarayana N. and R. Kumar, Gargi, 2005. Monograph on Indian tropical tasar silkworm food plants. Central Tasar Research and Training Institute, Central Silk Board, Ranchi, India.
2. Suryanarayana N. and A.K. Srivastava, 2005. Monograph on tropical tasar silkworm. Central Tasar Research and Training Institute, Central Silk Board, India.
3. Hansda, G., R. Manohar Reddy, M.K. Sinha, N.G. Ojha and N.B.V. Prakash, 2008. *Ex-situ* stabilization and utility prospects of '*Jata*' ecorace of tropical tasar silkworm *Antheraea mylitta* Drury. International J. Industrial Entomol., 17(2):169-172.
4. Ojha, N.G., R. Manohar Reddy, G. Hansda, M.K. Sinha, N. Suryanarayana and N.B.V. Prakash, 2009. Status and potential of Jata, a new race of Indian tropical tasar silkworm (*Antheraea mylitta* Drury). Academic J. Entomol., 2(2): 80-84.
5. Srivastava, A.K., A.H. Naqvi, A.K. Sinha, S.R. Vishwakarma and G.C. Roy, 2004. Genotype and environment interaction in *Antheraea mylitta* Drury and its implications. Perspectives of Cytology and Genetics, 11: 219-224.

6. Mulder, H.A. and P. Bijma, 2005. Effects of genotype x environment interaction on genetic gain in breeding programs. J. Animal Sci., 83: 49-61.
7. Davidowitz, G., L.J.D. Amico and H.F. Nijhout, 2004. The effects of environmental variation on a mechanism that controls insect body size. Evolution and Ecology Res., 6: 49-62.
8. Miller, W.E., 2005. Extrinsic effects on fecundity-maternal weight relations in capital-breeding Lepidoptera. J. Lepidopteron Society, 59(3): 143-160.
9. Manohar Reddy, R., M.K. Sinha and B.C. Prasad, 2010. Application of parental selection for productivity improvement in tropical tasar silkworm *Antheraea mylitta* Drury-a review. J. Entomology, 7(3): 129-140.
10. Moghaddam, S.H.H., N. Emam Jomeh, S.Z. Mirhosseini and M.R. Gholamy, 2005. Genetic improvement of some traits in four strains of silkworm, *Bombyx mori* L. International J. Industrial Entomol., 10(2): 95-99.
11. Rajnarain., S.S., Rath, G.S. Singh, M.K. Singh and N. Suryanarayana, 2008. Strategy for race maintenance in tropical tasar. Indian J. Sericulture, 47(2): 234-238.
12. Manohar Reddy, R., N. Suryanarayana, N.G. Ojha, G. Hansda, S. Rai and N.B.V. Prakash, 2009. Basic seed stock maintenance and multiplication in Indian tropical tasar silkworm *Antheraea mylitta* Drury-A strategic approach. International J. Industrial Entomol., 18(2): 69-75.
13. Manohar Reddy, R., G. Hansda, N.G. Ojha and N. Suryanarayana, 2009. Heterobeltiosis inF_1 hybrids of wild and domesticated ecoraces of tropical tasar silkworm *Antheraea mylitta* Drury. Sericologia, 49(2): 189-195.
14. Manohar Reddy, R., N. Suryanarayana, M.K. Sinha, N.S. Gahlot, G. Hansda, N.G. Ojha and N.B.V. Prakash, 2009. Silk filament progression with backcross breeding generations in tropical tasar silkworm, *Antheraea mylitta* D. International J. Industrial Entomol., 19(1): 187-192.
15. Yadav, G.S., B.M.K. Singh, B.R.R.Pd. Sinha and K. Thangavelu, 2001. Studies on association between moth weight and fecundity of ecorace Bhandara of tasar silk moth (*Antheraea paphia* Linn.). Bulletin of Indian Academy of Sericulture, 5: 59-67.
16. Calvo, D. and J.M. Molina, 2005. Fecundity-body size relationship and other reproductive aspects of *Streblote panda* (Lepidoptera: Lasiocampidae). Annals of Entomological Society of America, 98: 191-196.
17. Chandrasekhar, K. and H.K. Basavaraja, 2008. Changes in qualitative and quantitative characters in bivoltine silkworm breeds of *Bombyx mori* (Linn.) under different selection methods. Indian J. Sericulture, 47(2): 175-182.
18. Manohar Reddy, R., N. Suryanarayana and N.B.V. Prakash, 2008. Heterosis potential in selective parental F_1 hybrids of divergent geographic ecoraces of tropical tasar silkworm, *Antheraea mylitta* Drury (Lepidoptera: Saturniidae). Academic J. Entomol., 1(2): 32-35.
19. Kwanchai, A.G. and A.G. Arturo, 1984. Statistical procedures for agricultural research. 2^{nd} edition, Kwanchai, A.G and A.G. Arturo, (eds.), John Wiley and Sons, New York, pp: 84-118.