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Heterosis Potential in Selective Parental F1 Hybrids of Divergent Geographic Ecoraces of Tropical Tasar Silkworm, *Antheraea mylitta* D (Lepidoptera: Saturniidae)

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Abstract: Selective parental crossings done with divergent geographic ecoraces of tropical tasar silkworm, *Antheraea mylitta* Drury viz., Jata, Raily and Daba, to study the potential of relative heterosis for fecundity, egg fertility, shell weight and silk ratio in F1 hybrid combinations and reciprocals during commercial crop season. The combination of high pupal and high shell weights of Daba x Jata [PxS] recorded positive heterosis potential for fecundity, egg fertility, shell weight and silk ratio. The combination of high pupal and high pupal weights of Jata x Daba [PxP] recorded highest positive heterosis potential only for fecundity, whilst combination of high pupal and high shell of Jata x Daba [PxS] was positive in shell weight and silk ratio along with fecundity. The high shell and high shell combination of Daba x Raily [SxS] and its reciprocal have recorded better positive heterosis for shell weight and silk ratio and the high pupal and high shell combination of Raily x Daba [PxS] have recorded highest positive heterosis potential in egg fertility in addition to shell weight and silk ratio. The hybrid combination with high pupal weights of Daba x Jata has shown positive heterosis potential for fecundity and combinations of high shell weights of Daba x Jata and Daba x Raily for shell weight and silk ratio. The F1 hybrid combinations with selective parents have recorded better heterosis potential for the selected characters than the general hybrids and the study infers that the breeding with specific parents is an impending tool to optimize heterosis for genetic improvement in the desired direction to augment fecundity and shell weight, the most desired traits of commercial importance in tropical tasar silkworm.

Key words: *Antheraea mylitta* · Heterosis · Selective crossing · Geographic · Divergent

INTRODUCTION

The biological selection of parents on specific trait will lead to representation of explicit individuals by their progeny in later generations, an advantage to have genotype of specific genetic class [1]. When a silkworm strain with somewhat low fecundity crossed with another strain improved the fecundity remarkably but for fewer unfertilized and dead eggs [2]. The success in developing productive hybrids in Indian tasar silkworm *Antheraea mylitta* needs selection of genetically diverged parents and by involving parental ecoraces viz., Daba, Raily, Sukinda, the high yielding segregants can be developed [3, 4]. The parent Daba is a good combiner for absolute silk yield and the combined effect of many economic cocoon characters, mostly the quantitative parameters are highly heritable in tasar silkworm [5, 6]. The dominance of gene action is found vital in regulating the economic traits of hatching and shell weight [7]. The tasar breeds N1 and N2 have recorded good general combining ability for fecundity, ERR and absolute silk yield [8] and the absolute silk yield was the total effect of fecundity, hatching, ERR and shell weight [9, 10]. Daba x Modal and Raily x Laria hybrid combinations recorded high heterosis in respect of fecundity and hatching [11]. However, the information on the selection of parents with desired traits for hybridization and their impact at F1 level in tropical tasar silkworm is not available. Hence, in the present study, the hybridization conducted with parents of specific pupal and shell values using three divergent geographic ecoraces i.e. Jata (Orissa), Raily (Chhattisgarh) and Daba (Jharkhand) raised during seed crop season (July-August) to cram the potential of heterosis in commercial crop season (October-December), being important rearing season for tasar rearers.

MATERIALS AND METHODS

The parental stocks of ecoraces viz., Jata, Raily and Daba of tasar silkworm *Antheraea mylitta* were raised

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during the seed crop rearing season, July-August, 2007, to minimize the problems of erratic emergence and non synchronization in moth coupling (experienced with the wild stocks collected from nature), while preparing the Disease free layings (DFLs) of general and specific F1 hybrid combinations. The male and female moths emerged out of non-diapausing cocoon stocks of the above three divergent geographic ecoraces were used for the study. The ecorace wise selfing, general and selective F1 hybrid combinations were prepared along with their reciprocals based on pupal/ shell weights at grainage house during September, 2007. The four general and twelve selective F1 hybrid combinations along with three parents, nineteen (19) in totals, were reared in a completely randomized block design with three replications for each treatment on economic plantation, *Terminalia tomentosa* (WandA) at field laboratory of Central Tasar Research and Training Institute, Ranchi, Jharkhand, India in commercial crop season i.e. October-December, 2007. The total number of eggs, fertilized eggs of one Dfl in respect of parents as well as hybrids was considered as one replication and single shell weight, silk ratio were calculated with equal number of random cocoon samples. The observations recorded on seed and cocoon commercial characters like fecundity, egg fertility, shell weight and silk ratio were subjected for statistical analysis.

RESULTS

The ANOVA (Table 1) revealed the variances between the divergent geographic ecoraces Jata, Raily and Daba for fecundity, egg fertility and shell weight characters indicating genetic diversity and substantial variability in the parental material for both seed and cocoon parameters. Among hybrids, the variance was highly significant in all the four characters studied, while the mean sum of squares of parents vs hybrids, which is the measure of potential in heterosis, found significant in respect of fecundity and silk ratio, emphasizing the imminent of parental specificity and selective crossing on heterotic expression for related characters. In contrary, the ANOVA among the common parent of the hybrids, i.e. Daba with hybrids (Table 2), the variability found significant in all the characters viz., fecundity, egg fertility, shell weight and silk ratio indicating the positive heterotic potential against the only semi-domesticated and most commercially exploited Daba parental ecorace.

Fecundity and Egg Fertility: The relative heterosis for fecundity (Table 3) found positively potential in Jata x Daba [PxP] selective F1 hybrid combination (35.89%) followed by Daba x Jata [PxP] selective (22.13%) and Daba x Jata general F1 hybrid combinations (17.45%). However, the heterosis was negative (ranging between -41.97 to -26.34%) in Daba x Raily general and selective F1 hybrid combinations and their reciprocals with negatively highest in Raily x Daba [PxP] selective hybrid combination. Highest potential of positive heterosis for egg fertility (Table 3) was recorded in Raily x Daba [PxS] selective F1 hybrid combination (20.74%) followed by Daba x Jata general combination (11.58%), while the heterosis was negative (-17.68%) in the selective F1 hybrid combination of Jata x Daba [PxP]. Further, the potential of relative heterosis in other hybrid

Table 1: Anova for Egg and Cocoon Characters of Daba, Jata, Raily Parents and Their Hybrids

		Source: Mean Sum of Squares			
Particulars	DF	Fecundity (no)	Egg fertility (%)	Shell Weight (g)	Silk Ratio (%)
Replicates	02	0395.5	0097.0	0.01	01.60
Parents	02	1979.1 NS	7551.4 ***	0.32 **	07.15 NS
Parents vs					
Hybrids	01	5547.8 **	1868.5 NS	0.08 NS	16.17 *
Hybrids	15	8898.3 ***	6360.0 ***	0.84 ***	42.89 ***
Error	36	0644.3	0454.6	0.05	02.51

* : Significant at 5% level, ** : Significant at 1% level, *** : Significant at 0.1% level, NS: Non significant

Table 2: Anova for Egg and Cocoon Characters of Daba Parent and its Hybrids

		Source: Mean Sum of Squares			
Particulars	DF	Fecundity (no)	Egg fertility (%)	Shell Weight (g)	Silk Ratio (%)
Replicates	02	0230.5	107.2	0.01	01.10
Parents vs					
Hybrids	01	7683.8 **	469.5 **	0.54 **	27.07 **
Hybrids	15	8898.3 ***	144.8 **	0.84 **	42.89 ***
Error	32	0646.1	049.6	0.06	02.75

** : Significant at 1% level, *** : Significant at 0.1% level

Table 3: Relative Heterosis (Percentage) in General and Specific F1 Hybrid Combinations

Combination	Fecundity (no.)	Egg fertility (%)	Shell Weight (g)	Silk Ratio (%)
Daba X Jata [R]	+17.45	+11.58	+34.76	+30.49
Daba X Jata [PxP]	+22.13	+07.20	-30.48	-30.22
Daba X Jata [PxS]	+00.43	+05.21	+13.41	+02.07
Daba X Jata [SxS]	-03.83	-04.13	+45.12	+26.95
Jata X Daba [R]	+01.70	-08.95	+27.44	+24.15
Jata X Daba [PxP]	+35.89	-17.68	-32.93	-25.42
Jata X Daba [PxS]	+11.06	-17.80	+09.15	+01.67
Jata X Daba [SxS]	-15.74	-04.09	+33.54	+27.95
Daba X Raily [R]	-33.76	+05.79	+42.44	+42.60
Daba X Raily [PxP]	-26.34	+06.13	-38.37	-23.71
Daba X Raily [PxS]	-33.74	+05.05	-07.56	=00.00
Daba X Raily [SxS]	-34.98	+01.65	+25.58	+31.92
Raily X Daba [R]	-28.81	+02.92	+43.60	+46.78
Raily x Daba [PxP]	-41.97	-02.86	-26.16	-10.19
Raily x Daba [PxS]	-31.27	+20.74	+12.79	+23.50
Raily x Daba [SxS]	-32.51	+06.94	+56.98	+54.00

[R] = Random coupling [PxP] = High pupal weight female and High pupal weight male [PxS] = High pupal weight female and High shell weight male [SxS] = High shell weight female and High shell weight male

combinations was either little positive or negative and ranging between -8.95 to +7.20%. The relative heterosis for egg fertility was positive in all Daba x Raily general and selective F1 hybrid combinations and their reciprocals except for Raily x Daba [PxP], where it was negative in all the parameters studied including egg fertility.

Shell Weight and Silk Ratio: Highest potential of positive heterosis for shell weight (Table 3) recorded in Raily x Daba [SxS] selective F1 hybrid combination (56.98%) followed by Daba x Jata [SxS] (45.12%), Raily x Daba (43.60%), Daba x Raily (42.44%). In other F1 hybrid combinations, the relative heterosis was potential positively and ranging between 27.44 to 9.15%. But the selective F1 hybrid combinations [PxP] of Daba x Jata, Daba x Raily and their reciprocals have recorded heterosis negatively for shell weight and was ranging between -7.56% to -38.37 with negatively highest in Daba x Raily [PxP] and negatively least in Daba x Raily [PxS] selective F1 hybrids. Highest potential of positive heterosis for silk ratio (Table 3) recorded in Raily x Daba [SxS] selective F1 hybrid combination with 54.00% followed by 46.78% in Raily x Daba, 42.60% in Daba x Raily, 31.92% in Daba x Raily [SxS] and 23.50% in Raily x Daba [PxS]. However, the relative heterosis of all the [PxP] selective F1 hybrid combinations was negative for silk ratio ranging between -30.22 to -10.19% with negatively highest in Daba x Jata [PxP] and negatively least in Raily x Daba [PxP] combinations.

DISCUSSION

The low fecundity/egg fertility with better cocoon characters and poor cocoon commercial characters with moderate fecundity/egg fertility of the ecoraces is one of the major prevailing constraints in commercial tasarculture. The reason for the selection of three ecoraces was their nativity of varied ecozones and the selection of individual parents for crossings with specific pupal and shell weights was their close association with commercially important fecundity, egg fertility, shell weight and shell ratio traits. The potential of selection response in chosen character of parental herd was found improved in the offspring generation; however it basically depends on genetic variation, selection accuracy and intensity among the parents [1]. The high heterosis potential recorded for fecundity in selective F1 hybrid combinations of Jata x Daba [PxP] and its reciprocal indicates the selection response between the chosen traits of divergent geographic ecoraces. Selection of desired commercial character among the parents based on breeding value is essential for stock improvement [12] and the silk moth from heavier pupae laying more eggs is of great concern in silkworm breeding [13], might also be the reasons for improvement of fecundity in the F1 hybrid combination of parents with chosen character of high pupal weight. This is of great applicability against persistent problem of low fecundity in many ecoraces of tropical tasar silkworm, which were otherwise good in all other cocoon commercial

characters. Also, the positive relative heterosis showed by selective hybrid combinations and reciprocals of Daba x Jata [SxS] and Daba x Raily [SxS] in respect of shell weight and shell ratio indicates the selection response of parents with high shell weights. The most important objective of improving the shell weight is to attain overall gain in the silk yield of the silkworm strain. While aiming so, the gradual decrease in fecundity is noticed and same could be improved again by crossing with another silkworm strain possessing he trait of good fecundity [2]. The improvement in shell weight and silk ratio also might be due to positive heterotic effect and better combinability of parents Daba and Raily for yield contributing traits [4, 11].

The better potential of positive heterosis on seed and cocoon characters in Daba x Jata and its reciprocal indicates that Daba and Jata are the best combiners and these findings are in conformity with earlier reports that Daba as the best combiner [5, 6]. Further, the positive heterotic gain among the random coupling of parents Daba, Jata in general hybrids and reciprocals might be the reason of epistasis effect [14]. The positive heterosis for egg fertility, shell weight and silk ratio in Daba x Raily and its reciprocal hybrid combinations indicates their probable contribution towards the better silk yield as egg fertility and cocoon shell weights along with ERR are the factors responsible for total silk yield in tropical tasar culture. However, the low intensity of heterosis for fecundity and shell weight in general hybrids than the selective hybrid combinations emphasizes the impact of parental selection on potential of relative heterosis on the desired character.

CONCLUSION

The F1 hybrid combinations with selective parents have recorded better heterosis potential for the selected characters than the general hybrids and the study infers that the breeding with specific parents is an impending tool to optimize heterosis for genetic improvement in the desired direction to augment fecundity and shell weight, the most desired traits of commercial importance in tropical tasar silkworm.

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