EVALUATION OF OAK TASAR SILKWORM HYBRIDS IN DIFFERENT SEASONS FOR IMPROVEMENT IN PRODUCTIVITY

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ABSTRACT: The rearing performance of sixteen hybrid combinations were evaluated to find out the superior hybrids. Rearing of the F_1 hybrid progenies was conducted as per standard procedures during spring and summer crop in the years 2017 and 2018.The data generated in respect of eight economically important traits during spring and summer seasons of two years was recorded replication wise and pooled. The data was analyzed statistically and subjected to multiple trait evaluation index by following Mano's evaluation index method. The breeds were ranked as per the cumulative score and the value of a particular trait in a particular breed was compared with the ranking. Seven hybrid combinations scored higher E.I. values greater than 50, out of which C_{27} × RPP and RPP × C_{27} displayed significantly superior performance in all the traits under study during both spring and summer seasons. The highest average cumulative evaluation index score of 70.11 was recorded in C_{27} × RPP hybrid. The superior hybrids may be considered for large scale trials for assessing their commercial exploitability under specified environmental conditions in the valley regions of Manipur.

KEY WORDS: Oak tasar, silkworm, *Antheraea proylei*, hybrid, evaluation index

Sericulture is the art and science of producing silk, the elegant natural fibre, which has an ever-increasing demand in the global scenario. India boasts of being the only country in the world to produce five different types of silk, *viz.*, Mulberry, Muga, Eri, Tropical Tasar and Temperate/Oak Tasar. Oak Tasar silk is a unique textile fibre which has a huge domestic demand due to its ethnicity and elegance. India and China are the only two major countries producing Oak Tasar silk in the global context. Manipur is the leading producer of Oak tasar silk in the country. However, the production in the state ranges between 5-7 metric tonnes per annum and is not sufficient to meet the domestic demand. Among various reasons for low productivity, the lack of highly productive breeds suitable to the prevailing environmental conditions and poor performance of the breeds due to continuous inbreeding stand prominent.

Enrichment of silkworm breeds has always been an important factor contributing to increase the productivity in sericulture. Continuous renewal and combination of existing breeds/hybrids with new superior varieties and their commercialization is essential to improve silk productivity and to meet the consumer demand. The choice of a breed/hybrid depends not only on the genotype but also on its performance under diverse environmental conditions (Rahman & Ahmed, 1988). In this regard, it is of paramount importance to know the seasonal performance of the different hybrid combinations of oak tasar silkworm breeds. Keeping the above aspects in view, the seasonal performance of sixteen hybrid progenies was assessed by using Multiple trait evaluation index

(E.I.) to identify most promising hybrid (s) so as to maximize Oak tasar cocoon yield and productivity.

MATERIALS AND METHODS

Diseases free layings of sixteen hybrid progenies were obtained by utilizing the parental oak tasar silkworm species/breeds, *viz.*, RPP, RP, *A. pernyi*, PRP_5, BY_1, B_6, *A. proylei*, Blue, PRP_{12} and C_{27} in different cross combinations based on their combining abilities (unpublished data). The rearing was conducted on *Quercus serrata* plants at the experimental farm of RSRS, Imphal during spring (March-April) and summer (July-August) seasons of 2017 and 2018 by following standard package of practices (Singh et al., 2012). The silkworms were reared on *Quercus serrata* plants.

The larvae of each breed were reared in three replications and each replication comprised of 200 larvae. During the rearing period, larvae and cocoons were assessed for different parameters *viz.*, fecundity, hatching percentage, larval weight, larval duration, cocoon yield, cocoon weight, shell weight and shell ratio. The data recorded with regard to different parameters was pooled separately and subjected to multiple trait evaluation index method as per the procedure described by Mano et al. (1993). The evaluation index value for negative traits *viz.*, larval duration was computed separately by using the modified formula (Talebi & Subramanya, 2009).

$$\textit{Evaluation index } (EI) = \frac{A - B}{C} \times 10 + 50$$

Where,
A = Value of a particular breed for particular trait,
B = Mean value for a particular trait of all the breeds,
C = Standard Deviation of a particular trait for all the breeds,
10 = Standard unit,
50 = Fixed value.

The average E.I. value fixed for selection of a breed is >50. The breeds that scored above the limit were considered to possess greater economic value.

RESULTS AND DISCUSSION

The data pertaining to rearing performance of sixteen hybrids of oak tasar silkworm under RSRS, Imphal farm conditions during spring and summer seasons along with E.I. scores are presented in Tables 1 and 2 respectively. The spring crop performance showed that among the sixteen hybrids, C_{27} × RPP recorded highest values for the traits fecundity (152 nos), cocoon/Dfl (68 nos.), larval weight (23.81 g), cocoon weight (7.58 g) and shell weight (0.78 g) and shortest larval duration (34 days), whereas RPP × C_{27} exhibited highest hatching percentage (80 %) and PRP_{12} × BY_1 showed highest shell ratio (10.35 %). Similarly during summer crop, C_{27} × RPP outperformed all the other hybrids with higher values for the traits, hatching percentage (88 %) cocoon/Dfl (36 nos.), larval weight (22.11 g), cocoon weight (7.01 g), shell weight (0.72 g) and shell ratio (10.27 %) and lowest value for the trait, larval duration (39 days), RPP × C_{27} exhibited highest fecundity of 171 numbers.

Evaluation index assessment is the multiple performance of a population for selection/short-listing of the breeds/hybrid combinations by taking into consideration all the economic traits. The multiple trait evaluation index of all the traits of the hybrids are shown in parentheses in Tables 1 and 2. In spring crop rearing, five hybrids exhibited E.I. scores above 50 with highest E.I. value of 71.22 by C_{27} × RPP, followed by RPP × C_{27} (66.23), BY_1 × *A. proylei* (58.74), Blue × PRP_{12} (56.25) and PRP_5 × BY_1 (54.99). For the trait hatching percentage, six hybrids scored E.I. values above 50, the highest being in RPP × C_{27} (79.82). The highest E.I. value for cocoon yield/Dfl was exhibited by C_{27} × RPP (75.64) followed by RPP × C_{27} (72.56), RP × *A.pernyi* (55.13) and *A.pernyi* × RP (53.07). For the trait, larval duration, E.I. scores greater than 50 was calculated in C_{27} × RPP (70.54) followed by RPP × C_{27} (63.7) and PRP_5 × BY_1 (63.7), BY_1 × PRP_5 (56.85), BY_1 × *A.proylei* (56.85) and BY_1 × PRP_{12} (56.85). For the cocoon characters, C_{27} × RPP scored highest E.I. values of 73.44 and 72.5 respectively for cocoon weight and shell weight, with scores above 50 in four hybrids for cocoon weight and five hybrids for shell weight. Nine hybrids scored above 50 for the trait shell ratio and PRP_{12} × BY_1 exhibited highest E.I. value of 64.54. The cumulative evaluation index scoring for performance during spring season ranked the hybrids in the order- C_{27} × RPP > RPP × C_{27}, BY_1 × *A. proylei* > PRP_{12} × BY_1 > RP × *A. pernyi* > Blue × PRP_{12} > BY_1 × PRP_{12}.

Summer crop performance revealed higher (>50) E.I. values in seven out of sixteen breeds where RPP × C_{27} scored 68.77. For the remaining seven traits, C_{27} × RPP exhibited highest E.I. values of 75.21 (hatching percentage), 71.74 (cocoon/Dfl), 71.13 (larval duration), 67.39 (cocoon weight), 67.50 (shell weight) and 66.96 (shell ratio). The cumulative evaluation index scoring from the performance during summer season ranked the hybrids in the order- C_{27} × RPP > RPP × C_{27} > PRP_{12} × BY_1 > PRP_5 × BY_1 > RP × *A. pernyi* > BY_1 × *A. proylei*.

Utilization of E.I. methods to identify potential pure races and hybrids is remained as powerful tool in adjudicating promising parental races and hybrids (Krishnaswami et al., 1964; Singh & Subbarao, 1993; Sudhakara Rao et al., 2001; Ramesh Babu et al., 2002; Rao et al., 2006 and Ramesha et al., 2009). Any effort to improve the yield requires consideration of cumulative effect of the major traits, which influences the silk yield impartially. A selection index makes it possible to select for a character by selecting simultaneously for two or more characters related to it. Evaluation index is one method that increases the precision of selection of breed among an array of breeds by a common index giving due weightage to all the yield component traits (Bhargava et al., 1994). The present study has yielded good information in identifying promising oak tasar silkworm hybrids having greater economic value in terms of maximum traits. Based on the performance and evaluation of sixteen Oak tasar silkworm hybrids, C_{27} x RPP, RPP x C_{27}, BY_1 x *proylei*, PRP_{12} x BY_1 and RP x *pernyi* were well-suited for both rearing seasons in the valley regions of Manipur. The hybrids Blue x PRP_{12} and BY_1 x PRP_{12} exhibited better performance only in the spring crop, while PRP_5 x BY_1 scored an overall high E.I. value during summer crop. Evaluation and identification of promising hybrids should be the first step to judge the optimum potential of the hybrid before popularizing them in the field. It is therefore evinced that large scale trials can be taken up for assessing the commercial exploitability of these superior hybrids and can also be considered for designating season specific hybrids in the interest of the industry.

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Table 1. Rearing performance of F_1 hybrids of *Antheraea* species during spring season (Average of two years).

Sl. No.	Crosses	Fec (No.)	H%	Coc/ Dfl	LW (g)	LD (days)	CW (g)	SW (g)	SR (%)	C.EI	Rank
1	RP × *A.pernyi*	126 (38.76)	71 (48.24)	48 (55.13)	21.64 (54.17)	38 (43.15)	7.13 (59.37)	0.72 (57.50)	10.10 (53.18)	51.19	**V**
2	*A.pernyi* × RP	129 (42.51)	69 (41.23)	46 (53.07)	21.07 (49.42)	38 (43.15)	6.80 (49.06)	0.69 (50.00)	10.15 (55.45)	47.98	
3	RPP × C_{27}	148 (66.23)	80 (79.82)	65 (72.56)	23.57 (70.25)	35 (63.70)	7.47 (70.00)	0.76 (67.50)	10.17 (56.36)	68.30	**II**
4	C_{27} × RPP	152 (71.22)	76 (65.79)	68 (75.64)	23.81 (72.25)	34 (70.54)	7.58 (73.44)	0.78 (72.50)	10.29 (61.81)	70.40	**I**
5	PRP_5 × BY1	139 (54.99)	73 (55.26)	42 (48.97)	20.72 (46.50)	35 (63.70)	6.58 (42.19)	0.65 (40.00)	9.93 (45.45)	49.63	
6	BY1 × PRP_5	132 (46.25)	69 (41.23)	40 (46.92)	21.13 (49.92)	36 (56.85)	6.61 (43.12)	0.67 (45.00)	10.10 (53.18)	47.81	
7	B_6 × PRP_5	134 (48.75)	69 (41.23)	41 (47.95)	21.21 (50.58)	38 (43.15)	6.73 (46.87)	0.68 (47.50)	10.14 (53.24)	47.41	
8	PRP_5 × B_6	127 (40.01)	70 (44.74)	40 (46.92)	20.33 (43.25)	39 (36.30)	6.49 (39.37)	0.64 (37.50)	9.84 (41.36)	41.18	
9	PRP_{12} × *A.proylei*	130 (43.76)	71 (48.24)	42 (48.97)	20.85 (47.58)	38 (43.15)	6.76 (47.81)	0.67 (45.00)	9.91 (44.54)	46.13	
10	*A.proylei* × PRP_{12}	122 (33.77)	69 (41.23)	38 (44.87)	19.35 (35.08)	39 (36.30)	6.53 (40.62)	0.63 (35.00)	9.58 (29.54)	37.05	
11	PRP_{12} × Blue	131 (45.01)	70 (44.74)	37 (43.85)	18.78 (30.33)	38 (43.15)	6.44 (37.81)	0.62 (32.50)	9.62 (31.36)	38.59	
12	Blue × PRP_{12}	140 (56.25)	72 (51.75)	36 (42.82)	21.15 (50.05)	37 (50.00)	6.81 (49.37)	0.69 (50.00)	10.12 (54.09)	50.54	**VI**
13	BY1 × *A.proylei*	142 (58.74)	72 (51.75)	43 (50.00)	21.18 (50.33)	36 (56.85)	6.94 (53.44)	0.72 (57.50)	10.31 (62.73)	55.17	**III**
14	*A.proylei* × BY1	127 (40.01)	70 (44.74)	38 (44.87)	20.86 (47.67)	38 (43.15)	6.58 (42.19)	0.65 (40.00)	9.87 (42.73)	43.17	
15	BY1 × PRP_{12}	136 (51.25)	73 (55.26)	36 (42.82)	21.05 (49.25)	36 (56.85)	6.77 (48.12)	0.68 (47.50)	10.01 (49.09)	50.02	**VII**
16	PRP_{12} × BY1	139 (54.99)	71 (48.24)	35 (41.79)	21.52 (53.17)	37 (50.00)	7.02 (55.94)	0.73 (60.00)	10.35 (64.54)	53.58	**IV**
	Mean	135	71.5	43	21.14	37	6.83	0.69	10.03		
	S.D.	8.01	2.85	9.75	1.20	1.46	0.32	0.04	0.22		
	S.E.	2.53	1.45	2.35	0.30	0.36	0.08	0.01	0.05		
	C.D. @ 5%	7.01	4.01	6.51	0.83	1.01	0.22	0.03	0.15		

Table 2. Rearing performance of F_1 hybrids of *Antheraea* species during summer season (Average of two years).

Sl. No.	Crosses	Fec (No.)	H%	Coc/ Dfl	LW (g)	LD (days)	CW (g)	SW (g)	SR (%)	C.EI	Rank
1	RP × *A.pernyi*	151 (49.01)	78 (57.94)	28 (46.42)	18.82 (48.68)	43 (41.05)	6.73 (55.22)	0.67 (55.00)	9.95 (53.04)	50.80	V
2	*A.pernyi* × RP	144 (42.09)	76 (54.49)	30 (52.75)	18.59 (46.98)	43 (41.05)	6.54 (46.96)	0.64 (47.50)	9.78 (45.65)	47.19	
3	RPP × C_{27}	171 (68.77)	86 (71.76)	35 (68.58)	21.95 (71.69)	40 (63.61)	6.92 (63.48)	0.70 (62.50)	10.11 (50.00)	65.05	II
4	C_{27} × RPP	168 (65.81)	88 (75.21)	36 (71.74)	22.11 (72.87)	39 (71.13)	7.01 (67.39)	0.72 (67.50)	10.27 (66.96)	69.82	I
5	PRP_5 × BY1	156 (53.95)	74 (51.03)	33 (62.25)	18.62 (47.21)	40 (63.61)	6.57 (48.26)	0.65 (50.00)	9.89 (50.43)	53.34	IV
6	BY1 × PRP_5	146 (44.07)	68 (40.67)	27 (43.26)	19.04 (50.29)	42 (48.57)	6.78 (57.39)	0.66 (52.50)	9.73 (43.48)	47.53	
7	B_6 × PRP_5	152 (50.00)	71 (45.84)	26 (40.09)	18.16 (43.82)	42 (48.57)	6.63 (50.87)	0.65 (50.00)	9.80 (46.52)	46.96	
8	PRP_5 × B_6	149 (47.03)	69 (42.40)	30 (52.75)	18.13 (43.60)	41 (56.09)	6.31 (36.96)	0.62 (42.50)	9.82 (47.39)	46.09	
9	PRP_{12}×*A.proylei*	162 (59.88)	72 (47.58)	31 (55.91)	18.65 (47.43)	43 (41.05)	6.52 (46.09)	0.64 (47.50)	9.81 (46.96)	49.05	
10	*A.proylei*×PRP_{12}	153 (50.99)	70 (44.13)	26 (40.09)	17.59 (39.63)	44 (33.54)	6.33 (37.83)	0.61 (40.00)	9.63 (39.13)	40.67	
11	PRP_{12} × Blue	159 (56.92)	70 (44.13)	30 (52.75)	16.88 (34.41)	42 (48.57)	6.08 (26.96)	0.56 (27.50)	9.21 (20.87)	39.01	
12	Blue × PRP_{12}	158 (55.93)	70 (44.13)	27 (43.26)	18.43 (44.85)	43 (41.05)	6.48 (44.35)	0.65 (50.00)	10.03 (56.52)	47.51	
13	BY1 × *A.proylei*	142 (40.12)	69 (42.40)	27 (43.26)	18.66 (47.50)	41 (56.09)	6.71 (54.35)	0.68 (57.50)	10.13 (60.87)	50.26	VI
14	*A.proylei* × BY1	137 (35.18)	73 (49.31)	27 (43.26)	18.74 (48.09)	43 (41.05)	6.65 (51.74)	0.66 (52.50)	9.92 (51.74)	46.61	
15	BY1 × PRP_{12}	133 (31.23)	69 (42.40)	25 (36.93)	19.15 (51.10)	42 (48.57)	6.67 (52.61)	0.66 (52.50)	9.89 (50.43)	45.72	
16	PRP_{12} × BY1	147 (45.06)	71 (45.84)	28 (46.42)	20.48 (60.88)	41 (56.09)	6.88 (61.74)	0.69 (60.00)	10.03 (56.52)	54.07	III
	Mean	152	73.4	29.13	19.00	41.81	6.61	0.65	9.88		
	S.D.	10.12	5.79	3.16	1.36	1.33	0.23	0.04	0.23		
	S.E.	2.53	1.45	0.79	0.34	0.33	0.06	0.01	0.06		
	C.D.@5%	7.01	4.01	2.19	0.94	0.92	0.16	0.03	0.16		