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Screening of Multi × BI Silkworm Hybrids for Adverse Season for Sub-Tropical Areas

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Abstract

Twenty five multi × bi hybrids were prepared to identify promising hybrids under adverse rearing seasons for sub-tropical areas. Observations were made on 12 economically important cocoon and silk contributing characters. Data were analyzed by anova and multiple Mano's evaluation Index methods. Ten hybrids recorded mean evaluation index values > 50 ranging from 50.60 to 62.94. Three hybrids viz. G × Chang Nang, M_2 × NB_4D_2 and Sarupat × NB_4D_2 recorded EI values of 62.94, 57.65 and 56.99 respectively and were found to be best for rearing during adverse season for sub-tropical areas.
Key words : Multi × bi hybrids, *Bombyx mori* L., Adverse season.

Silkworm (*Bombyx mori* L.) is one of the most important domesticated insects. Centuries of domestication have led to development of different races suited for different agro climates. Two groups of races viz. bivoltine and multivoltine races having distinct features are widely reared. The bivoltine races are high yielders but do not have resistance to large temperature fluctuations. These races are suitable for temperate areas only where temperature does not exceed 30 C where as multivoltine races are low yielders with tough characters and can tolerate slightly higher temperature conditions. In sub-tropical areas like Jammu, winter and summer seasons show extremes of temperature conditions and rearing of bivoltines is possible only during spring and autumn season when temperatures are sub-30 C. During adverse season (summer) multi × bi hybrids are known to yield good results as they inherit yield character of bivoltine race and toughness of multivoltine blood. Govindan et al. (1) and Kantaratanakul et al. (2) have emphasized the use of multi × bi hybrid rearings for commercial purpose. In view of this background the present study was taken up to screen some multi × bi hybrids during unfavorable seasons i.e., late spring (May) and early autumn (June) under sub-tropical conditions of Jammu so as to increase the number of commercial rearings per year which at present is just one only.

Methods

In the present study five multivoltine races viz. G, Nistari, M_2, Sarupat and Raj were crossed with five bivoltine races viz. J_{122}, Chang Nang, Yakwei, Pam-101 and NB_4D_2. Twenty five combinations were made with female component of multivoltine and male component of bivoltine races.

Hybrids were reared twice during early and late summer (May/June) following normal practice (3). Observations were made on different characters which included hatching percentage, larval weight, larval duration, ERR by number and weight, cocoon weight, shell weight, shell percentage, cocoon yield per 100 dfls filament length, denier, renditta and reelability. The experiment was laid in randomized block design with three replicates. Data of two rearing seasons were pooled for analysis following Panse and Sukhatme (4) and Mano's multiple trait evaluation method (EI) to screen the promising hybrids for commercial exploitation (5).

$$EI = \frac{A\text{-}B \times 10 + 50}{C}$$

Where A = Value obtained for a particular trait of a particular hybrid combination, B = Mean value of a

Table 1. Average values of some worm characters in different hybrids.

	Hybrid	Hatching (%)	Worm wt (g/10 worm)	Larval duration D:H	ERR Wt. (kg)	ERR Number
1	G×J_{122}	93.83	34	27:00	13.350	9665
2	Nistari × J_{122}	94.94	31	25:03	12.480	9519
3	M_2 × J_{122}	95.88	31	26.06	12.880	8869
4	Sarupat×J_{122}	94.73	29	28.06	8.830	6978
5	Raj × J_{122}	93.97	30	26:08	10.380	8276
6	G × Chang Nang	94.14	36	25:23	14.140	9693
7	Nistari × Chang Nang	96.62	32	26:00	11.830	9360
8	M_2 × Chang Nang	93.16	31	26:03	13.230	9628
9	Sarupat × Chang Nang	94.55	33	26:00	9.100	6564
10	Raj × Chang Nang	94.32	32	25:23	13.270	9735
11	G × Yakwei	96.04	29	26:01	11.380	9040
12	Nistari × Yakwei	98.85	31	24:00	9.870	8569
13	M_2 × Yakwei	95.71	31	26:00	13.080	8900
14	Sarupat × Yakwei	94.78	31	27:00	11.510	8850
15	Raj × Yakwei	94.81	34	27:04	11.020	9500
16	G× Pam 101	96.87	31	27:00	11.040	9356
17	Nistari × Pam 101	94.13	29	25:15	10.890	9058
18	M_2 × Pam 101	97.00	34	25:18	12.370	7815
19	Sarupat × Pam 101	87.58	31	26:14	8.080	6326
20	Raj × Pam 101	93.87	28	25:18	11.500	8972
21	G × NB_4D_2	94.14	31	28.01	8.020	5786
22	Nistari×NB_4D_2	96.00	32	27:07	7.930	6215
23	M_2 × NB_4D_2	95.59	31	26:21	13.770	9778
24	Srupat×NB_4D_2	96.58	32	27:06	12.930	9563
25	Raj × NB_4D_2	87.75	31	27:01	9.030	6694
	CD 5%	NS	1.963	0.727	2.655	1524

particular trait of all the hybrid combination, C = Standard deviation of a particular trait of all the hybrid combinations.

Results and Discussion

The results obtained on different characters have been summarized in Tables 1 to 4. Although there are about 21 characters contributing towards silk yield (6) in the present study 12 major economic characters were studied. The data show significant differences amongst different hybrids for all the characters. Table 1 reveals that most of the hybrids recorded hatching percentage >90 with best value of 98.85% in Nistari × Yakwei and lest hatching percentage of 87.58% in Sarupat × Pam-101. Worm weight of 10 mature larvae showed a range of 36 g in G × Chang Nang to 28 g in

Table 2. Average values of some cocoon characters of different hybrids.

	Hybrid	Cocoon wt (g)	Shell wt (g)	Shell ratio (%)	Cocoon yield (kg/100 dfls)
1	G × J_{122}	1.39	0.256	18.41	49.560
2	Nistari × J_{122}	1.28	0.191	14.92	41.560
3	M_2 × J_{122}	1.28	0.215	16.79	49.160
4	Sarupat × J_{122}	1.29	0.252	19.53	27.400
5	Raj × J_{122}	1.24	0.219	17.66	30.100
6	G × Chang Nang	1.46	0.264	18.08	53.670
7	Nistari × Chang Nang	1.28	0.198	15.46	44.960
8	M_2 × Chang Nang	1.44	0.247	17.15	45.000
9	Sarupat × Chang Nang	1.43	0.257	17.97	23.700
10	Raj × Chang Nang	1.38	0.247	17.89	48.430
11	G × Yakwei	1.25	0.205	16.40	42.700
12	Nistari × Yakwei	1.37	0.178	12.99	33.500
13	M_2 × Yakwei	1.33	0.223	16.76	50.360
14	Sarupat × Yakwei	1.30	0.222	17.07	33.400
15	Raj × Yakwei	1.21	0.208	17.19	33.060
16	G × Pam 101	1.27	0.219	17.24	32.760
17	Nistari × Pam 101	1.29	0.206	15.96	35.060
18	M_2 × Pam 101	1.21	0.224	18.51	40.200
19	Sarupat × Pam 101	1.31	0.231	17.63	33.130
20	Raj × Pam 101	1.22	0.227	18.60	27.600
21	G × NB_4D_2	1.44	0.245	17.01	30.700
22	Nistari × NB_4D_2	1.38	0.233	16.88	32.830
23	M_2 × NB_4D_2	1.47	0.268	18.23	37.260
24	Sarupat × NB_4D_2	1.43	0.270	18.88	35.630
25	Raj × NB_4D_2	1.29	0.228	17.67	18.730
	CD 5%	0.14	0.033	1.61	7.623

Table 3. Average values of post cocoon characters of different hybrids.

	Hybrid	Filament length (m)	Denier (d)	Reelability (%)	Renditta (kg)
1	G × J_{122}	861	1.50	82	1.95
2	Nistari × J_{122}	617	1.70	83	2.72
3	M_2 × J_{122}	715	1.92	77	2.04
4	Sarupat × J_{122}	698	1.72	73	2.81
5	Raj × J_{122}	807	1.83	86	2.17
6	G × Chang Nang	791	2.01	85	2.79
7	Nistari × Chang Nang	699	2.04	79	2.66
8	M_2 × Chang Nang	778	2.21	81	2.76
9	Sarupat × Chang Nang	833	1.81	82	2.87

Table 3. Continued.

Hybrid	Filament length (m)	Denier (d)	Reelability (%)	Renditta (kg)
10 Raj × Chang Nang	851	1.90	85	2.55
11 G × Yakwei	741	1.87	81	2.71
12 Nistari × Yakwei	502	1.84	69	2.97
13 M_2 × Yakwei	684	1.96	83	2.41
14 Sarupat × Yakwei	679	2.03	73	2.88
15 Raj × Yakwei	593	2.11	76	2.76
16 G × Pam 101	653	2.09	75	3.12
17 Nistari × Pam 101	681	1.69	70	3.29
18 M_2 × Pam 101	763	1.80	80	3.26
19 Sarupat × Pam 101	775	1.89	83	2.30
20 Raj × Pam 101	767	2.05	82	2.45
21 G × NB_4D_2	790	1.80	74	3.10
22 Nistari × NB_4D_2	699	1.93	75	2.74
23 M_2 × NB_4D_2	830	2.16	85	2.47
24 Sarupat × NB_4D_2	824	2.59	79	2.80
25 Raj × NB_4D_2	803	1.81	83	2.11
CD 5%	123.9	0.35	6.5	0.60

Raj × Pam-101. In most of the hybrids average mature larval weight observed was 31.40 g. The total larval period on an average stood at 26 d : 06 h with a maximum larval span of 28 d : 06 h in Sarupat × J_{122} and a minimum of 24 d : 00 h in Nistari × Yakwei.

Table 2 records the observations on the cocoon characters of 25 hybrids studied. During adverse season, single cocoon weight remained under 1.5 g with a maximum single cocoon weight of 1.47 g in M_2 × NB_4D_2 and a minimum of 1.21 g in M_2 × Pam-101 and Raj × Yakwei. The cocoon shell showed an average of 0.229 g and in hybrid Sarupat × NB_4D_2 a maximum of 0.270 g and a minimum of 0.178 g in Nistari × Yakwei was recorded. The cocoon shell ratio fluctuated from 19.53% in Sarupat × J_{122} to 12.99% in Nistari Yakwei. Hybrid G × Chang Nang recorded a maximum of 53.760 kg cocoon yield from 100 dfls while as Raj × NB_4D_2 had least cocoon yield of 18.730 kg per 100 dfls. On an average cocoon yield stood at 37.222 kg per 100 dfls during adverse season.

Table 3 records the result of post cocoon parameters. In hybrid G × J_{122} maximum filament length of 861 m was recorded. Hybrid Nistari × Yakwei recorded the shortest filament length of 502 m. Denier showed wide variation ranging from a high of 2.21 d to 1.50 d in G × J_{122}. Highest reelability of 86% was observed in Raj × J_{122} with least 69% in hybrid Nistari × Yakwei. Renditta on dry weight basis ranged between 3.290 kg in Nistari × Pam-101 to 1.950 kg in G × J_{122}. Table 3 shows that G × J_{122} produced best results for filament length and renditta which are two important characters from reeling point of view. However hybrid G × Chang Nang excelled in worm weight and ERR by weight parameters.

In silkworm, large number of hybrids needs to be tested and amongst them promising ones selected on

Table 4. Average evaluation index values of 10 selected hybrids for commercial traits.

Hybrid	Hatching	Wt of 10 mature larvae	Larval life	ERR/10,000 larvae By wt	ERR/10,000 larvae By no.	Single cocoon wt	Single shell wt	Shell ratio	Yield/100 dfls	Non-breakable filament length	Denier	Renditta	Reelability	Av EI
1 G × Chang Nang	50.29	76.51	45.10	64.89	59.14	66.25	70.00	56.81	68.30	56.53	88.57	53.88	62.02	62.94
2 M_2 × NB_4D_2	53.17	47.94	55.30	63.12	59.80	67.50	70.00	55.92	50.07	60.94	58.21	45.00	62.54	57.65
3 Sarupat × NB_4D_2	55.13	53.65	62.55	58.75	58.14	62.50	75.00	64.81	48.19	60.26	37.85	54.16	49.97	56.99
4 G × J_{122}	49.88	65.08	55.30	60.78	58.92	57.50	65.00	58.14	63.66	64.44	34.64	30.55	55.38	55.32
5 M_2 × Chang Nang	48.35	47.94	46.83	60.15	58.64	65.00	60.00	47.55	58.68	55.07	60.00	53.05	54.93	55.09
6 Raj × Chang Nang	50.65	53.65	45.10	60.36	59.47	57.50	60.00	52.81	62.34	55.86	48.92	47.22	61.14	55.00
7 M_2 × Pam 101	55.97	65.08	42.95	55.67	44.64	35.00	50.00	59.62	53.28	53.37	45.35	66.94	51.25	52.24
8 M_2 × Yakwei	53.42	47.94	45.51	59.37	53.02	50.00	50.00	47.48	64.55	44.45	51.07	43.33	58.91	51.46
9 Sarupat × Chang Nang	51.11	59.37	45.51	38.69	34.98	62.50	65.00	54.44	35.04	61.28	45.71	56.11	51.02	50.82
10 G × Pam 101	55.71	47.94	55.71	48.75	56.54	43.75	50.00	52.22	45.10	40.94	55.71	63.05	42.27	50.60

the basis of their economic traits (5, 7). The rationale for judging the utility of values are actually based on the reason that all the characters considered in such studies are important in making a decision jointly in selecting the promising hybrids based on the number of economic characters which are of great importance to silkworm rearers and reelers. Minagawa and Otsuka (8) have reported existence of inter-relationship between multiple characters in silkworm and the yield potential requires cumulative effect of major contributing characters which influence silk yield (5). For short listing the best hybrids, Mano's multiple evaluation index was applied (Table 4). The EI analysis reveals that only ten hybrids qualified the average EI value of >50. The EI values ranged from 62.94 to 50.60. The best result of 62.94 EI value was recorded in G × Chang Nang. This hybrid registered EI value of >50 in almost all characters (Table 4). Hybrids $M_2 \times NB_4D_2$ and Sarupat × NB_4D_2 were second best with EI values of 57.65 and 56.99 respectively followed by G × J_{122}, M_2 × Chang Nang and Raj × Chang Nang with average EI values of 55.32, 55.09 and 55.00 respectively.

As regards superior male component, Chang Nang behaved better in its multi × bi constituents for all the characters studied followed by NB_4D_2 and Pam-101 whereas M_2 behaved better as female component in short listed hybrids. This is also evident from data recorded on yield component wherein hybrid G × Chang Nang recorded 53.760 kg of cocoon yield/100 dfls followed by M_2 × Yakwei with 50.360 kg.

Conclusion

From the foregoing discussion on the rearing performance of multi × bi hybrids, conclusion can be drawn that the behavior of Chang Nang and NB_4D_2 among bivoltines and M_2 and G among multivoltine races with G × Chang Nang and $M_2 \times NB_4D_2$ as multi × bi hybrids are best for rearing during adverse season under sub-tropical conditions of Jammu which can supplement the earning of poor silkworm rearers.

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