The Pharma Innovation Journal 2021; 10(6): 1279-1281

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(6): 1279-1281

www.thepharmajournal.com
Received: 03-04-2021
Accepted: 05-05-2021

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Evaluation of tropical and temperate breeds of silkworm *Bombyx mori* L. under different seasons in Kashmir

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Abstract
The results of the present study indicated that fifth instar larval duration was short in SH_6 (173.01h) and Nistari (149.70h) during spring and summer respectively. Total larval duration was recorded shortest in NB4D2 (645.56h) during spring, however during summer it was short in Nistari (501.16h). SKUAST-28 recorded the shortest total larval duration of 667.97h among the bivoltines during the same season. Significantly higher cocoon yield by number (9116.50 cocoons/10,000 larvae) and by weight (16.95 kg) was recorded by SKUAST-28 during spring, while during summer cocoon yield by number was high in Nistari (9399.87cocoons/10000 larvae).

Keywords: *Bombyx mori L., cocoon yield, larval duration, survival, spring.*

Introduction
Rural poverty has many forms and is much more complex phenomenon. Poverty alleviation requires suitable policy interventions and appropriate technological options that can increase agricultural productivity without adversely affecting the productive capacity of natural resources (Dewangan *et al.*, 2011) [6]. Indian economy is currently suffering from high incidence of rural poverty, un-employment and under-employment. Under such circumstances adoption of multidiscplinary income augmenting ventures is of paramount importance which will not only go in a long way to increase the better livelihood earnings but will definitely improve the socio-economic status of farmers. One such venture which not only is women friendly, but also fetches quick returns to the farmers comparatively at a greater ease, is sericulture-the practice of silkworm, *Bombyx mori* L rearing for production of cocoons which finally yields splendid fabric of high elegance and drupability. Sericulture is practiced in 52,360 villages all over the country (Bharathi, 2016) [5]. At present, the raw silk production of India is 36,152 MT while the domestic demand is 42000MT (Anonymous, 2020a) [1]. Thus, there is scope for production of additional quantity of quality silk in the country to meet the domestic demand.

Jammu and Kashmir is the traditional sericulture belt of India where sericulture is practiced in 20 districts. The major silk producing districts are Anantnag, Kupwara, Pulwama, Bandipora, Baramulla, Ganderbal, Udhampur, Rajouri, Reasi and Kathua. Kashmir silk is considered of very high quality as per the international quality standards. Presently, about 27,000 rural families are directly or indirectly associated with the silk industry and are generating an income of Rs.2026.00 lakhs annually (Anonymous, 2020b) [2]. The cocoon and the raw silk production in J&K during 2019-20 were 890MT and 117 MT respectively (Anonymous 2020b) [2] which is much less than the capacity and scope of silk production JKUT has. Therefore the present study was framed with an aim to find a prolific silkworm breed with higher survival under varied climatic conditions.

Materials and Methods
Six breeds of the mulberry silkworm, *Bombyx mori* L. comprising of two multivoltines (Pure Mysore and Nistari), two temperate bivoltine breeds (SKAU-R-6 and SKUAST-28) and two tropical bivoltine breeds (NB_4D_2 and SH_6) were evaluated in the present study. Disease free layings of these races were obtained from the germplasm bank maintained at Central Sericultural Germplasm Resource Centre (CSGRC), Hosur Tamil Nadu and Silkworm Breeding and Genetics section of COTS (SKUAST-K).The material was incubated under laboratory conditions at 25ºC and relative humidity of 75 per cent and then allowed to hatch. Rearing of all the silkworm breeds under study was carried out as per the standard package of

practices. After 3rd moult counting of the worms was done and for each treatment three replications were maintained and each replication comprised of 200 silkworms of uniform age and size. The statistical design of the experiment was design completely randomized block design. At the end of the experiment the following observations were recorded:

Fifth age larval span (hr): It was calculated as total hours taken from the first day of fifth age upto mounting of the ripe worms.

Total larval duration (hr): It was calculated as total hours taken from the date of brushing to the mounting of ripe worms.

Effective rate of rearing (by number): The effective rate of rearing by number was calculated by adopting the following formulae:

$$\text{By Number} = \frac{\text{No. of cocoons harvested from each replicate}}{\text{No. of worms retained after } 3^{rd} \text{ moult}} \times 10{,}000$$

Effective rate of rearing (by weight: The effective rate of rearing by weight was calculated by adopting the following formulae:

$$\text{By weight (kg)} = \frac{\text{Weight of cocoons harvested from each replicate}}{\text{No. of worms retained after } 3^{rd} \text{ moult}} \times 10{,}000$$

Statistical analysis

The data so generated was put to statistical analysis (OP Stat) for interpretation of the results.

Results and Discussion

1. **Fifth instar larval duration (h):** The larval duration is considered as an important trait by sericulturists as the reduction in larval duration would help in minimising the quantum of the total food consumption and labour requirement, besides completion of larval period within a desirable time period. In the present study, fifth instar larval duration was found to be shortest in SH_6 (173.01h) and bivoltine breeds were found to register lower larval duration as compared to the tropical multivoltine breeds during spring (Table-1). However, during summer the trend was reverse and there was reduction in the fifth instar larval duration of tropical multivoltine breeds, whileas all the bivoltine breeds except SKUAST-28 showed an increase in the fifth instar larval duration. Among the bivoltine breeds SH_6 recorded the significantly low fifth instar larval duration of 177.18h during summer (Table-2). The current results are similar to the findings of Hadimani (2000) [7] and Ashoka *et al.* (2012) [3]. Mukherjee *et al.* (1999) [13] also reported the longer fifth instar larval duration in Pure Mysore during spring season and is in agreement with our findings. The reduction in the total and fifth instar larval period with increase in rearing temperature could be attributed to the growth rate which is directly related to the prevailing temperature in silkworm (Shiv Kumar *et al.*, 1995) [17] and other insects (May, 1985) [12].

2. **Total larval duration (h):** Total larval duration was comparatively shorter in bivoltine breeds than the tropical multivoltine breeds during spring season, whereas the trend was vice-versa during summer season (Table-1 and Table-2). The shortest total larval duration was recorded in case of NB_4D_2 (645.56h) during spring, while it was recorded shortest in case of Nistari (501.16h) during summer season. The present results are in conformity with the report of Ashoka *et al.* (2012) [3], who observed the total larval duration of 600.17h for MY_1 (a multivoltine breed) and 789.37h for KSO_1(a bivoltine breed) during summer. Kumaresen *et al.* (2004) [10] alo made the similar type of observations and reported shorter larval duration (552.00h) in respect of C.Nichi, a multivoltine breed than NP_2 (624.11h) under tropical climatic conditions. The variations in larval duration could be due to difference in the quality of leaf and seasonal variations.

3. **Effective rate of rearing (By number):** Survival rate (by number) was reported higher under present investigation in bivoltine breeds than the tropical multivoltine breeds during spring and it was significantly higher in SKUAST-28 (9116.50/10,000 larvae) among all the breeds studied (Table-1). The higher cocoon yield in bivoltine breeds in spring season than summer could be attributed to the higher survivability of the breeds due to favourable hygro-thermic conditions for the rearing and availability of quality mulberry leaf. These findings are well supported by Legay (1958) [11] who reported that cocoon production is chiefly dependent on nutritive value of mulberry leaves and the conversion efficiency of the larvae which is affected by weather conditions. However, during summer, effective rate of rearing was higher in tropical multivoltine breeds than the bivoltine breeds. Higher effective rate of rearing in case of multivoltine breeds viz., Nistari (9399.87/10,000 larvae) and Pure Mysore (8100.00/10,000 larvae) during summer (Table-2) obtained in the present study are in line with the findings of Krishna Rao *et al.* (2001) [9] who reported that effective rate of rearing was highest in Pure Mysore (94.19%) and MH1 (92.35%) under tropical conditions. Jolly (1986) [8] also reported higher effective rate of rearing in multivoltine breeds under high temperature conditions and this is in conformity with the present findings. The present observations are also in tune with the finding of Murugesh *et al.* (2011) [14], who observed higher effective rate of rearing in the multivoltine breeds than the bivoltines. In the present study, it was also observed that among bivoltine breeds, SKUAST-28 recorded highest effective rate of rearing by number (6900.00/10,000 larvae) during summer, which could be attributed to the better nutrient utilization ability of the breed and the breed potential for high temperature tolerance could be due to the expression of some thermo-tolerant genes (hsp's) under high temperature conditions. Similar type of studies have been carried out by Naseema Begum *et al.* (2001) [16], who evolved a number of thermo-tolerant bivoltine breeds for rearing under adverse climatic conditions of summer season.

4. **Effective rate of rearing (by weight):** Cocoon yield (by weight) was significantly higher in SKUAST-28 (16.95 kg and 11.82 kg/10,000 larvae) during both the seasons and all the bivoltine breeds proved to be better breeds than the multivoltines with respect to this parameter during spring. However, reverse trend was observed during summer season except for SKUAST-28, which

again excelled in summer among all the races studied (Table 1& 2). Similar type of results have been reported by Narayanswamy *et al.* (2000) [15], who reported highest cocoon yield in NB_4D_2 (252.37g/200 larvae) and by Ashwath *et al.* (2010) [4] who found maximum effective rate of rearing (by weight) in CSR_2 (17.9 kg/10,000 larvae). The difference in the cocoon yield (by weight) could be attributed to climatic factors prevailing during the rearing and the potential of the breed to adjust to the prevailing environment.

Table 1: Larval duration and cocoon yield of different breeds of silkworm, *Bombyx mori* L. during spring seasons (Data pooled over same seasons of 2011 and 2012)

Race	Fifth Instar larval duration (hrs)	Total larval duration (hrs)	Cocoon yield/10,000 larvae	
			By number	By weight (kg)
Pure Mysore	208.86	668.33±5.11	7166.62±58.92	8.91±0.04
Nistari	226.10	746.49±4.31	7683.25±82.49	8.22±0.01
NB_4D_2	173.70	645.56±4.98	8033.37±31.18	15.55±0.18
SH_6	173.01	652.63±5.83	7466.20±206.49	13.22±0.11
SKAU-R-6	188.64	647.06±5.11	8216.63±47.13	14.94±0.33
SKUAST-28	198.75	658.95±5.71	9116.50±297.44	16.95±0.14
$C.D_{(p\leq 0.05)}$	4.231	5.671	464.794	0.525

Each value represents the mean±S.E of four replications

Table 2: Larval duration and cocoon yield of different breeds of silkworm, *Bombyx mori* L. during summer seasons (Data pooled over same seasons of 2011 & 2012)

Race	Fifth Instar larval duration (hrs)	Total larval duration (hrs)	Cocoon yield/10,000 larvae	
			By number	By weight (kg)
Pure Mysore	161.73	584.50±4.91	8100.00±35.34	10.43±0.01
Nistari	149.70	501.16±3.84	9399.87±35.35	10.80±0.07
NB_4D_2	191.05	669.39±6.06	6400.00±124.16	10.02±0.16
SH_6	177.18	680.46±7.11	6066.62±96.46	9.41±0.009
SKAU-R-6	194.25	669.37±7.04	5166.62±31.17	8.53±0.06
SKUAST-28	190.22	667.97±7.04	6900.00±35.34	11.82±0.10
$C.D_{(p\leq 0.05)}$	3.910	3.141	209.750	0.265

Each value represents the mean±S.E of four replications

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