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SEASONAL EFFECTS ON DEVELOPMENT AND ECONOMIC CHARACTERS OF MUGA SILKWORM (ANTHERAEA ASSMA WESTWOOD)

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Abstract

The environmental conditions plays a significant role and influence the quantitative and qualitative characters of silkworm such as larval duration, larval growth, effective rate of rearing, single cocoon weight, shell weight, pupal weight, silk ratio, filament length, denier and reelability of cocoon etc. Larvae of muga silkworm (*Antheraea assma* Ww.) were reared on Som (*Persea bombycina* Kost.) in different seasons / crops namely Katia, Jethua, Bhadia, Chatua, Aherua and Jarua crop. The data were recorded as Larval duration 29.74±0.550 days, 27.26±0.893 days, 25.01±0.076 days, 34.22±0.284 days, 23.28±0.200 days and 46.25±0.396 days; Effective Rate of Rearing by number 57.85x1.110 %, 55.52±0.580 %, 44.42±0.774 %, 42.50±0.590 %, 39.68±l.020 %, 36.15±l.210 %; Single cocoon weight Male 4.890±0.119(gm), Female 7.226±0.399(gm); Male 4.750±0.109(gm), Female 7.175±0.145(gm); Male 4.390±0.393(gm), Female 6.515±0.321(gm); Male 2.875±0.149(gm), Female 4.595±0.285(gm); Male 4.350±0.414(gm), Female 6.389±0.348(gm); Male 3.765±0.430(gm), Female 4.975±0.441(gm); Single shell weight Male 0.484±0.015(gm), Female 0.670±0.071(gm); Male 0.450±0.038(gm), Female 0.655±0.061(gm);

Male 0.420±0.018(gm), Female 0.595±0.041(gm); Male 0.243±0.040(gm), Female 0.362±0.020(gm); Male 0.395±0.064(gm), Female 0.560±0.058(gm); Male 0.332±0.015(gm), Female 0.395±0.051(gm); Shell Ratio Male 9.897±0.221(%), Female 9.272±0.629(%); Male 9.663±0.723(%), Female 9.129±0.866(%); Male 9.567±0.637(%), Female 9.132±0.332(%); Male 8.452±1.078(%), Female 7.878±0.289(%); Male 9.080±1.032(%), Female 8.765±1.087(%); Male 8.818±0.731(%), Female 7.940±0.690(%); filament length 589.00±5.910m, 407.00±4.620m, 390.60±8.130m, 278.00±6.928m, 450.60±9.710m, 256.30±6.020m in Katia, Jethua, Bhadia, Chatua, Aherua and Jarua crop respectively. The highest non breakable filament length was found in Katia crop and lowest in Jarua crop. Denier 5.40±0.042, 5.20±0.117, 4.77±0.047, 4.38±0.019, 4.72±0.023 and 4.47±0.016; Reelability 91±0.943(%), 91±0.816(%), 88±1.633(%), 84±1.054(%), 87±1.633(%) and 80±1.247(%) in Katia, Jethua, Bhadia, Chatua, Aherua and Jarua crop respectively.

INTRODUCTION

Assam is the homeland for natural silk of fine texture. It was very much demanding Europe and formed a trade of the East India Company during the 18th through early 19th centuries. The custom house at Haida opposite Goalpara, fixed a duty fees of 10% according to the terms of commercial treaty executed with Gaurinath Singh by Captain Welsh on behalf of East India company in 1793 A. D. Around 224 mounds of Muga silk thread were exported and the value was placed at Rs. 53899.00 during that period (Gait, 1905). The muga silk, peculiar to the country, affords the dress which is considered rich and valuable (Robinson, 1941, Barua, B.K., 1969). The chief jungle products of the Goalpara districts are bees wax and dyes; but it is supposed that fibre are to be found, and that will be that these will be form an article of trade (Hunter, W.W. 1998). The first official records of Muga silkworm and Muga silk culture appeared in 1662. The culture of silkworm could be traced out from the notes of great writer Shihabuddin tallish, who was accompanied by Mirjumla at the time of invasion of Assam, (Guwahati was occupied on 4th Feb, 1662). There was mention in his describing on the dresses, the people of Assam used. The collection of official papers issued by the Bengal Board of Trade in 1819 mentioned of mooga (Muga) being the most common and plentiful, the thread coarse but winds easily. The gutis (cocoon) were sold direct from the forest. This was mentioned separately from 'tussah' (tasar) silk so that its very feasibility was intended to denote muga silkworm (Watt, 1893).

Muga silkworm *Antheraea assama* Westwood is endemic polyphagous insect and feeds on a wide range of different food plant species mainly Som (Assamese) locally known (Bennet,

1887) [*Persea bombycina* (King ex Hook. f.) Kosterm, formerly named as *Machilus bombycina* (King ex Hook. f.)], Soalu (*Litsea monopetela* Roxb.= *polyantha* Juss.) and few other food plants. Som is one of the major consumed species throughout North Eastern India for muga silkworm rearing that produces natural muga (Assamese), or golden silk nowhere in the world (Chowdhury, 1982).

The muga silkworm is multivoltine in nature, having five to six generations, successive broods in a year in which the worms were bred and spun cocoons are designated in the Assamese calendar as 'Jethua', 'Aherua', 'Bhadia', 'Katia', 'Jarua' and 'Chatua' corresponding to the months of April-May, June-July, July-August, September-October, November-December and February-March, respectively, (Watt,1893; Robinson,1941); Chowdhury,1964c, 82, 92; Bharali, 1968, 69, 70b, 71;Gogoi,1977, 79a; Borah *et al.*,1988; Thangavelu *et al.*,1988; Subha Rao,1998; Sahu *et al.*,2000). The commercial crops during autumn and spring namely 'Katia' and 'Jethua' producing quality silk and the other seed crops were Jarua, Chatua, Aherua and Bhadia, (Subha Rao, 1998). 'Aherua' and 'Bhadia' seed broods were reared chiefly in Kamrup district and some part of Goalpara district (Watt, 1893). Occasionally 'Bhadia' brood of inferior quality was reared in Sibsagar on high lying patches.

The larvae are reared in different photoperiodic regimes; the effect of temperature can influences the effect of photophase during the developmental period. High temperature and constant light as well as low temperature and short photophase are deleterious with respect to food utilization and growth. The sensitivity to photoperiod decreases towards fifth instars when the larvae are more sensitive to temperature. This sensitivity of the insect to light and temperature may help to formulate conservation strategy (Bora, 2006).

The rearing parameters i.e. larval duration, effective rate of rearing, melting percentage; cocoon characters i.e. single cocoon weight, shell weight, shell ratio; reeling parameters i.e. average filament length, denier, rendita, reelability percentage are depend upon the ideal environmental condition i.e. 23°C temperature and 70% relative humidity during the spinning of mulberry silkworm CSR hybrids CSR2 x CSR4 and CSR2 x CSR5 (Rahman, 1999).

The climate of Goalpara district is very hot and humid in summer and dry cool in winter. On the basis of temperature and rainfall the season of the place is divided mainly into winter, pre-monsoon, monsoon and summer. The maximum temperature is up to 38° Celsius and minimum, 8° Celsius during summer and winter respectively. The average relative humidity is 51.1%-91.2% at day and 35.3-%-75.2% at night during summer and winter respectively (Taher

and Ahmed, 2001). Various factors i.e. temperature, humidity, photoperiod and air current influence the physiological activities affecting their growth and development as well as the expression of economic traits (Kogure, 1933). The silkworm is cold blooded (Poikilothermic) insect and by nature quite delicate and very sensitive to the environmental condition. Therefore, silkworm rearing has a certain amount of risk invariably experienced by sericulturists as it is greatly influenced by the environmental factors, i.e. temperature, humidity, photoperiod and air current from incubation to cocooning Tazima, (1978).

Hence, it is essential to ascertain the seasonal effect of environmental condition in different crop which is the best for rearing of muga silkworm to get higher production and quality of silk an ultimate goal to increase the production and productivity of the cocoon per unit area and time with low cost of production for improving economic condition of the poor sericulture farmers. In this context the present study has been undertaken.

MATERIALS AND METHOD

The study of seasonal effects on the growth, development and economic characters of Muga silkworm and experiments pertaining to some aspects of its were carried out in Govt. Sericulture Farm, Agia, Goalpara district and Govt. Muga Reeling Unit Khanapara, Assam, India, different seasons from February, 2012 to January, 2015.

The general method of outdoor rearing of muga silkworm was followed as recommended by Bharali, (1970) and Choudhury, (1982). The rearing was conducted in six different crops/ seasons and observations were made on different aspects of silkworm growth and rearing performance, cocoon parameters. Cooking and reeling of muga cocoons were done by method suggested by Chowdhury, (1970b) and Rathi *et. al.*, (1988).

The experiment was laid out in completely randomized design. The data were statistically analyzed by Fisher's methods of analysis of variance following Panse and Sukhatme (1989).

Figure: Study Area Govt. Sericultural Farm, Agia, Goalpara district, Assam

RESULTS AND DISCUSSION

The study reveals that there are

considerable variations in rearing performance and cocoon characters when the muga silkworm reared in different seasons/ crops. The growth, development of muga silkworm and the economic characters in all crops are not equal. The growth, development of muga silkworm and the economic characters of muga silkworm reared in all the different seasons on Som are recorded as below.

Larval period

The larval period is directly correlated with the surrounding environmental conditions specially temperature and relative humidity prevailing during the rearing. The larval duration was recorded 29.74±0.550 days in Katia crop, 27.26±0.893 days in Jethua crop, 25.01±0.076 days in Bhadia crop, 34.22±0.284 days in Chatua crop, 23.28±0.200 days in Aherua crop and 46.25±0.396 days in Jarua crop. The shorter larval duration was found in Aherua crop and longer larval duration was in Jarua crop (Table 1, Figure1). Similar study made by some authors Kakati *et al*., 2004 and found that the larvae complete within 20-25 days in summer and 45-55 days in winter. Watt (1893) mentioned the minimum and maximum periods were 26-40 days in larval stage. Chowdhury, (1982) reported that 24-70 days in larval stage.

Full grown larval weight

Table 1 & Figure 2 show the full grown larval weight of muga silkworm. The fully mature larva attains male 8.640±0.090 gm, female 13.100±0.495 gm in Katia crop, male 8.490±0.033 gm, female 12.525±0.069 in Jethua crop, Male 6.540±0.559gm, female 12.245±0.141 in Bhadia crop, male 6.940±0.011gm, female 10.950±0.030 gm in Chatua crop, male 6.343±0.136 gm, 12.230±0.048 gm Aherua crop and male 8.550±0.275, 12.690±0.037 in Jarua crop. The highest grown observed in Katia crop and lowest in Chatua crop. Generally the female larvae are larger and heavier than the male larvae.

Effective rate of rearing

Yield was recorded during all the crops (Table 1, Figure 3). The highest ERR by number was 57.85x1.110 % during Katia crop followed by 55.52±0.580 in Jethua crop, 44.42±0.774 in Bhadia crop, 42.50±0.590 in Aherua crop, 39.68±l.020 in Chatua crop and lowest 36.15±l.210 in Jarua crop. Similar results were reported by Siddiqui *et al*., (2000).

Table 1: Total larval period (days), Full grown larval weight (gram) and Effective rate of rearing (ERR) of muga silkworm in different crops

Crop/ Season	Total larval period (days)	Full grown larval weight (gram)		Effective rate of rearing
		Male	Female	
Katia	29.74±0.550	8.640±0.090	13.100±0.495	57.85x1.110
Jethua	27.26±0.893	8.490±0.033	12.525±0.069	55.52±0.580
Bhadia	25.01±0.076	6.540±0.559	12.245±0.141	44.42±0.774
Chatua	34.22±0.284	6.940±0.011	10.950±0.030	39.68±l.020
Aherua	23.28±0.200	6.343±0.136	12.230±0.048	42.50±0.590
Jarua	46.25±0.396	8.550±0.275	12.690±0.037	36.15±l.210

Data represent means of 3 replications (10 individuals/replication)

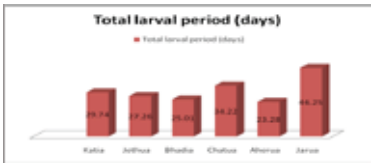

Figure 1: Total larval period (days) of muga silkworm in different crops

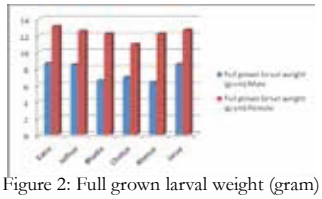

Figure 2: Full grown larval weight (gram) of muga silkworm in different crops

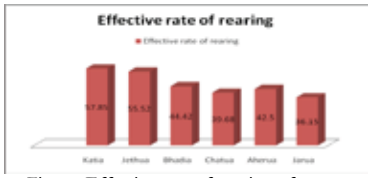

Figure: Effective rate of rearing of muga silkworm in different crops

Single cocoon weight

The results are presented in the Table 2 & Figure 4. A perusal of the data of table 2 that the maximum cocoon weight male and female have been obtained from the cocoons reared in Katia crop and lowest in Chatua crop. The Jethuwa and Khotia (Katia) were the best crops as to quality and quantity. The 'Aheruwa' and 'Bhadia' yielded a small quantity of inferior of silk (Robinson, 1941),

Single shell weight

The shell weight of different crops were recorded and presented in the table 2 and figure 5. The maximum shell weight male 0.484±0.015 gm, female 0.670±0.071 gm have been obtained from the cocoons reared in Katia crop and lowest male 0.243±0.040 gm and female 0.362±0.020 in Chatua crop.

Shell Ratio

The shell ratio was recorded and presented in table 2 & figure 6. Highest muga cocoon shell ratio was found male 9.897±0.221 %, female 9.272±0.629 % in Katia crop and lowest was male 8.452±1.078 % female 7.878±0.289 % in Chatua crop.

The cocoon productions in different seasons are not uniform in their commercial characters. The cocoon weight varies from 2.6-8.6gm, shell weight from 0.2-0.76gm, shell ratio percent from 4.7-10.5 %, (Borah *et al.*, 1988). Thangavelu, (1988) found that cocoon weights were to be 4.1gm, 5.2gm, 4.5gm, 4.5gm, and 5.8gm shell weights were 0.28gm, 0.48gm, 0.35gm, 0.35gm and 0.57gm in 'Chatua' 'Jethua', 'Aherua', 'Bhadia', 'Katia' respectively.

Table 2: Single cocoon weight, Single shell weight and Shell Ratio of muga silkworm reared in different crops.

Crop/ Season	Single cocoon wt (gm)		Single shell wt (gm		Shell Ratio (%)	
	Male	Female	Male	Female	Male	Female
Katia	4.890±0.119	7.226±0.399	0.484±0.015	0.670±0.071	9.897±0.221	9.272±0.629
Jethua	4.750±0.109	7.175±0.145	0.450±0.038	0.655±0.061	9.663±0.723	9.129±0.866
Bhadia	4.390±0.393	6.515±0.321	0.420±0.018	0.595±0.041	9.567±0.637	9.132±0.332
Chatua	2.875±0.149	4.595±0.285	0.243±0.040	0.362±0.020	8.452±1.078	7.878±0.289
Aherua	4.350±0.414	6.389±0.348	0.395±0.064	0.560±0.058	9.080±1.032	8.765±1.087
Jarua	3.765±0.430	4.975±0.441	0.332±0.015	0.395±0.051	8.818±0.731	7.940±0.690

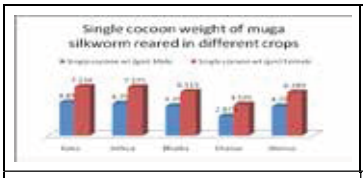

Figure 4: Single cocoon weight of muga silkworm reared in different crops

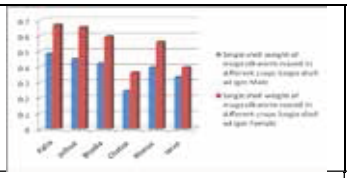

Figure 5: Single shell weight of muga silkworm reared in different crops.

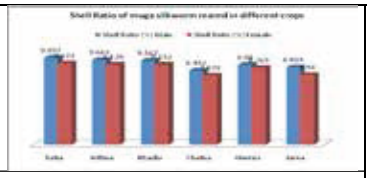

Figure 6: Shell Ratio of muga silkworm reared in different crops.

Average filament length

The continuous length of filament is very important character for commercial silk. Average length of the filament was taken out and calculated for single cocoon producing the filament in meter. Maximum filament length found 589.00±5.910m in Katia, 407.00±4.620m in Jethua, 390.60±8.130m in Bhadia, 278.00±6.928minChatua,450.60±9.710m in Aherua, 256.30±6.020m in Jarua crop (Table 3 & Figure 7). The reelable single cocoon filament length from 221-556 metre (Borah *et al.*, 1988), the filament length were 204m, 400m, 225m, 300m and 500m in 'Chatua' 'Jethua', 'Aherua', 'Bhadia', 'Katia' respectively Thangavelu, (1988).

Non breakable filament length

The table 3 & figure 8 shows the non breakable filament length (NBFL). The highest non breakable filament length was found in Katia crop and lowest in Jarua crop.

Average Filament size (Denier)

Denier is inversely proportional to rendita which is also a very important parameter to decide the rate of reeling cocoons. The denier of muga silkworm reared on different season recorded and presented in table 3 & Figure 9.

Reelability

The data represented in table 3 & figure 10. The reelability is highest in Katia but lowest in Jarua crop.

Table 3: Total filament length, Non breakable filament length, Denier and Reelability of muga silkworm reared in different crops.

Crop/ Season	Total filament length (m)	Non breakable filament length (m)	Denier	Reelability (%)
Katia	589.00±5.910	482.00±8.393	5.40±0.042	91±0.943
Jethua	407.00±4.620	383.20±1.590	5.20±0.117	91±0.816
Bhadia	390.60±8.130	335.10±16.454	4.77±0.047	88±1.633
Chatua	278.00±6.928	154.10±10.447	4.38±0.019	84±1.054
Aherua	450.60±9.710	302.00±:4.080	4.72±0.023	87±1.633
Jarua	256.30±6.020	135.50±8.963	4.47±0.016	80±1.247

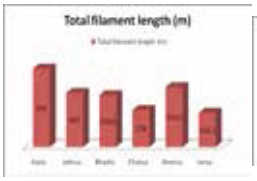

Figure 7: Total filament length of muga silkworm reared in different crops.

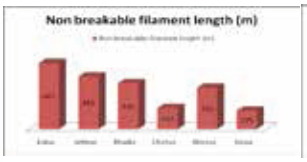

Figure 8: Non breakable filament length of muga silkworm reared in different crops

Figure 9: Denier of muga silkworm reared in different crops

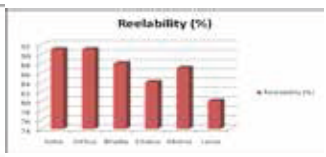

Figure 10: Reelability of muga silkworm reared in different crops

Conclusion

India is a tropical country and environmental conditions are the limiting factors of muga silkworm rearing. Majority of muga rearers encounters the various environmental problems and lose their crops or produce inferior quality of cocoon and silk. Based on the experiments and findings, the inference drawn in it is given below:

❖ The effective rate of rearing, larval weight, larval duration, cocoon weight, shell weights, denier, and reelability significantly depends on environmental conditions.

❖ Jarua crop (Dec-Jan) low temperature and low humidity conditions rearing should be avoided as larvae unable to take leave, hence, larval period increases significantly. Aherua crop (Jun-Jul), high temperature (34-36 °), high humidity (81-91%) during rearing to be avoided as the larvae become imbalance physiologically and susceptible to diseases due to their fluctuations, water stagnation in rearing field leading to high humidity, Wastage of early stage worms due to heavy rain and hailstorms, high incidence of pest and predators like ants, spiders, bugs, wasps, birds etc, high incidence of bacterial and viral diseases. During pre-seed and seed crops the climatic conditions mostly remain unsuitable with high incidence of diseases and heavy infestation of pest and predators.

By all the above modifications and suggestions, muga silkworm rearing may be conduct and quality of cocoons and silk can be improved where environmental variation is more.

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