GLOBAL JOURNAL OF BIO-SCIENCE AND BIOTECHNOLOGY

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A COMPARATIVE STUDY ON SIX STRAINS OF ERI SILK WORM (*SAMIA RICINI;* DONOVAN) BASED ON MORPHOLOGICAL TRAITS

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ABSTRACT
This study was conducted to compare six strains of eri silk worm, *Samia ricini* in terms of their growth and cocoon characters. The six strains of eri silk worms were identified morphologically and inbreeding was carried out for eight generations to get the six pure line strains. The six strains are Greenish blue plain (GBP), Greenish blue spotted (GBS), Greenish blue zebra (GBZ), Yellow plain (YP), Yellow spotted (YS), Yellow zebra (YZ) were arranged into six groups. The growth of larva, silk glands, Silk Gland Tissue Somatic Index(SGTSI), cocoon shell weight, shell ratio of all the six strains were compared and it was found that a correlation is exist between the larval and silk gland weight from which silk thread results as well as with cocoon characters. At the end of the fifth instars measurements were performed of larvae nweight on a number of 20 individuals from each strain groups. After that silk glands were extracted with dissection kit and their weight were determined by weighting with electronic balance. The YZ is reported to have the highest larval weight(6.57g) followed by YS(6.43g) where yellow plain has the least(5.77g).The yellow zebra recorded highest silk gland weight(1.40g) and highest Silk gland somatic index(21.21) which is followed by GBS (20.2). The growth rate is highest in all the strains during 1st instar and it decreases gradually with the advancement of the larval stages and highest growth rate was observed in case of YZ. A correlation study between them revealed a strong correlation between larval and silk gland weight r_{xy}=.96 in spring and r_{xy}=.65 in autumn. The strain YZ (14.09) recorded highest shell ratio followed by YS (13.92). GBS was recorded highest ERR (94.7%). GBP is better in terms of fecundity and ERR. Correlation is observed between larval and silk gland weight, cocoon shell weight. The study reported that the strain with higher larval weight have higher silk gland weight and also show high shell ratio. YZ was better in terms of larval and silk gland weight and also have higher shell ratio therefore expected to produce more fibers than other strains. This study revealed YZ as the best strain in terms of growth and cocoon characters. GBS and YS were also recorded as better strains for rearing and may be the better strains for hybridization with YZ.

KEYWORDS: Eri silkworm, Strain, larval silk gland, *Samia ricini*, pure line , inbreeding, cocoon, correlation, fecundity.

INTRODUCTION

The North East region of India is an ideal natural home for a variety of silkworms. A total of 47 species of silkworms are recorded from India, out of which 24 reported from North East region (Singh and Suryanarayan, 2005). Out of these only four species of sericigenous insects are cultured which are – muga, Eri, tasar and mulberry. Among these Eri and muga Silkworms are predominantly cultured in NE region. There are total 19 species of Eri (genus=Samia) all over the world of which only three species are reported from India and out of which two from NE region they are *Samia canningi* which is a wild species and *samia ricini*, a totally domesticated species (Pigler and Naumann 2003). The structure of the genitalia, wing pattern and chromosome number demonstrate that *Samia ricini (*Danovan) is derived from its wild form *samia canningi* (Hutton).Seven Eco-races of eri silkworm (*Samia ricini*) were collected from different locations of North East India and maintained at the Regional Research Station at Mendipathar. The Ecorces are Borduar, Titabar, Khanapara, Nongpoh, Mendipathar, Dhanu bhanga, Sille, Kokrajhar, Diphu etc.These races are evaluated during 1995-97 (siddiqui *et al.,* 2000). Sarmah *et al.* (2002) studied the diversity in eri silkworm eco-races and their utilization for sustainable development in north east India. Six pure line strains were isolated from Borduar and Titabor eco-races. These are yellow plain (YP) yellow spotted (YS), yellow zebra (YZ), greenish blue plain (GBP) greenish blue spotted (GBS) and greenish blue zebra (GBZ). Debraj *et al.* (2001) performed elite crosses utilizing these lines of eri silkworm. Phenotypic diversity and characterization of different six strains of eri silk worm may be useful for selection of breeding components for developing high silk productive breeds of silk worm. Few studies are undergone in the shell weight, shell ratio but no study has been done to relate the shell characters with the silk gland weight and with larval weight and SGTSI. The quality of cocoon Eri silkworm is a polyphagous, multivoltine worm whose primary host is castor. They also fed on kesseru, bor kesseru, gomari, Payam, topioca.(Sarmah *et al*., 2000) emphasized on the host plant improvement of eri silk worm. Eri silk yarn produced by this worm is unique for its typical quality of white soft yarn possessing thermal properties (Noumann *et al*., 2003). To enhance the productivity and quality of silk fiber many attempts have been made through genetic manipulation. Since the information on the genetic basis, phenotypic variability and genetic diversity within

populations of Eri silkworm is scanty, few attempts had been made to understand the genetic diversity among six populations *viz.,* Yellow plain (YP),Yellow spotted (YS), Yellow Zebra (YZ), Greenish blue Plain (GBP), Greenish blue Spotted (BGS) and greenish blue Zebra (GBZ.). B. K. Singh *et al.,* 2011 carried out study on morphological characters of eco races and six strains of eri silk worm and find out their rearing performance. They had recorded Yellow Zebra as the best strain in terms of rearing performance. Morphological and biochemical parameters are studied among the four different strains eri silk worm the strain GBS was found to be best in terms of high fiber content, with maximum shell weight and sericin content. This strain can be reared in bulk and can be utilized in breeding programme for high silk production. This strain was followed by G, Y and Ys in terms of fiber content. High shell weight was recorded in G and Y varieties and the values were at par with Gs variety. Similar results were also reported by Vijayan *et al*. (2006).The morphological characters like body color, shell weight, cocoon weight etc., have been traditionally used To be identified silk worm Population. Few studies have been done to correlate larval weight and silk gland weight on different silk worms. The protein present in silk is synthesized by silk gland cells and stored in the lumen of the silk glands. Subsequently, it is converted into silk fibres. When the silkworms secrete the liquid silk during the spinning, it passes through the anterior gland and expelled out through the spinneret opening Quantity and nature of sericin are fundamental characteristics in conferring distinctive traits to the cocoon. The natural silk synthesized by the silkworm and spun in the form of a silk cocoon is originally synthesized in the silk gland. It is a paired organ consisting of modified labial/salivary glands located at the two lateral sides under the alimentary canal. Each gland is basically a tube made of glandular epithelium with two rows of cells surrounding the lumen. The cells constituting the gland are huge polyploid cells each with extremely ramified nucleus containing numerous nucleoli. Nuclear ramification develops gradually as the larva grows and reaches conspicuous size in the 4th and 5th instars. Ramification considerably enlarges the nuclear surface and apparently facilitates the transfer of materials related to the silk synthesis between the nucleus and the cytoplasm. According to its morphology and function, the silk gland can be divided into three distinct regions. The posterior part, about 15 cm long and is composed of about 500 secretary cells, which synthesize silk fibroin. The middle silk gland in the lumen of which silk proteins are stored until spinning, is about 7 cm long and contains about 300secretory cells producing silk sericin, the protein which cements the fibroin thread of the cocoon. The anterior part about 2 cm long is a thin duct composed of about 250 cells with no known secretory function. Akai *et al*. (2005) reported that the *Bombyx mori* silk gland secretes one fibroin and three layers of sericin from the each posterior and middle silk gland in a normal larva. The larval and eri silk gland volumes were assessed and silk gland ratio was calculated in comparision with cocoon characters By Rajesh Kumar *et al*. They observed that the ratio of silk gland volume was directly proportional to the rate of increase in the larval body volume. Therefore considering these studies we designed our study to correlate larval growth , silk gland growth and cocoon characters of six strains of eri silk worm. As the study correlating these parameters of these strains are lacking, This present study was carried out to evaluate the best strain for rearing in commercial purpose. The study help to compare different strains on the basis of their larval weight, silk gland weight and cocoon characters. The silk worm are cultured in different parts of assam but to get the best yield people should have some knowledge that which breed is more beneficial than others. This study will help us to select best breed for rearing as well as to choose parents for hybridization.

MATERIALS & METHODS

The experiment was carried out at Department of Zoology of Gauhati University and in department of zoology Nowgong College. Eggs of eri silkworm were procured from Directorate of sericulture, Khanapara(Assam). The primary food plants, Castor (*Ricinus communis*) was supplied to the larvae, The rearing was started from February 2011 The experiments were conducted on two seasons, viz. autumn and spring. The standard rearing methods were adopted as recommended by Sarkar (1988).In the fifth instars the strains were separated on the basis of their morphology and reared separately for inbreeding and to get the pure line strains after rearing eight crops for eight different parameters are studied. The larval weight was taken daily before and after feeding and fifth instar larval weight is taken in empty stomach. The larval weight, silk gland weight, Shell weight were measured using an electronic balance.

Ex.1: The larval body and silk glands of different strains were evaluated seasonally. The larval growth rate was evaluated by adopting the equation of Waldbauer (1968).

Growth rate (GR):G/TA

Where, G=Fresh or dry weight gain of larva during feeding period

T=Duration of feeding

A=Mean fresh or dry weight of larva during feeding period.

Ex.2 The weight of silk gland tissue were recorded individually. The larvae were weighted individually at maturity and the mean data were recorded. Individual larvae were used for dissection of silk gland a dissection tray.The dissected silk gland were allowed for 5-7 mins in the buffer and later transferred to thin and neat blotting paper to remove the excess moisture on the surface of the gland and immediately the morphological features like weight of silk gland, length and colour were recorded. The length of the silk gland is also correspond to the weight of the larvae and silk gland weight. The silk gland tissue somatic tissue index (SGTSI) gives an idea of quantity of silk that can be spun by the larva.

A correlation was established between larval and silk gland weight by using the following equation

$$r_{xy} = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{n\sum x^2 - (\sum x)^2}\ \sqrt{n\sum y^2 - (\sum y)^2}}$$

Here,x and y are the variables representing larval weight and silk gland weight respectively

Ex.3 The silk gland tissue somatic index was determined by taking the the weight of silk gland tissue and larval body following Venkata Ram Reddy and Benchamin (1989).

$$\text{SGTSI: } \frac{\text{Weight of the silk gland tissue(g)}}{\text{Weight of the larval body (g)}} \times 100$$

The cocoon characters

The most important commercial character of cocoon is weight which indicates approximate quantity of silk that can be spun from it. More important than the cocoon weight is the cocoon shell weight as it is the shell that yields silk. Higher the shell weight greater the silk yield from it The shell ratio indicates the quantity of silk that can be spun from a lot of fresh cocoon.

Ex.4 The cocoon weight (with pupa) and cocoon shell weight (without pupa) were recorded individually and shell ratio were calculated in percentage following Krishnaswami *et.al(1972).*

$$\text{Shell ratio= } \frac{\text{weight of the cocoon shell}}{\text{weight of the whole cocoon}} \times 100$$

Ex.5 ERR can be measured from the following formula

$$\text{ERR= } \frac{\text{Number of cocoon yield}}{\text{Number of larvae brushed}} \times 100$$

RESULTS

This chapter contains details account of experimental findings of the present study in respect of growth and of cocoon characters of eri silkworm strains, *Samia ricini*. The results of the experiments are depicted in the form of Tables and Figures and are described under the Following heads and sub-heads. The result revealed the correlation between larval weight and silk gland weight. The larval and silk gland growth is recorded more during autumn than in spring in both 2011 and 2012. The data represents the mean of 20 larvas of each of the two replication. The group VI (YZ) shows highest larval and silk gland weight while Group V(YS) is next to it.

TABLE1: Representing the larval and silk gland weight of all strains in both spring and autumn. Each data is the mean of 20 individuals of each of the two replicas. The mean value of both the seasons is also represented

Strains	Spring		Autumn		Mean	mean
	Larval weight (g)	Silk gland weight (g)	Larval weight (g)	Silk gland weight (g)	Larval weight(g)	Silk gland(g)
GR.I(GBP)	6.O4	1.15	6.23	1.29	6.14	1.22
GR.II(GBS)	6.17	1.21	6.34	1.32	6.25	1.27
GR.III(GZ)	6.01	1.05	6.38	1.19	6.20	1.12
GR.IV(YP)	5.42	.903	6.11	.966	5.77	.935
GR.V(YS)	6.33	1.34	6.54	1.36	6.43	1.35
GR.VI(YZ)	6.56	1.40	6.57	1.39	**6.57**	**1.40**

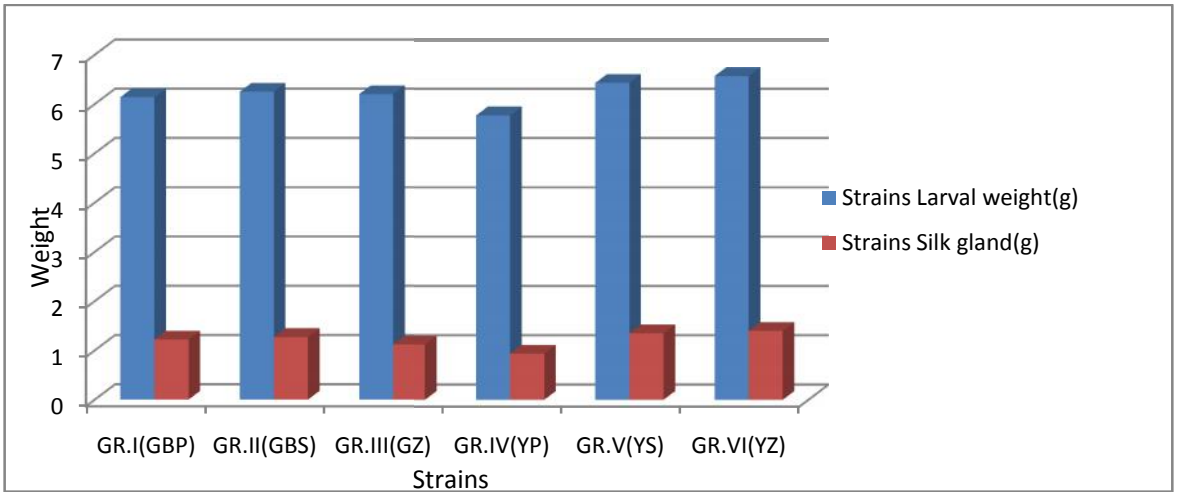

FIGURE 1: Graph showing the silk gland weight and larval weight of six strains of eri silk worm, *Samia ricini*. The result was the average value of two seasons

When the two variables are put in the formula for correlation we got a positive correlation between larval and silk gland weight. In both autumn and spring the value of correlation is found. In spring $r_{xy=}.96$ and for autumn the value is $r_{xy=}.65$. A strong correlation is observed in the first case.

TABLE 2: Representing the silk gland tissue somatic index.(SGTSI) mean value of both season is presented

Strains	Spring	Autumn	Mean
GR.I(GBP)	19.03	20.71	19.87
GR.II(GBS)	19.61	20.82	20.21
GR.III(GZ)	17.47	18.6	18.04
GR.IV(YP)	16.66	15.81	16.24
GR.V(YS)	21.16	20.79	20.98
GR.VI(YZ)	**21.27**	**21.15**	**21.21**

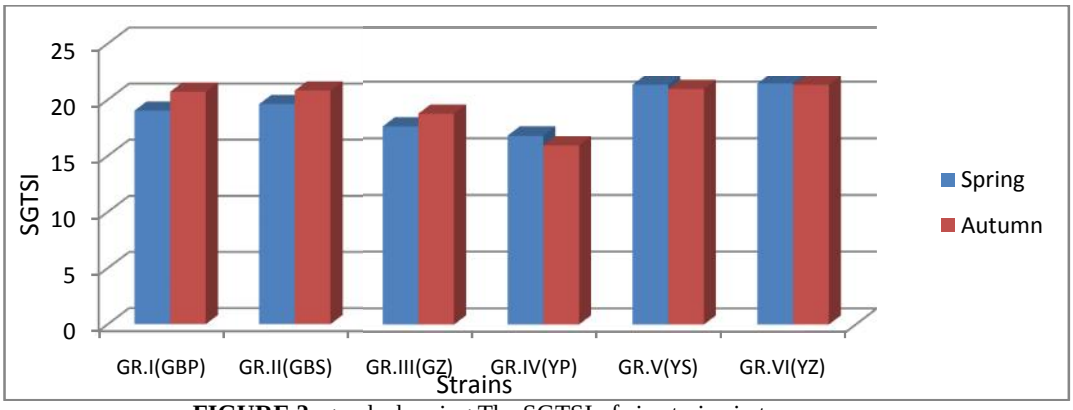

FIGURE 2: graph showing The SGTSI of six strains in two seasons

The table showing YZ having highest SGTSI followed byYS and then by GBS. High SGTSI may indicate high shell weight of cocoon.

TABLE 3: Representing larval growth rate at all instars of all the strains.

LARVAL GROWTH RATE IN FIVE INSTARS					
Strains	I	II	III	IV	V
GrI(GBP)	.733	.588	.430	.342	.317
GRII(GBS)	.720	.548	.501	.415	.312
GRIII(GZ)	.703	.535	.482	.320	.310
GRIV(YP)	.680	.525	.365	.263	.230
GRV(YS)	.693	.512	.405	.388	.295
GRVI(YZ)	.760	.586	.455	.398	.321

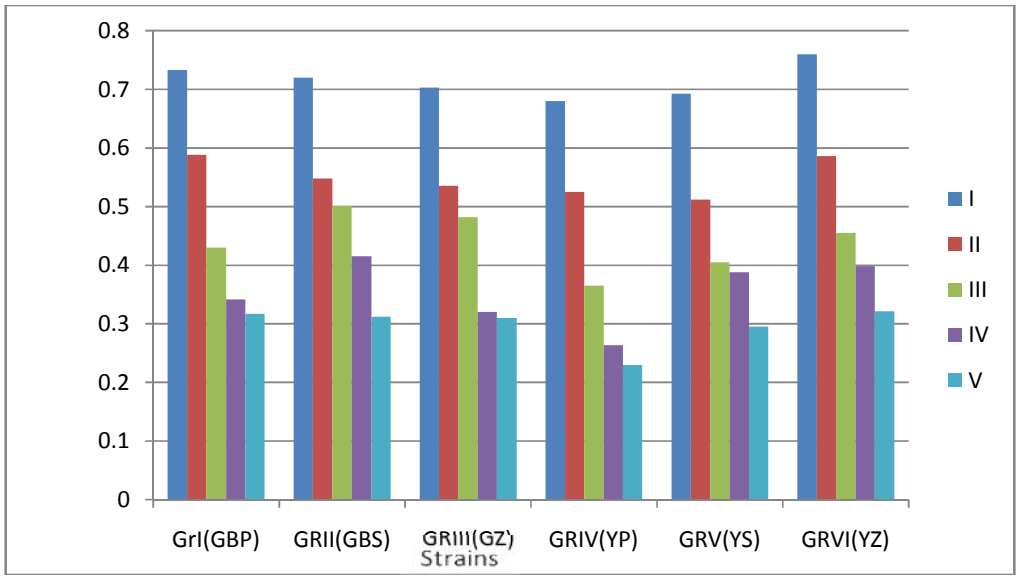

FIGURE 3: graph showing the growth rate in all the instars of six eri strains

The results in the table showing higher growth rate during early larval stages and with advancement of larval instars growth rate decreases gradually .The growth rate is lowest in case of fifth instar larva in all the strains. Of all the strains YZ shows highest growth rate in fifth instar stage followed by GBP and GBS.

TABLE 4: The ERR, Shell weight, shell ratio are the average of both the seasons as there is no significant different is observed in those parameters

Strains	ERR	Fecundity	Single cocoon weight	Single shell weight	Shell ratio
GrI(GBP)	88.9	357.54	3.44	.45	13.08
GrII(GBS)	**94.7**	**458.34**	3.45	.47	13.60
GrIII(GBZ)	91.3	435.60	3.56	.44	12.36
GrIV(YP)	90.4	456.70	3.34	.45	13.47
GrV(YS)	86.7	445.20	3.52	.49	**13.92**
GrVI(YZ)	88.9	430.23	**3.83**	**.54**	**14.09**

DISCUSSION

Data on growth, rearing performance and cocoon characters of eri silkworm *viz*., larval weight (g), silk gland weight, SGTSI , effective rate of rearing (ERR %), cocoon weight (g), shell weight (g) and shell ratio (SR%) of different e strains of eri silkworm are presented at Table from 1to4. The experimental findings revealed highest ERR in greenish blue spotted worm (94.7%) followed by Greenish blue zebra (90.06%) and performance of both the strains was significantly higher than other the strains. That GBS was better in terms of ERR than other strains.

The experimental findings revealed that larval weight was significantly higher in Yellow Zebra (6.57g) followed by Yellow spotted (6.43g) and both the strains were found to show higher silk gland weight YZ(1.40g) and YS(1.35g) than other strains. YZ and YS are better in terms of larval and silk gland weight and expected to produce more fibres than other strains. Silk gland the site of synthesis of silk protein, the amount of secretion of silk is based on the genetic background of the individual insect also corresponding to the size of silk gland. Therefore silk gland related traits could be used as one of the parameters to study the phenotypic diversity characterization. The single cocoon weight (3.83g) and shell weight (0.54g) were found to be highest in Yellow Zebra while shell ratio (SR%) were found to be higher in Yellow zebra followed by Yellow spotted(13.92%)and Greenish blue spotted (13.60%).The result show a clear correlation between larval weight, silk gland weight and cocoon shell weight. The overall findings revealed comparatively better performance in Yellow Zebra compared to other strains. The experimental findings also revealed that larval weight was recorded higher during autumn (g) followed by spring It was expected that mass of larvae and silk gland mass, to be in inter-reciprocal, because the higher larvae have a mass greater, the silk gland have a higher mass, and is expected to produce more silk, filament length of these breeds and hybrids were done by Mărghitas *et al.* (2011). The correlation between larval and silk gland weight was observed in all the strains of eri silk worm. K sham *et al.* (1995) reported a high correlation among cocoon weight and cocoon shell weight, cocoon weight and cocoon shell percentage. Study conducted by Ghanipoor *et al. (*2006) denoted a negative correlation between cocoon weight and cocoon shell weight. In the literature, Sumioka *et al.* (1982) have observed that the leaf consumption influenced the body weight, which influences the silk output. Other studies: on body weight of larvae were made (Ueda and Suzuki, 1967; Singh and Ninagi, 1995), correlation between shell weight and filament length (Petkov, 1981), shell ratio and cocoon quality (Singh *et al.,* 1992), cocoon weight and larval weight (Satenahalli *et al.,* 1990). Rajesh kumar assessed the larval and eri silk gland volumes and also the silk gland ratio in comparison with cocoon characters. He found that the ratio of silk gland volume was directly proportional to the rate of increase in the larval body volume. The similar work on larval weight silk gland weight and its comparison with cocoon characters indicate a strong positive correlation between them. The strain with higher larval weight have higher silk gland weight and also show high shell ratio.GBS show high fecundity(458.34) than other strains. The larval growth rate is found to be highest in all the strains in first instar but decreases gradually with advancement of larval stage. The growth rate is least in fifth instar.The growth rate is highest in YZ followed by GBP. Therefore YZ can be regarded as better strain for rearing in commercial purpose.

ACKNOWLEDGEMENT Authors are grateful to the Department of Zoology, Gauhati University,Guwahati and department of Zoology Nowgong College,Nagaon for providing laboratory facilities and directorate of sericulture,Khanapara(Assam) for providing me with Eri seeds for my work.

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