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Growth Attributes of Eco Races of Eri Silkworm, *Philosamia Ricini* Donovan in the Western Zone Conditions of Tamil Nadu

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Abstract

One of the most economic exploitation, widely cultivated, and financially viable non-mulberry silkworms is the eri silkworm (*Philosamia ricini*). The feeds that eri silkworms consume have a significant impact on their yield and silk production. A study was conducted to assess the growth characteristics of the eco races of the eri silkworm in the circumstances of western region of Tamil Nadu. The Central Muga and Eri Research Institute in Jorhat, Assam provided the eco races of eri silkworm. Three replications of the Completely Randomized Design (CRD) were used to set up the treatments. By feeding worms with castor leaves in the cellular rearing method, the growth characteristics of eco races of eri silkworm, specifically the larval parameter and cocoon parameter, were examined. Among the eco races of eri silkworm in comparison with standard F1 hybrid, the eco race Jonai recorded the maximum growth attributes such as larval weight (7.09 g), cocoon weight (3.93 g), shell weight (0.66 g), shell ratio, ERR (16.78 %) which was on par with F1 hybrid followed by Khanapara and Titabar. The least was observed in Barpathar and Adogiri. This study reveals that amongten eco races of eri silkworm, the eco race Jonai recorded performed well in western zone condition of Tamil Nadu and it can be commercially reared in alternative to Commercial F1 breed.

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Eri Silkworm;
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Introduction

Sericigenous insects of the phylum Arthropoda's order Lepidoptera, which feed on particular species-specific host plants, make silk, a proteinaceous strand. Raising silkworms for purpose of producing raw fabrics, which is the yarn made from the cocoon spun by specific species of lepidopteran insects, is known as s*ericulture.*[1] India's various agroclimatic regions have made it a suitable habitat for the emergence and diversification of a vast species of sericigenous insects.[2] India uses four different kinds of silk for commercial purposes. There are a few more sorts of silk that are just as lovely as the wonderful mulberry silk, which is quite well-

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known around the world. Tasar, Eri, and Muga are collectively referred to as Vanya silk, or non-mulberry silk. The eri silkworm, *Philosamia ricini*, is the only non-mulberry silkworm used for commercial purposes that has adopted to complete indoor rearing year-round.[3,4]

A domestic and wild multivoltine silkworm known as the eri is used in the commercial production of silk from the dawn of time. The Sanskrit word "eranda" is the root of the term "eri," which signifies castor plant. Vedic literature dates the history of eri silk to 1600 B.C., with origins thought to be in India.[5] Eri holds a distinct place due to its traditional cotton qualities, such as silky yarn with thermophysical behavior. Eri fabric is used in place of wool because of its thermophysical behavior. The rural tribes in the north-eastern region engage in it primarily as a traditional and recreational activity to partially meet their needs for food and clothes. Nearly 2 lakh families are involved in ericulture either directly or indirectly, with women participating at a rate of about 65% and members of the less privileged sections of society at a rate of 52.4%.[6]

Ericulture is currently becoming popular in various non-traditional Indian states as a second source of income. It is also grown in Meghalaya, Nagaland, Manipur, Mizoram, and Arunachal Pradesh in addition to Assam. Additionally, it is currently gaining ground in a number of non-traditional states, including Andhra Pradesh, Tamil Nadu, Karnataka, Gujarat, Jharkhand, and Chhattisgarh. Eri silk is now produced in quantities of 4726 MT, with Assam contributing a maximum of 2012.70 MT.

Eri silkworm may be raised all year long at temperatures between 25 and 30° C and relative humidity levels between 75 and 80 %. Due to its polyphagous nature, it consumes a variety of food plants. Since castor is suited year-round, regardless of the season, for eri silkworm rearing, it is regarded as the principal food plant. Kesseru, Tapioca, Papaya, Jatropha, Barpat, and Payam are the second important food source for eri silkworms[7,8,9] proved that Castor was the most effective in terms of the silk worm's several growth characteristics, including larval weight, Effective Rate of Rearing (ERR), cocoon weight, and shell weight. As a result, the present study chose castor as its food crop.

The behaviour and potential of a race varies with region especially in non traditional areas. Hence, the aim of the present study is to find an eco race that is suitable to western zone conditions of Tamil Nadu, so the study is undertaken with ten eco races in comparison with commercially exploited breed, *Samia cynthia ricini* by feeding castor leaves.

Materials and Methods

The aim of the current experiment is to find the ecoraces that are most suited to the environmental circumstances in western zone of Tamil Nadu. During the academic year 2020–2021, the study was carried out at Department of Sericulture, Forest College and Research Institute.

Collection of Eco Races of Eri Silkworm

From the Central Muga and Eri Research Institute in Jorhat, Assam, eggs of eco races of the eri silkworm were obtained. The eco races are Adokgri, Jonai, Titabar, Diphu, Mendipathar, Nongpoh, Borduar, Khanapara, Barpathar, and Lahing. These eco-races were contrasted with F1 commercial hybrids that were kept as the norm.

Rearing of Eco Races

The eco races of eri silkworm such as Adokgri, Jonai, Titabar, Diphu, Mendipathar, Nongpoh, Borduar, Khanapara, Barpathar, Lahing, as well as commercial F1 hybrid eggs from the Central Muga and Eri Research Institute in Jorhat, Assam, were grown using the usual rearing technique.[10] Rearing was carried out during the year 2020-2021.

After the second moult, three replications of 400 larvae for each eco race were kept separate. Instar IV and V phases involved feeding castor leaves four times per day. To avoid contamination, injured and sick larvae were gathered and buried. To prevent over population, the ideal number of larvae were kept in each dish.

The different growth attributes recorded were Larval weight (g), Larval duration (d), Single cocoon weight (g) and Shell weight (g). Shell ratio (%), Effective Rate of Rearing (ERR %), Mortality (%)were calculated. Yield/400 larvae (by weight in Kgs) were also estimated.

Larval Weight (g)
Fifth instar matured larva were selected randomly before ripening and calculated the larval weight in the following expression

Single Larval weight (g) = 10 nos. of matured larval weight before ripening / 10

Larval duration (h.)
Day of hatching to day of ripening.

Single Cocoon Weight (g)
Randomly selected male and female cocoon (1:1 ratio) after harvest were weighed and calculated in the following expression

Single cocoon weight (g) = 10 nos. of live cocoon with pupa / 10

Shell Weight (g)
After crop harvest, randomly selected male and female cocoon (1:1 ratio) were cut open, pupae was removed and shell weight was calculated using the formula

Single shell weight (g) = 10 nos. of cocoon shell / 10

Shell Ratio (%)
The grade of the silk which can be drawn from numerous living cocoons is indicated by the shell ratio. Male and female live pupa were included in the cocoon weight, which was recorded separately from the cocoon shell weight of the same lot, which was estimated in percentage using the following expression.[11]

Shell ratio (%) =Cocoon shell weight without pupa/ Cocoon weight with live pupa X 100

Effective Rate of Rearing (ERR %)
Using the following formula, the effective rate of reproduction was determined from the total number of larvae brushed and cocoons collected.

Effective Rate of Rearing (ERR %) = Number of cocoons harvested / Number of larvae brushed X 100

Mortality (%)
Mortality (%) was calculated as per[12]

Mortality (%) = No. of dead larvae / No. of larvae brushed X 100

Yield/400 larvae (by no. and by weight in kgs)
The yield was calculated by counting the number of cocoons and also by the weight basis.

Result and Discussion
Larval Weight (g)
Larval weight is an important factor deciding the pupal and cocoon characters. Significant variation was observed among the eco races of eri silkworm. In the midst of the eco races of eri silkworm, F1 hybrid and Jonai performed well recording the highest larval weight of 7.13 g and 7.09 g respectively. Khanapara, Lahing and Titabar were the next best recording the larval weight of 6.90 g, 6.76 g and 6.74 g respectively followed by Nongpoh (6.69 g), Mendipathar (6.66 g) and Diphu (6.64 g). Barpathar (6.33 g) and Adokgri (6.42 g) recorded the lowest larval weight. The current findings are consistent with those of,[13] who indicated that larval weights in Titabar and Borduar, respectively, were 6.75 g and 6.52 g (Table 1)

Larval Duration
Farmers who practise sericulture view the larval length as a crucial trait since it reduces the amount of food used overall without impacting the yield of cocoons. The eco race Jonai performed well recording the lowest larval duration of 542.5 h. which was on par with F1 hybrid (541 h.) and the next best were Khanapara, Lahing and Titabar recording the larval duration of 548 h., 564 h., 564 h., respectively followed by Mendipathar (570 h.) and Diphu (570 h.) and both were on par with each other. The highest larval duration was recorded in Adokgri (589 h.) and Barpathar (589 h.) and both in turn were on par with each other. The present result got strengthened with the result of[14] who reported the similar larval duration in Borduar (573 h.) and Titabar (568 h.) (Table 1).

Cocoon Weight
One of the key commercial characteristics taken into account in price fixation is cocoon weight. In the present study, Jonai recorded the highest cocoon weight of 3.93 g and was on par with standard (3.96 g) and lowest cocoon weight was recorded in Barpathar (3.23 g) (Table 1). Interestingly, F1 hybrid recorded the highest cocoon weight of 3.96 g.

The findings of,[15] who stated the cocoon weight of 3.89 g are supported by present result. Khanapara (3.82 g) and Titabar (3.67 g) were the next best and both were on par with each other followed by Nongpoh (3.60 g), Mendipathar (3.52 g) and Diphu (3.44 g). Borduar, Adokgri and Barpathar recorded the lowest cocoon weight of 3.37 g, 3.30 g, and 3.23 g respectively and all were on par with each other. Variation in cocoon weight is noticed between the eco races. This might be due to the impact of environment and the genetic potential of the race. Variation in quantitative and qualitative characters of the cocoon not only depended on the environment but also on the type of food plants used for feeding.[16]

Shell Weight

Enhanced shell weight (0.66 g) was obtained in Jonai which was on par with standard (0.67 g) followed by Khanapara (0.63 g), Lahing (0.61 g) and Titabar (0.60 g) and all were on par with each other. Barpathar (0.43 g) and Adokgri (0.47 g) recorded significantly lowest shell weight and was next to Nongpoh (0.58 g), Mendipathar (0.56 g) and Diphu (0.54 g) which were on par with each other. In the present result, Borduar registered the shell weight of 0.50 g (Table 1). This outcome is consistent with the research findings of[17] who reported shell weight of 0.48 g for the same. Variation in shell weight was observed in the eco races studied. The present study agrees with results of[18] that the population of *Samia ricini* showed variation in quantitative characters such as cocoon weight, shell weight and shell ratio.

Shell Ratio

The weight of the shell determines how much silk may be extracted from each cocoon. Consequently, it is crucial to determine the shell ratio. Among the eco races, F1 hybrid recorded significantly the heighest shell ratio of 16.91 per cent and it was on par with Jonai (16.78 %)(Table 1). Similarly, more than 16 per cent shell ratio was reported by[19] in eco races at different regions.

Table 1: Larval, cocoon and shell parameters of eco races of eri silkworm

Eco races	Larval weight (g)	Larval duration (h.)	Cocoon weight (g)	Shell weight (g)	Shell ratio (%)
Adokgri	6.42d	589d	3.30d	0.47d	14.23d
Jonai	7.09a	542.5a	3.93a	0.66a	16.78ab
Titabar	6.74b	564b	3.67c	0.60b	16.34b
Diphu	6.64c	570c	3.44cd	0.54c	15.65c
Mendipathar	6.66c	570c	3.52cd	0.56c	16.02bc
Nongpoh	6.69c	569.5bc	3.60c	0.58c	16.22b
Borduar	6.53d	576d	3.37d	0.50c	14.96cd
Khanapara	6.90b	548ab	3.82b	0.63ab	16.48b
Barpathar	6.33d	589d	3.23d	0.43d	13.46d
Lahing	6.76b	564b	3.75b	0.61b	16.37b
F1 hybrid	7.13a	541a	3.96a	0.67a	16.91a
SEd	0.0228	2.4066	0.3056	0.0151	0.0158
CD (0.05%)	0.0474	4.9909	0.6338	0.0313	0.0329

Means followed by similar letter(s) are not significantly different by DMRT (P = 0.05)

Khanapara, Lahing, Titabar and Nongpoh were on par with each other recording shell ratio of 16.48, 16.37, 16.34 and 16.22 per cent respectively followed by Mendipathar (16.02 %) and Diphu (15.65 %). This outcome is consistent with[20] findings, who noted a comparable shell weight in Mendipathar. Adokgri and Barpathar recorded the lowest shell ratio of 14.23 and 13.46 per cent respectively.

Effective Rate of Rearing

ERR is an imperative physiological criteria for selecting the superior silkworm hybrids.[21] ERR has direct impact on the ultimate cocoon yield. ERR was recorded highest in F1 hybrid (93.23%) and was on par with Jonai (90.99%). Variation in ERR was observed in the eco races studied. The findings of,[22] who indicated that dynamic environmental conditions had variations on growth and development as well as the expression of ERR in various silkworm eco types, support the conclusions of our study. The next best were Khanapara (88.86 %), Lahing (88.08 %) and Titabar (83.48 %) and all were on par with each other followed by Nongpoh (78.78 %), Mendipathar (78.06 %) and Diphu (76.15 %). The lowest ERR was recorded in Barpathar (62.11 %) and Adokgri (67.03 %) and were next to Borduar (73.44 %).In the most recent outcome, Diphu had an ERR of 76.15 percent (Table 2). This outcome is consistent with research by,[23] who reported an ERR of 75% in Diphu. In the current result, F1 hybrid (standard) has an ERR of 93.23 percent. This result comes in line with those of 24 who observed similar ERR in *Samia ricini.*

Table 2: Economic parameters of eco races of eri silkworm

Eco races	ERR (%)	Survival rate (%)	Mortality (%) due to factors		Cocoon yield (in kgs)
			Abiotic	Biotic	
Adokgri	67.03d	75.47d	16.37g	8.15e	0.765d
Jonai	90.99a	93.36a	3.79a	2.84a	1.370a
Titabar	83.48bc	89.81b	6.56d	3.62b	1.106b
Diphu	76.15c	83.17c	10.75f	6.07d	0.932c
Mendipathar	78.06c	84.63c	9.77f	5.60c	0.983c
Nongpoh	78.78c	85.46c	8.80e	5.74c	1.016b
Borduar	73.44cd	81.12c	12.08f	6.79d	0.875c
Khanapara	88.86b	91.64b	4.94b	3.42b	1.255b
Barpathar	62.11d	71.14d	18.86g	11.99f	0.707d
Lahing	88.08b	90.97b	5.81c	3.21b	1.188b
F1 breed	93.23a	94.55a	3.30a	2.14a	1.404a
SEd	0.7007	0.6161	0.0321	0.0446	0.1553
CD (0.05%)	1.4531	1.2815	0.0741	0.0867	0.3144

Means followed by similar letter(s) are not significantly different by DMRT (P = 0.05)

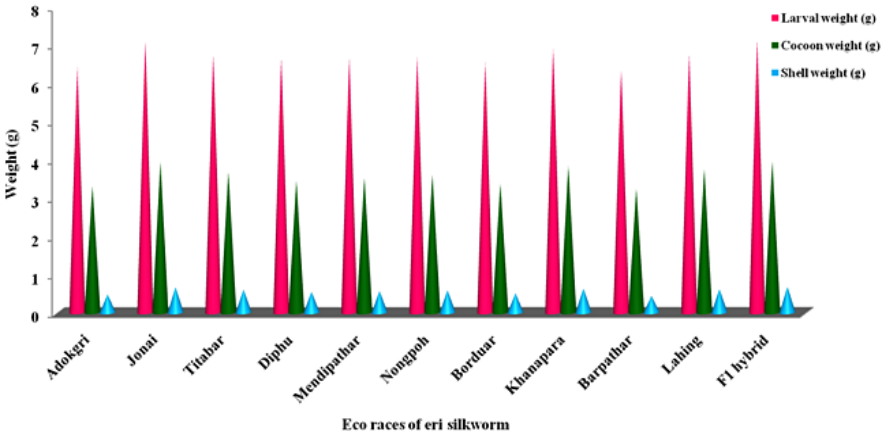

Fig 1: Growth attributes of eco races of eri silkworm

Survival Rate (%)

Among the eco races evaluated, both standard (F1 hybrid) and Jonai performed well recording the survival of 94.55 and 93.36 per cent respectively. The present result on higher performance of F hybrid (93.36 %) compared to other eco races got strengthened with findings of Kedir Shifa *et al.* (2014) who reported that commercial breed, F1 recorded the survival more than 90 per cent.

The next best eco races were Khanapara (91.64 %), Lahing (90.97 %) and Titabar (89.81 %) and all were on par with each other followed by Nongpoh (85.46 %), Mendipathar (84.63 %), Diphu (83.17 %) and Borduar (81.12 %).Adokgri (75.47 %) and Barpathar (71.14 %) recorded the lowest survival rate (Table 2). This result confirms with the work of 27.

Mortality

Mortality Due to Abiotic Conditions

Minimum mortality indicates more sustainability to environment and disease infection.[25] In the present result, among the eco races studied, Jonai recorded the lowest mortality of 3.79 per cent and was on par with standard which recorded the mortality of 3.30 per cent (Table 2). Khanapara (4.94 %), Lahing (5.81 %), Titabar (6.56 %) and Nongpoh (8.80 %) were the next best followed by Mendipathar (9.77 %), Diphu (10.75 %) and Borduar (12.08 %) which were all are on par with each other. The highest mortality was recorded in Barpathar (18.86 %) and Adokgri (16.37 %) and both were on par with each other. Present result revealed that maximum mortality was recorded in Barpathar (18.86 %) and temperature fluctuation was identified as the major reason for the mortality of larvae. The current findings are consistent with[26] findings that the eri silkworm's optimal temperature range for growth was between 20°C and 35°C and that temperatures over 35°C resulted in larval mortality.

Mortality Due to Biotic Factor

Both F1 hybrid and Jonai recorded the lowest mortality of 2.14 and 2.84 per cent respectively. Lahing (3.21 %), Khanapara (3.42 %) and Titabar (3.62 %) recorded the next lowest mortality and all were on par with each other followed by Nongpoh (5.74 %) and Mendipathar (5.60 %). The highest mortality was recorded in Barpathar (11.99 %) and was next to Diphu (6.0 %), Borduar (6.79 %) and Adokgri (8.15 %).

The change in environmental condition alters the physiology of worms and hence they become susceptible to either environment or diseases. In the present result, highest mortality was recorded in Barpathar (11.99 %) and it was caused by bacteria. According to,[25] eri silkworms are typically more resilient and resistant to illnesses than mulberry silkworms. In the present result, F1 hybrid recorded the lowest mortality of 2.14 per cent. In general, hybrids are robust compared to eco races. The present result strengthened with the findings of 14th at commercial breed recorded lower mortality compared to eco races(Table 2).

Cocoon yield

Both F1 hybrid and Jonai performed well recording the highest cocoon yield of 1.404 and 1.370 kg respectively followed by Khanapara (1.255 kg), Lahing (1.188 kg), Titabar (1.106 kg) and Nongpoh (1.016 kg) and all were on par with each other. Barpathar recorded the lowest cocoon yield of 0.70 kg and was on par with Adokgri (0.76 kg) and were next to Mendipathar (0.98 kg), Diphu (0.93 kg) and Borduar (0.87 kg). In the present study, Jonai had the greatest recorded cocoon yield (1.37 kg), which was typical (1.40 kg) (Table 2). There were differences in cocoon yield across the eco types investigated. The works of,[28] which stated that economic metrics like yield, cocoon weight, and shell weight are known to be influenced by many environmental conditions including temperature, relative humidity, and photoperiodic cycle, strengthened the present finding.

Conclusion

The findings indicate that the eco races of the eri silkworm have quite different growth characteristics. The eco race Jonai outperformed the others by having superior development characteristics, and this can be used commercially to increase the production of eri cocoons in non-traditional places including Tamil Nadu followed by eco races Khanapara, and Lahing.

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Conflict of Interest
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