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Study of Morphological Characters, Growth and Yield Performance of Eri Silkworm (*Samia ricini* Donovan) Eco Races

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Abstract: This study evaluated the morphological characters, growth performance, and yield potential of four Eri silkworms (*Samia ricini*) eco races namely C2, Borduar, Nongpoh and Jonai (reared on castor leaves) to identify superior strains for commercial silk production. Phenotypic analysis revealed that all eco races were multivoltine with consistent egg and cocoon characteristics, but showed significant variation in larval coloration and markings. The C2 breed exhibited the highest larval survival rate (100%) and adult emergence (89.33%), while Jonai showed the lowest survival (64.53%). Growth parameters demonstrated superior performance of C2 breed while the Nongpoh breed recorded the greatest larval length. Yield analysis revealed significant differences ($p<0.01$) across all parameters. C2 breed outperformed all strains with highest fresh cocoon weight, shell weight, shell ratio, and cocoon yield. For reproductive traits, C2 breed demonstrated superior fecundity (356 eggs), effective rearing rate (84.02%), and hatching percentage (83.91%) with favorable female-biased sex ratio (1:2). The study concludes that C2 consistently outperformed across all biological, phenotypic, and economic parameters, making it the most suitable candidate for intensive commercial Eri-culture. Nongpoh and Borduar showed moderate potential for selective breeding programs, while Jonai exhibited limited commercial viability under the tested conditions. These findings provide valuable insights for optimizing Eri silk production through strategic selection of superior eco races.

Keywords: Borduar, Castor cultivar, C2, Ericulture, Eri silkworm, Jonai, Nongpoh, *Samia ricini*

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Introduction

Ericulture forms a unique component of Agroforestry-based farming and thrives in north-eastern India, where Agroforestry based farming is predominant. Eri silk is next only to the mulberry silk in the silk production of India. The year 2023-24 witnessed a total production of 7183 MT of Eri silk. Apart from providing spun silk, it provides food to farmers in the form of pre-pupa and pupa. It is rich in proteins and lipids (Verma, 2017). Eri spun silk has good thermal properties and is used in various fabrics (Swathiga *et al.*, 2019). Eri silkworm (*Samia ricini* Donovan), a commercial silk producing insect, is believed to have originated in the Brahmaputra Valley of India. It had restricted distribution in India, China, and Japan for two centuries (Arya and Sachan, 2023; Kalita *et al*., 2025). This insect belongs to order-Lepidoptera and family-Saturniidae of Arthropods, which is the largest phylum of Animal Kingdom (Verma and Prakash, 2020). The primary food plant of this polyphagous insect is castor (*Ricinus communis* L.), but it also feeds on Papaya (*Carica papaya*), Jatropha (*Jatropha curcas*), Barpat (*Ailanthus grandis*), Payam (*Evodia fraxinifolia*), Ceara rubber tree (*Manihot glaziovii*), variegated tapioca (*Manihotesculenta variegata*), and Gulancha/Champa (*Plumeria acutifolia*) (Sirimungkararat *et al*., 2005; Virk *et al*., 2009; Thanga *et al*., 2021). Besides, the new food plants, the alternative food plants are also very suitable to feed Eri silkworm in some cases. The wild *Samia canningi* silkworm (the progenitor of the domesticated *Samia ricini*) completes one to three generations per year depending on geographical position and climatic condition of region; however, up to six generations occur in the domesticated cultures (Neupane *et al.*, 1990). Populations of Eri silkworm that have been commercially exploited are available in different regions of north-east India showing wide variations in morphological and quantitative characters such as absolute silk content, larval weight, cocoon weight, cocoon shell weight, and silk ratio (Siddiqui *et al*., 2000; Sarmah *et al*., 2011).

The domesticated variety of Eri silkworm, *Samia ricini*is is multivoltine in nature. Eri is also known as 'Errandi and Endi Silk'. The word 'Eri' is inspired by the Assamese word 'era', which means castor. Eri is the only silkworm reared completely indoors among the Vanyasilks (Anonymous/utsavpedia.com). Eri silkworm forms an open-ended cocoon, which enables extraction of live pupa from the cocoon making it Ahimsa silk, wherein the pupa can fully complete metamorphosis to its moth stage. Furthermore, the resilience of Eri silkworm to various biotic and abiotic stresses enhances their adaptability to diverse agro climatic conditions. (Arya, 2017). It is most suitable for an integrated farming ecosystem in Northeast India as it is polyphagous with host plants both annual and perennial. In essence, Eri culture symbolizes not only a thriving industry but also a harmonious synergy between traditions, sustainability and innovation in Indian agriculture. (Mahesh *et al*., 2020)

In Uttar Pradesh, a non-traditional Eri cultural state, Ericulture has gained importance as alternate cash crop. The challenge before Ericulture is to increase productivity of Eri silk and simultaneously reduce its production cost (Kumar and Elangovan, 2010) Metagenomics plays a significant role in understanding the microbial diversity associated with Eri silkworms (*Samia ricini*), especially in improving their health, productivity, and silk yield. It involves the direct genetic analysis of microbial communities from silkworm gut, rearing environment, and associated flora without the need for culturing. (Arya and Hemprabha, 2025).

The Internet of Things (IoT) revolutionizes sericulture by enabling real-time monitoring of environmental conditions, crop health, and production processes. IoT devices, such as sensors, cameras, and weather stations, collect data on temperature, humidity, light levels, and other variables, and transmitting this data to cloud-based platforms for analysis and visualization. By accessing real-time insights into their operations, sericulturists can identify issues, optimize workflows, and make informed decisions to improve productivity and profitability (Arya, 2024).

The purpose of current study was to evaluate the most suitable Eri silkworm Eco races for heat tolerance, silk enrichment and higher yielding production in silk industry.

Materials and Methods

Eri silkworm Eco races

DFLs of Eri silkworm Eco races collected from (CSB-CMER & TI) Central Muga Eri Research and

Training Institute, Lahdoigarh, Jorhat, Assam, India, Central Silk Board, and Ministry of Textiles Government of India. Four Eri silkworm Eco races -C2 Breed (Hybrid breed), Borduar (SR-001), Nongpoh (SR-004) and Jonai (SR-019) were taken for the study. The larvae of all Eco races were fed with castor leaves cultivar KALPI-6.

Rearing management and Environmental conditions

The rearing method (Trays method) was used from Eri Chawki rearing practices (Mahesh *et al*., (2022, 2024a).

- In winter season, the optimum temperature (25-28ºC) can be maintained by using Electric circumferential heaters and measured by Room thermometer.
- The Relative humidity (60-85%) maintained by using humidifier and measured by Digital hygrometer.
- During the summer months, the wet gunny clothes should be placed upon space or walls around the rearing house to reduce the temperature and raise the humidity.
- Eri silkworms require a minimum of 16 h of light per day and 8 h of darkness and proper disinfection with hygiene.
- To ensure optimal growth and development of Eri silkworm during rearing, a well-structured feeding management plan was also implemented.

Comparative Analysis of Phenotypic characters, Growth and yields of Eri silkworm Eco races

Eri silkworm Eco races investigated for phenotypic characters of larva, larval duration (include every molt), survival rates, and the yield components of cocoons and eggs. The following data were recorded: weight and size of each instar (24 h after molting). Survival rates from 1^{st} – 5^{th} larva instar and larva (1^{st} – 5^{th} instar) adult, cocoon yields (fresh cocoon weight, pupa weight, shell weight, shell ratio, total cocoon shell weight and fresh cocoon weight/10,000 larvae), and egg yields (eggs/ moth, hatching eggs, total eggs, and total hatching eggs). Cocoon or pupa were weighed up to four decimal by using a balance (Sartorius BP 210S Germany).

Growth Parameters

The following formulae were used to calculate the growth performance:

$$\text{Weight gain (g)} = \text{Final Weight (g)} - \text{Initial weight (g)}$$

$$\text{Weight Gain (\%)} = \frac{\textit{Final Weight Gain} - \textit{Initial Weight Gain}}{\textit{Initial Weight Gain}} \times 100$$

$$\text{Length gain (g)} = \text{Final length gain (g)} - \text{Initial Length gain (g)}$$

The Eco races served as treatments with three replications. Each replication contained 50 larvae of Eri silkworm. Analysis of variance (ANOVA) done and means of the treatments was compared statistically using Duncan's multiple range test (DMRT).

Results and Discussion

The Eri silkworm is a Multivoltine and polyphagous insect. It has complete metamorphosis to its moth stages. These four Eco races had similar morphological characters in all developed stages; Egg, Larvae, Pupae and adult. Both sexes have similar characterization in shape and color. In the rearing of Eri silkworm Eco races, used castor leaves cultivar KALPI-6. It showed that all Eco races had nearly similar larval duration of 21-24 days. The age of both male and female moth was also in between 5-10 days and died naturally. Adult moths do not feed and merely focus on reproduction. Mahesh *et al.* (2023) reported similar findings as observed in the present study.

Table 1 illustrates phenotypic evaluation of four eco-races of *Samia ricini* DONOVANC2 Breed (Hybrid), Borduar (SR-001), Nongpoh (SR-004), and Jonai (SR-019) fed with leaves of castor cultivar Kalpi-6. It exhibits that all strains were Multivoltine, suggesting their ability to produce multiple generations annually. The egg color was uniformly creamy white across all the eco-races, indicating no genetic variation in this trait. However, significant variation was observed in larval characteristics. The C2 Breed showed a wide range of larval colors, including YP, GBP, YZ and

Table 1: Phenotypic character of four different Eco races of Eri silkworm (*Samia ricini*DONOVAN) fed with leaf of castor cultivar Kalpi-6

Characters	Eco-races			
	C2 Breed (Hybrid)	**Borduar (SR-001)**	**Nongpoh (SR-004)**	**Jonai (SR-019)**
Voltinism	Multivoltine	Multivoltine	Multivoltine	Multivoltine
Egg colour	Creamy White	Creamy White	Creamy White	Creamy White
Larval colour	YP, GBP, YZ, GBZ	YP, GBP, YZ	YP, GBP	YP
Larval marking	Plain, Zebra	Plain, Zebra	Plain	Plain
Cocoon colour	White	White	White	White
Cocoon shape	Oval	Oval	Oval	Oval
Moth colour (Both Sexes)	Blackish gray	Blackish gray	Blackish gray	Blackish gray

Fig. 1: Strains of C2 breed (YP, GBP, YZ, and GBZ).

GBZ with both plain and zebra markings (Fig. 1). In contrast, Jonai exhibited a single larval color and plain marking. The cocoon characteristics such as color and shape were consistent across all eco-races white and oval, respectively while the moth color in both sexes was blackish gray, showing no phenotypic variation in adult stages. Arya (2019) and Mahesh *et al.* (2024b) found similar results in their investigations.

In the survival percentage, the C2 Breed gave the highest larval survival (100% from 1st to 5th instar) and an adult emergence rate of 89.33% (Table 2). This suggests breed's strong adaptability and resistance to environmental stress. Present finding showed close conformity with the findings of Kumar and Elangovan (2010), Hussain and Rashid 2024 and Joan *et al.* (2022). On the other hand, Jonai showed the lowest survival rates with only 64.53% reaching the 5th instar and 63.35% maturing into adults. Borduar and Nongpoh had intermediate survival rates. The F-test for both larval and adult stages indicated statistically significant differences ($p < 0.01$) among the eco-races, confirming that genetic makeup strongly influences survivability under uniform feeding conditions.

Table 2: Survival of Eri silkworm (*Samia ricini*) fed with leaf of castor cultivar Kalpi-6

Eco races	Survival rate (%)	
	Larva (1st - 5th instar)	Larva (1st - 5th instar) - Adult
C2 Breed (Hybrid)	100.00	89.33
Borduar (SR-001)	76.87	72.55
Nongpoh (SR-004)	82.66	82.66
Jonai (SR-019)	64.53	63.35
CV %	15.75986564	12.83129583
F-test	0.683475064	

** = significantly different at 1% level

Table 3: Mean weight of Eri silkworm (*Samia ricini* DONOVAN) fed with leaf of castor cultivar Kalpi-6

Eco races	Mean weight of Eri silkworm larva (g)					
	1st instar	2nd instar	3rd instar	4th instar	5th instar	5th instar - Adult
C2 Breed (Hybrid)	0.0021	**0.0296**	**0.2316**	**1.0967**	**4.0432**	**8.443**
Borduar (SR-001)	0.0021	0.0136	0.1733	0.6089	3.2934	6.0377
Nongpoh (SR-004)	**0.0022**	0.0158	0.1954	0.5031	4.5513	7.6404
Jonai (SR-019)	0.0021	0.0147	0.1568	0.6422	2.5668	5.6741
F-test	**	**	**	**	**	**
CV %	2.037706832	35.27058681	14.79976909	31.92805769	20.81048302	16.35435818

** = significantly different at 1% level

The larval weight (Table 3) measured across developmental stages, highlighted the superior growth performance of the C2 Breed. Beginning at 0.0021g in the 1st instar, C2 larvae reached a maximum weight of 8.443 g by adulthood. This pattern was consistently higher than that of the other eco-races, where adult weights were significantly lower. This indicates the hybrid's efficient utilization of food and superior metabolic efficiency. Similarly, larval length followed a comparable trend. C2 Breed larvae were longer at each instar, peaking at 7.8 cm in the 5th instar, whereas Jonai larvae had the shortest lengths. These metrics demonstrate that the C2 Breed produces greater biomass, an essential trait for enhanced cocoon yield (Damodhara *et al.*, 2024).

The duration of the larval period, including molting hours, was recorded for four Eco races of *Samia ricini* reared on the castor cultivar Kalpi-6. The data (Table 4) revealed significant differences (F-test, $p < 0.01$) across all instars and in the total larval duration, indicating that genetic variation among the Eco races strongly influenced their development rate under uniform rearing conditions. The C2 hybrid breed had the longest total larval period (24 days) among all strains, with stage-wise durations of 4, 5, 4.5, 4, and 6.5 days for the 1st through 5th instars, respectively. The extended larval duration, particularly in the 5th instar, suggests a longer feeding period, which is often associated with increased biomass

Table 4: Larval period (including Molting hours) of four Different Eco races of Eri silkworm(*Samia ricini* DONOVAN) fed with castor cultivar Kalpi-6

Eco races	Larval Period (including Molting hours)					
	1st instar	2nd instar	3rd instar	4th instar	5th instar	Total Period
C2 Breed (Hybrid)	4	5	4.5	4	6.5	**24**
Borduar (SR-001)	3	5	3.5	3.5	6	21
Nongpoh (SR-004)	3	5	3.5	4.5	6	22
Jonai (SR-019)	3	5	4	3.5	6	21.5
F-test	**	**	**	**	**	**
CV %	13.32347	0	10.69879	10.69879	3.534798	5.14713762

** = significantly different at 1% level

Table 5: Length of Eri silkworm (*Samia ricini*DONOVAN) fed with leaf of castor cultivar Kalpi-6

Eco races	Length/size (cm.)				
	1st instar	2nd instar	3rd instar	4th instar	5th instar
C2 Breed (Hybrid)	1	1.25	2.38	3.2	7.8
Borduar (SR-001)	0.7	1.2	2.2	3.6	7.3
Nongpoh (SR-004)	**1.3**	**2**	**3**	**3.8**	**8.5**
Jonai (SR-019)	0.6	1.1	1.8	2.9	6.5
F-test	**	**	**	**	**
CV %	30.42903097	25.78214058	18.44442114	10.34388151	9.691662555

** = significantly different at 1% level

accumulation. This correlates well with the superior cocoon and shell yields observed for this breed (Table 6), indicating efficient nutrient assimilation and silk synthesis. The Nongpoh (SR-004) strain recorded a total larval duration of 22 days, with the longest 4th instar among the non-hybrid breeds (4.5 days), suggesting a slightly delayed transition during this stage compared to others. It supports earlier observations of better body size (Table 5) and moderate cocoon yields (Table 6), likely resulting from a longer feeding phase in the mid-larval stages (Devi *et al.,* 2025)

Both Borduar (SR-001) and Jonai (SR-019) had shorter total larval durations of 21 and 21.5 days, respectively. These Eco races showed consistently shorter instar durations, particularly in the 3rd and 4th instars, which may reflect a faster metabolic development but potentially at the cost of biomass accumulation. This trend aligns with their relatively lower cocoon weights and shell yields observed (Table 6) suggests reduced feeding or lower assimilation efficiency. The coefficient of variation (CV %) was highest in the 1st instar (13.32%), indicating notable variability among Eco races in early development. Variation was moderate in the 3rd and 4th instars (~10.70%), likely due to differences in genetic growth potential and host plant assimilation. The 2nd instar showed no variation, suggesting a genetically conserved stage across all Eco races. The total larval period had a CV of 5.15%, indicating relatively consistent overall development times, despite stage wise differences (Damodhara *et al.*, 2024) found similar results in their investigations.

It can be said that the C2 hybrid exhibited the longest larval duration, which likely contributed to its superior silk yield through prolonged feeding and growth. Nongpoh demonstrated moderate duration with slightly extended mid-larval stages,

Table 6: Yield of Eri silkworm (*Samia ricini* DONOVAN) fed with leaf of castor cultivar Kalpi-6

Eco races	Average Yield					
	Fresh cocoon wt.(g)	Pupa weight (g)	Shell weight (%)	Shell ratio (%)	Total cocoon shell weight (g)	Fresh cocoon weight/ 10,000 larvae (kg)
C2 Breed (Hybrid)	3.641	2.864	0.5204	14.28	11.95	36.71
Borduar (SR-001)	2.952	2.256	0.3879	13.34	10.18	26.59
Nongpoh (SR-004)	3	2.381	0.3956	13.16	10.02	31.6
Jonai (SR-019)	2.093	1.865	0.2184	10.44	8.37	22.33
F-Test	**	**	**	**	**	**
CV %	18.83516181	15.23366643	28.21804822	11.16853661	12.51075749	18.38442793

** = significantly different at 1% level

supporting its decent growth and yield traits. Borduar and Jonai, with shorter larval periods, may mature quickly but at the expense of cocoon quality and weight. These findings highlight the importance of larval duration as a determinant of productivity in Eri silkworm breeding programs (Sharma and Kalita, 2017).

The length of different Eco races of *Samia ricini* fed with the Kalpi-6 castor cultivar was evaluated by measuring body length across all five instars. The results (Table 5) showed significant differences (F-test, $p < 0.01$) at each larval stage, indicating that genetic variation among Eco races influenced larval size when fed the same host plant. Among the four Eco races studied, the Nongpoh (SR-004) strain exhibited the greatest larval length throughout the development stages. Starting from 1.3 cm in the 1st instar and reaching 8.5 cm in the 5th instar, the highest among all. Its consistent superiority in size suggests a robust growth rate and better adaptability to the Kalpi-6 cultivar. (Mahesh *et al.*, 2023).

The C2 hybrid breed, though not the largest in early instars, maintained steady growth and reached a substantial 7.8 cm by the 5th instar, closely following Nongpoh. It showed moderate lengths in early stages (1 cm to 3.2 cm by the 4th instar) but caught up significantly by the final stage. This performance supports its reputation as a high-yielding hybrid with vigorous growth characteristics. The Borduar (SR-001) strain showed moderate growth across stages, starting at 0.7 cm in the 1st instar and reaching 7.3 cm at the 5th instar. While slightly behind C2 and Nongpoh, its performance remained consistent and above that of the Jonai strain. The Jonai (SR-019) Eco race showed the least growth, with the smallest body lengths at nearly all stages-- 0.6 cm in the 1st instar and only 6.5 cm in the 5th instar. These results suggest slower growth and possibly lower efficiency in nutrient utilization or adaptability to the Kalpi-6 castor cultivar.The coefficient of variation (CV%) was highest in the early larval stages -- 30.43% in the 1st instar and 25.78% in the 2nd instar, indicating greater variability in early development among Eco races. This variability gradually decreased in later stages, with the lowest variation observed in the 5th instar (CV = 9.69%), reflecting more uniform growth patterns at maturity. Sharma and Kalita (2017) and Damodhara *et al.* (2024) reported similar experimental findings.

We found that, the Nongpoh strain demonstrated the most vigorous larval growth, followed by the C2 hybrid, both of which appear well suited for rearing on Kalpi-6. The Jonai strain, with the smallest size at all stages may require different environmental or dietary conditions for optimal performance. These results further underline the influence of genetic factors on larval development and the potential of selective breeding to enhance larval traits in Eri silkworms.

The yield-related parameters were observed and summarized in Table 6. Different *Samia ricini* Eco races reared on castor cultivar Kalpi-6 demonstrated significant variation across all metrics, as confirmed by the F-test ($p < 0.01$)**.** This underscores the substantial genetic influence on cocoon and shell traits under identical rearing conditions. It was found that the C2 hybrid breed outperformed all other Eco races across all yield parameters. It gave the highest fresh cocoon weight (3.641 g) and pupa weight (2.864 g)**,** indicating robust larval growth and effective cocoon formation. Additionally, it had the highest shell weight (0.5204 g) and shell ratio (14.28%)**,** suggesting excellent silk yield potential. Its total cocoon shell weight (11.95 g) and the highest fresh cocoon yield per 10,000 larvae (36.71 kg) further emphasize its commercial advantage in silk production (Tulu *et al.*, 2022).

The Nongpoh (SR-004) and Borduar (SR-001) Eco races showed moderate and comparable performance. Nongpoh recorded a fresh cocoon weight of 3.0 g**,** slightly higher than Borduar (2.952 g), but had a slightly lower shell ratio (13.16%) compared to Borduar (13.34%). Both had similar total cocoon shell weights (10.02 g for Nongpoh and 10.18 g for Borduar), with Borduar slightly ahead in shell efficiency. In terms of fresh cocoon yield per 10,000 larvae, Nongpoh (31.6 kg) outperformed Borduar (26.59 kg), indicating that Nongpoh may possess better yield potential under mass rearing conditions (Joan *et al.*, 2022; Damodhara *et al.*, 2024).

The Jonai (SR-019) strain consistently showed the lowest performance across all parameters. It recorded the lowest fresh cocoon weight (2.093 g)**,** pupa weight (1.865 g)**,** shell weight (0.2184 g)**,** and shell ratio (10.44%)**,** reflecting poor biomass conversion efficiency. Its total cocoon shell weight (8.37 g) and fresh cocoon yield per 10,000 larvae (22.33 kg) were also the lowest, suggesting this strain may not be ideal for commercial rearing on Kalpi-6 castor leaves.The coefficient of variation (CV%) was highest in shell weight (28.22%)**,** indicating substantial variability in silk production efficiency among Eco races. The variability was moderate for fresh cocoon weight (18.83%), pupa weight (15.23%), and total cocoon shell weight (12.51%), while shell ratio (11.17%) and fresh cocoon yield per 10,000 larvae (18.38%) also showed notable but controlled variation.

It was found that the C2 hybrid strain demonstrated superior performance in all yield-related traits**,** making it the most suitable candidate for high-output silk production when fed Kalpi-6 castor leaves. The Nongpoh and Borduar Eco races offer moderate yield potential and may be further improved through selective breeding. The Jonai strain, due to its lower yield efficiency, may require targeted breeding or different host plant compatibility studies to enhance its performance (Lokesh *et al.*, 2022).

The performance of different Eco races of *Samia ricini* fed with castor cultivar Kalpi-6 revealed significant variation (F-test significant at $p < 0.01$) in all studied egg yield parameters including fecundity, effective rate of rearing (ERR), hatching percentage, total egg production, total hatching eggs, and sex ratio. Present findings (Table 7) showed close conformity with the finding of Siddiqui *et al.* (2000) and Mahesh *et al.* (2024b).

Among the tested Eco races, the C2 hybrid breed showed superior reproductive performance. It recorded the highest fecundity (356 eggs) and the highest ERR (84.02%)**,** with a hatching percentage of 83.91%**,** resulting in a total egg yield of 6327.85 eggs and 6003.15 hatching eggs. The female-biased sex ratio (1:2) in C2 also suggests a

Table 7: Egg yields (mean±SD) of Eri silkworm (*Samia ricini* DONOVAN) fed with leaf of castor cultivar Kalpi-6

Eco races	Average Yield					
	Fecundity(no.)	**ERR (%)**	**Hatching eggs (%)**	**Total eggs (eggs)**	**Total hatching eggs**	**Male: Female**
C2 Breed (Hybrid)	356	84.02	83.91	6327.85	6003.15	1:2
Borduar (SR-001)	338	79.38	79.65	4046.76	3672.08	1:1.3
Nongpoh (SR-004)	332	78.27	78.42	3986.2	3644.3	1:2
Jonai (SR-019)	304	46.72	66.92	2434.09	2605.23	1:1
F-Test	**	**	**	**	**	**
CV %	5.616496059	20.54108534	8.143345026	33.07736896	31.24817045	**

** = significantly different at 1% level.

productive female population that may contribute to the enhanced egg production (Joan *et al.* (2022).

The Borduar (SR-001) and Nongpoh (SR-004) strains performed moderately well, with fecundity values of 338 and 332**,** respectively. Their ERRs (79.38% and 78.27%) and hatching percentages (79.65% and 78.42%) were slightly lower than C2 but still comparatively high. Correspondingly, their total egg yields were 4046.76 (Borduar) and 3986.2 (Nongpoh)**,** and hatching egg counts were 3672.08 and 3644.3, respectively. These strains also showed a favorable female-biased sex ratio (1:1.3 and 1:2), contributing positively to overall yield Singh and Benchamin (2002) and Sirimungkararat *et al*. (2005) studied biology and ecology of Eri silkworm and found similar results.

The Jonai (SR-019) Eco race recorded the lowest performance, with a fecundity of 304 eggs**,** the lowest ERR (46.72%)**,** and a hatching percentage of 66.92%**.** Its total egg yield (2434.09) was the lowest, yet interestingly, its total hatching egg count (2605.23) appeared slightly higher than its total egg yield, likely due to rounding or data collection anomalies. The sex ratio here was balanced (1:1), indicating no significant gender skew but possibly a lower female productivity or viability. Wongsorn *et al.* (2015) and Swathiga *et al*. (2019) also studied the screening for Eri silkworm and found similar results. The coefficient of variation (CV %) was highest for total egg yield (33.08%) and total hatching eggs (31.25%), indicating considerable variability across Eco races in these traits. ERR showed particularly high variability (CV = 20.54%), reinforcing the significant differences observed. It was observed that, the C2 hybrid breed is the most promising Eco race for egg production when reared on Kalpi-6 castor leaves, likely due to its superior fecundity, hatching success, and female-biased sex ratio. Indigenous strains like Borduar and Nongpoh also show potential and may be improved through selective breeding or hybridization. The Jonai strain, while genetically diverse, may require further enhancement or may be more suitable for different host plants or rearing conditions. Tulu *et al.* (2022) also found similar results.

In conclusion, the comparative analysis of these four eco-races of *Samia ricini* confirms that the C2 Breed (Hybrid) consistently outperforms the traditional strains across all biological, phenotypic, and economic parameters. It is not only more resilient and faster growing but also more productive in terms of cocoon yield and reproductive traits. These qualities make it an excellent choice for intensive Ericulture programs. Conversely, the Jonai strain, despite a shorter developmental period, exhibited the lowest values in almost all parameters, suggesting its limited application in commercial rearing systems.

Additionally, Pallavi and Sannappa (2018) reported that, Borduar Eco races of Eri silkworm reared on local pink variety of castor showed supremacy for the commercial parameters and it can be exploited for maximization of Eri silk cocoon production. Devi *et al.* (2025) concluded that the yellow zebra strain performed robustly across multiple attributes and seasons, showing the highest stability among the strains that were studied. Hierarchical clustering analysis grouped the strains into three distinct clusters, reflecting their genetic and phenotypic relationships. Sharma and Kalita (2017) have reported that the better rearing condition with better variety silkworm leads to higher fecundity by silkworm moths. They concluded that there were significant differences in the rearing performances among six strains of *Samia ricini*, Donovan. Seasonal variation also has a significant impact on these parameters. These studies can be proved to be helpful in evaluating best strain in terms of rearing performance and those strains can be utilized for commercial rearing or can be considered as promising parents in breeding programs. Tulu *et al.* (2022) and Sarmah *et al.* (2011) revealed that different castor genotypes showed significant variations in agronomic performance under field conditions. Selection of castor genotypes based on leaf biomass showed that genotypes 219645, and 200390 were better than the other castor genotypes for the rearing of Eri-silkworm. Thus, the selection of castor genotypes is important to get the best larval development, cocoon, and silk yield.

Ethical Statement

The study on *Samia ricini* followed ethical standards, ensuring human handling, natural moth emergence, environmental safety, and no harm to larvae or pupae during morphological and yield performance analysis.

Author Contributions

Each author has contributed equally to the study's planning, analysis, writing, and editing. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

The authors declare no conflicts of interest.

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