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Prakruthi CS
Student, Department of Sericulture Science, University of Mysore, Karnataka, India

Keerthishree L
Student, Department of Sericulture Science, University of Mysore, Karnataka, India

Mashetty Ruchitha
Student, Department of Sericulture Science, University of Mysore, Karnataka, India

Saraswathi
Student, Department of Sericulture Science, University of Mysore, Karnataka, India

Sathish S
Student, Department of Sericulture Science, University of Mysore, Karnataka, India

B Sannappa
Student, Department of Sericulture Science, University of Mysore, Karnataka, India

Mohammed Jawad Ahamed
Student, Department of Sericulture Science, University of Mysore, Karnataka, India

Corresponding Author:
Mohammed Jawad Ahamed
Student, Department of Sericulture Science, University of Mysore, Karnataka, India

Impact of host plants on economic traits in different strains of the eri silkworm, (*Samia cynthia ricini* Boisduval)

Prakruthi CS, Keerthishree L, Mashetty Ruchitha, Saraswathi, Sathish S, B Sannappa and Mohammed Jawad Ahamed

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Abstract
The present investigation aimed to evaluate the impact of different host plants (green castor, Pink castor and Tapioca) on the economic traits of three strains of eri silkworm *viz.,* Yellow Plain, Green Plain and Hybrid (Green × Yellow). Results revealed significant variation in matured larval weight, pupal weight, cocoon yield, cocoon weight, shell weight, shell ratio, shell yield and silk productivity across host plants, silkworm strains and their interactions. The Yellow strain reared on Local Pink during early instars and Local Green during late instars recorded superior performance in most economic traits including cocoon and pupal weight. The Green strain on Local Pink + Local Green castor showed highest matured larval weight and shortest larval duration. The Hybrid strain with Local Pink + Local Green castor performed best in terms of shell weight and silk productivity. Shell ratio was highest in the Green strain reared on Local Pink + Local Pink castor. The findings suggest that host plant combination and strain selection play a pivotal role in enhancing the productivity of eri silkworms, offering a practical approach to improve cocoon yield under tropical conditions.

Keywords: Castor, economic traits, eri silkworm, host plant, *Samia cynthia ricini*, silk productivity, tapioca

Introduction
Silk has remained an integral part of human civilization for over 4,500 years and continues to hold its status as the Queen of Textiles despite competition from synthetic fibers. While mulberry silk is widely known, India also produces non-mulberry (vanya silks) *i.e.*, eri, tasar and muga, which hold cultural and economic significance. India stands as the second-largest silk producer globally, with a total raw silk production of 36,582 MT, comprising mulberry (27,654 MT), eri (7,349 MT), tasar (1,318 MT) and muga (261 MT) (Anonymous, 2023) [1]. Among non-mulberry silkworms, the eri silkworm (*Samia cynthia ricini* Boisduval) is fully domesticated, adaptable to indoor rearing (Reddy *et al*., 1999) [12] and resistant to temperature variations (13-36 °C) and various diseases (Thangavelu & Barah, 1986) [17]. Ericulture is predominantly practiced in the northeastern states of India, such as Assam, Nagaland, Meghalaya and Manipur, accounting for 98% of the country's eri silk production. The eri silkworm is polyphagous and thrives in dryland climatic zones, feeding primarily on castor (*Ricinus communis* L.), with tapioca (*Manihot esculenta*), papaya (*Carica papaya*) and champa (*Plumeria acutifolia*) serving as secondary hosts. Of these, castor is the most preferred due to its superior nutritional profile (Sannappa *et al*., 2004) [13].

India, particularly Assam, cultivates a diverse range of local and high-yielding castor varieties. The selection of an appropriate castor genotype is crucial for enhancing eri silkworm growth, cocoon yield and egg production. The quality of host plants directly affects ingestion, digestion and conversion efficiency which ultimately affects the economic traits of eri silkworms (Krishnaswami *et al*., 1971) [7]. Additionally, the silk ratio varies depending on the host plant type and eri silkworm breed used for rearing (Dookia, 1980; Pandey, 1995) [4, 9]. Previous studies have highlighted that the biochemical quality of the host plant leaves, particularly castor, significantly affects larval development, cocoon quality and reproductive performance of eri silkworms (Pandey, 1995; Krishnaswami *et al*., 1971) [7, 9]. Enriching larval feed with supplements like probiotics, vitamins, and proteins has shown to improve silkworm health and silk yield (Etebari & Matindoost, 2005) [5]. Studies on eri eco-races and strains indicate that seasonal variations influence cocoon parameters (Ray *et al*., 2010) [11] and the Green Plain Spotted (GPS) strain performs best in terms of shell weight and sericin content (Singh *et al*., 2011) [16]. In this background, an investigation has been conducted to study the influence of host plants on the commercial characters of Green, Yellow and their hybrid strains of eri silkworm. The findings aim to identify optimal host-plant strain combinations for improving eri silk production efficiency and sustainability.

Materials and Methods

The present investigation was carried out at the Department of Studies in Sericulture Science, University of Mysore, Manasagangotri, Mysuru, to study the influence of host plants on the commercial traits of eri silkworm strains. The experiment involved three eri silkworm strains viz., Green Plain, Yellow Plain and their hybrid (Green × Yellow) which were reared on three different host plant combinations. The host plants included Local Pink castor (*Ricinus communis* L.), Local Green castor (*Ricinus communis* L.) and Tapioca (*Manihot esculenta*). Freshly harvested leaves were used for feeding the larvae throughout the experiment.

Eri silkworm cocoons were procured from the College of Sericulture, University of Agricultural Sciences, Chintamani and incubated under controlled conditions of 25-28 °C and 60-80% relative humidity (RH). Prior to rearing, the rearing house and appliances were thoroughly cleaned and disinfected with a 5% bleaching powder solution as per standard disinfection process (Dandin and Giridhar, 2014) [2]. Rearing was carried out following the standard procedure (Dayashankar, 1982) [3]. During the chawki stage (up to the 3rd instar), all silkworm strains were fed with Local pink castor leaves. For the late-age worms (4th and 5th instars), larvae were fed with three host plants. Treatment details were given in table 1. Each treatment included 50 larvae per replication with three replications.

Table 1: Treatment details

Late age silkworms (4th and 5th Instar)			
Strains	**Host plants**		
	T_1	**T_2**	**T_3**
Green	Green castor variety	Pink castor variety	Tapioca
Yellow			
Hybrid (Green X Yellow)			

Commercial characters such as matured larval weight (g), fifth instar larval duration (days), pupal weight (g), cocoon yield (kg/100 layings), cocoon weight (g), shell weight (g), shell yield (kg/100 layings), shell ratio (%) and silk productivity (cg/day) were recorded. The standard formulas for calculating Cocoon and shell yield, shell ratio and silk productivity is given below.

$$\text{Cocoon yield (kg/100 layings)} = \frac{\text{CYR X EH/100 X 30,000}}{\text{NLR}}$$

Where,
CY = Cocoon yield
CYR = Cocoon yield/replication (g)
EH = Egg hatching
NLR = Number of larvae/replication

$$\text{Shell yield (kg/100 layings)} = \frac{\text{SYR X EH/100 X 30,000}}{\text{NLR}}$$

Where,
SY = Shell yield
SYR = Shell yield/replication (g)
EH = Egg hatching
NLR = Number of larvae/replication

$$\text{Shell ratio (\%)} = \frac{\text{Shell weight (g)}}{\text{Pupal weight (g)}}$$

$$\text{Silk productivity (cg/day)} = \frac{\text{Shell weight (g)}}{\text{Fifth instar larval duration (days)}}$$

The data were statistically analysed using a two-way factorial completely randomized design (CRD) at a 5% level of significance. All statistical analyses were carried out using the OPSTAT software.

Results and Discussion

The commercial characters of eri silkworms were significantly influenced by the host plant combinations, strains and their interactions to varying degrees. Among these traits, matured larval weight, cocoon yield, cocoon weight, shell weight, shell yield, shell ratio, pupal weight and silk productivity showed clear trends based on the nutritional profiles of the host plants and the genetic potential of the silkworm strains.

Matured larval weight varied significantly across host plants, silkworm strains and their interactions (table 2). Larvae reared on Local Green + Local Pink castor recorded the highest weight (5.107 g), whereas the lowest was observed with Local Green castor + Tapioca (4.482 g). Among the strains, the Green strain exhibited the highest larval weight (5.229 g), while the Hybrid strain recorded the lowest (3.81 g). The interaction between Local Green + Local Pink castor and Yellow strain yielded the maximum matured larval weight (5.777 g), while the lowest (3.747 g) was noted in hybrid strain reared on Local Green + Local Green castor. The fifth instar larval duration was significantly affected by the host plant but not by the strains or their interaction (table 2). Larvae fed on Local Green castor + Tapioca took the longer time (5.278 days) to complete the fifth instar, whereas those fed on Local Green + Local Pink castor had the shorter duration (4.278 days). Among strains, the hybrid strain exhibited a slightly longer duration (4.667 days) compared to the Yellow strain (4.556 days). The longest duration (5.33 days) was recorded in Yellow strain reared on Local Green castor + Tapioca and the shortest (4.167 days) in the same strain reared on Local Green + Local Pink castor. Pupal weight also differed significantly across host plants and their interaction, but not among silkworm strains (table 2). The highest pupal weight was recorded in silkworms reared on Local Green + Local Pink castor (2.098 g) and the lowest in Local Green castor + Tapioca (1.438 g). The hybrid strain had slightly higher pupal weight (1.772 g) than the Yellow strain (1.690 g). The interaction between Yellow strain and Local Green + Local Pink castor yielded the highest pupal weight (2.18 g), while the lowest (1.35 g) was observed in Yellow strain reared on Local Green castor + Tapioca. The findings on larval growth are in line with Nurkomar *et al*. (2022) who found that eri silkworm larvae developed faster on castor than on cassava, indicating castor as a more suitable diet.

Cocoon yield was significantly influenced by all three factors (table 3). The highest yield was recorded from silkworms reared on Local Green + Local Pink castor (61.56 kg/100 DFLs), while the lowest was from Local Green castor + Tapioca (33.75 kg/100 DFLs). Among the strains, the hybrid strain performed best (53.973 kg/100 DFLs) and the Yellow strain the least (42.147 kg/100 DFLs). The highest cocoon yield (70.55 kg/100 DFLs) was achieved in the interaction of Local Green + Local Pink castor with Yellow strain and the lowest (26.08 kg/100 DFLs) in hybrid strain reared on Local Green castor + Tapioca. Cocoon weight followed a similar trend, varying significantly across all factors (table 3). The highest weight was recorded in Local Green + Local Pink castor (2.533 g) and the lowest in Local Green castor + Tapioca (1.389 g). The hybrid strain showed the maximum average cocoon weight (2.221 g), while the Yellow strain had the minimum (1.734 g). Interaction-wise, the maximum cocoon weight (2.903 g) was registered in hybrid strain reared on Local Green + Local Pink castor, and the minimum (1.073 g) in Yellow strain reared on Local Green castor + Tapioca. Shell weight also varied significantly among host plants and interactions, but not among strains (table 3). The highest shell weight was recorded in Local Green + Local Pink castor (0.283 g) and the lowest in Local Green + Tapioca (0.209 g). Among the strains, the hybrid strain had a slightly higher shell weight (0.261 g) compared to the Yellow strain (0.25 g). In the interaction, the Yellow strain reared on Local Green + Local Pink castor produced the highest shell weight (0.337 g), while the Yellow strain reared on Local Green castor + Tapioca had the lowest (0.157 g).

Shell yield varied significantly with host plants and interactions, but not among strains (table 4). The maximum shell yield was found in Local Green + Local Pink castor (6.885 kg/100 DFLs), while the lowest was in Local Green castor + Tapioca (5.076 kg/100 DFLs). Among the strains, the Yellow strain had a higher shell yield (6.345 kg/100 DFLs) than the hybrid strain (6.075 kg/100 DFLs). The interaction of Local Green + Local Pink castor with hybrid strain gave the highest shell yield (8.0 kg/100 DFLs) and the lowest yield (3.807 kg/100 DFLs) was noted in hybrid strain reared on Local Green castor + Tapioca. Shell ratio varied significantly among the host plants but not among strains or their interaction (table 4). The highest shell ratio was observed in Local Green + Local Green castor (15.909%), and the lowest in Local Green + Local Pink castor (12.977%). Among the strains, the Green strain exhibited a slightly higher shell ratio (14.673%) compared to the hybrid strain (14.542%). The highest shell ratio (16.66%) was recorded in the Yellow strain reared on Local Green + Local Green castor, while the lowest (12.03%) occurred in the Green strain reared on Local Green + Local Pink castor. Silk productivity showed significant variation with host plants and interaction effects, while strain differences were statistically non-significant (table 4). The highest silk productivity was recorded in Local Green + Local Pink castor (6.622 cg/day) and the lowest in Local Green castor + Tapioca (3.96 cg/day). Among strains, the Yellow strain (5.722 cg/day) marginally outperformed the Green strain (5.628 cg/day). The maximum silk productivity (8.067 cg/day) was obtained from the Yellow strain reared on Local Green + Local Pink castor, while the minimum (2.933 cg/day) was from the same strain reared on Local Green castor + Tapioca.

Matured larval weight, cocoon weight, cocoon yield, shell ratio and pupal weight differed significantly among host plants, eri silkworm strains and their interactions. Highest matured larval weight was observed in Green strain reared on Local Pink + Local Green and Yellow strain on Local Pink + Green castor. Fifth instar larval duration varied significantly with host plants; larvae reared on Local Pink + Tapioca exhibited longer duration, while those on Local Pink + Local Green showed shorter duration. Yellow strain reared on Local Pink + Tapioca recorded highest cocoon and pupal weight, while Local Pink + Local Pink and Local Pink + Local Green combinations stood best in respective traits. Shell weight and shell yield differed significantly with host plants and interactions, being highest in Hybrid strain on Local Pink + Local Green and Yellow strain on Local Pink + Local Green, respectively. Shell ratio was superior in Green strain on Local Pink + Local Pink, and Hybrid strain on Local Pink + Tapioca performed best in shell yield. Silk productivity varied with host plant and interaction, with Hybrid strain on Local Pink + Local Green recording the highest. These findings are in line with Prasanna *et al.* (2013) [10], who reported improved economic traits on local castor. Shilpi Devi Borah and Monimala Saikia (2020) [15] also highlighted castor as a suitable host for superior cocoon quality, particularly on Borduar eco-race. Pallavi and Sannappa (2018) [8, 13] emphasized the advantage of Local Pink and DCH-177 varieties. Similar trends in strain-wise performance were reported by Singh *et al.* (2011) and Kedir Shifa *et al.* (2014) [6, 16].

Table 2: Matured larval weight, fifth instar larval duration and pupal weight among three strains of eri silkworm reared on different host plants

Host (Young-age+ Late-age)	Matured larval weight (g)				Fifth instar larval duration (days)				Pupal weight (g)			
	Strain				Strain				Strain			
	Green	Yellow	Hybrid	Mean	Green	Yellow	Hybrid	Mean	Green	Yellow	Hybrid	Mean
T_1: Local Pink + Local Pink castor	25.97	16.71	24.71	22.46	4.33	4.00	4.16	4.16	1.261	1.156	1.242	1.220
T_2: Local Pink + Local Green castor	28.47	12.56	26.40	22.48	3.83	4.16	4.00	4.00	1.609	1.686	1.626	1.640
T_3: Local Pink castor + Tapioca	17.81	12.30	18.86	16.32	5.16	5.16	5.00	5.11	1.207	1.747	1.404	1.453
Mean	24.08	13.86	23.32		4.44	4.44	4.38		1.359	1.530	1.424	
Two-Way ANOVA	SE(m)±	SE(d)±	C.D at 5%		SE(m)±	SE(d)±	C.D at 5%		SE(m)±	SE(d)±	C.D at 5%	
Host	0.322	0.470	0.995		0.079	0.111	0.235		0.017	0.024	0.051	
Strain	0.470	0.470	0.995		0.079	0.111	-		0.017	0.024	0.051	
Host X Strain	0.576	0.814	1.724		0.136	0.192	-		0.030	0.042	0.089	

Table 3: Cocoon yield, cocoon weight and Shell weight among three strains of eri silkworm reared on different host plants

Host (Young-age+ Late-age)	Cocoon yield (kg/100 layings)				Cocoon weight (g)				Shell weight (g)			
	Strain				Strain				Strain			
	Green	Yellow	Hybrid	Mean	Green	Yellow	Hybrid	Mean	Green	Yellow	Hybrid	Mean
T_1: Local Pink + Local Pink castor	37.193	34.293	37.043	36.177	1.531	1.411	1.525	1.489	0.273	0.225	0.218	0.238
T_2: Local Pink + Local Green castor	44.837	47.220	46.797	46.284	1.845	1.943	1.926	1.905	0.237	0.260	0.300	0.266
T_3: Local Pink castor + Tapioca	35.247	48.427	40.017	41.230	1.451	1.993	1.647	1.697	0.243	0.243	0.243	0.243
Mean	39.092	43.313	41.286		1.609	1.783	1.699		0.251	0.243	0.254	
Two-Way ANOVA	SE(m)±	SE(d)±	C.D at 5%		SE(m)±	SE(d)±	C.D at 5%		SE(m)±	SE(d)±	C.D at 5%	
Host	0.358	0.507	1.073		0.015	0.021	0.044		0.005	0.007	0.014	
Strain	0.358	0.507	1.073		0.015	0.021	0.044		0.005	0.007	N/A	
Host X Strain	0.621	0.878	1.858		0.026	0.036	0.076		0.008	0.012	0.025	

Table 4: Shell yield, shell ratio and silk productivity among three strains of eri silkworm reared on different host plants

Host (Young-age+ Late-age)	Shell yield (kg/100 layings)				Shell ratio (%)				Silk productivity (cg/day)			
	Strain				Strain				Strain			
	Green	Yellow	Hybrid	Mean	Green	Yellow	Hybrid	Mean	Green	Yellow	Hybrid	Mean
T_1: Local Pink + Local Pink castor	5.917	5.460	5.273	5.550	17.793	15.973	14.283	16.017	6.280	5.620	5.233	5.711
T_2: Local Pink + Local Green castor	5.907	7.287	6.890	6.694	12.823	13.380	15.590	13.931	6.200	6.250	7.497	6.649
T_3: Local Pink castor + Tapioca	6.040	6.277	4.937	5.751	16.777	12.210	14.773	14.587	4.720	5.133	4.867	4.907
Mean	5.954	6.341	5.700		15.798	13.854	14.882		5.733	5.668	5.866	
Two-Way ANOVA	SE(m)±	SE(d)±	C.D at 5%		SE(m)±	SE(d)±	C.D at 5%		SE(m)±	SE(d)±	C.D at 5%	
Host	0.304	0.430	0.911		0.297	0.421	0.890		0.126	0.179	0.378	
Strain	0.304	0.430	N/A		0.297	0.421	0.890		0.126	0.179	N/A	
Host X Strain	0.527	0.745	N/A		0.515	0.728	1.542		0.219	0.309	0.655	

Conclusions

The present investigation revealed that the interaction between eri silkworm strains and different host plant combinations significantly influenced several economic traits. Among the combinations tested, the Yellow strain reared on Local Pink castor during early instars and Local Green castor during late instars showed superior performance across key parameters including cocoon weight, pupal weight, cocoon yield and shell yield. The Green strain reared on Local Pink + Local Green castor recorded the highest matured larval weight and shortest fifth instar larval duration, while the Hybrid strain on Local Pink + Local Green castor excelled in shell weight and silk productivity. The highest shell ratio was observed in the Green strain reared on Local Pink + Local Pink castor. Overall, the findings suggest that strategic rearing of eri silkworm strains on specific castor combinations, particularly the Yellow strain on Local Pink + Local Green castor, can enhance commercial traits and cocoon productivity under tropical conditions.

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Authors Contribution

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Disclaimer (Artificial Intelligence): Author(s) hereby declares that no generative AI technologies such as large language models (ChatGPT, Copilot, etc) and text-to-image generators have been used during writing or editing of manuscripts.

Declaration

The authors declare that they have no conflict of interest.

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