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Growth response of different eco races of ERI silkworm reared on various castor genotypes

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Abstract
Ericulture is mainly confined to North-Eastern region of India. Eri Silkworm (*Philosamia ricini*) has several isolated populations, geographically separated (Eco races) in the states of Assam and Meghalaya. In the present study, different eco races of eri silkworm *viz.*, Borduar, Barpathar, Khanapara, Mendipathar and Titabar were reared on five castor genotypes such as GCH 4, GCH 7, DCH 519, TMV 5 in comparison with local castor variety to record changes in the larval and cocoon parameters. The study revealed that, eri worms reared on the leaves of GCH 4 recorded significantly higher larval weight, larval duration, cocoon weight, cocoon yield, shell weight and shell ratio followed by DCH 519 and local castor variety. Among the eco-races, Borduar registered better in larval and cocoon parameters compared to other eco-races. The interaction between castor genotype x eri silkworm eco races, Borduar eco race of eri silkworm reared on the leaves of GCH 4 genotype found best for all parameters followed by GCH 4 x Titabar and the lowest was recorded in TMV 5 x Barpathar. It could be concluded that Borduar eco race of eri silkworm reared on GCH 4 castor genotype was found superior for the larval and cocoon parameters and same could be exploited for maximization of eri cocoon production.

Keywords: Eco races, Castor genotypes, larval and cocoon parameters

Introduction
Ericulture is an agro-based small scale industry of North Eastern India consisting of activities like host plant cultivation, silkworm rearing, spinning of yarn and weaving. Eri culture enjoys a unique location among other sericulture like Mulberry, Tasar and Muga for its typical quality of cotton like soft yarn with thermal property. Eri fabric is used as an alternative to woolbecause of its thermal property [1]. The silk produced by eri silkworm is considered as the third most vital silk in the world after mulberry and Chinese Tasar. North Eastern India contributes about 97 per cent of the national production of eri raw silk [2]

The eri silkworm larvae feed on various host plants of which castor (*Ricinus communis* L.,) is the primary host plants of eri silkworm. Castor is rich in biochemical composition, foliar constituents and rearing parameters compared to other secondary host plants because different host plants may often exert variable effects on the relative survival of an herbivore insect. Pandey (1995) reported that growth, development and cocoon yield are influenced by the castor genotype and quality of leaves on which worms are reared. Nutritional status of leaves has been considered as a prime factor in the survival of non-mulberry silkworms

The ideal range of temperature for the growth of Eri silkworms is from 20° C to 35°C and an increase in temperature beyond it causes less spinning, mortality of larvae and pupae and poor moth emergence and sterility at adult stage [4]. 19 species of eri silk moth were recorded in the tropical Asia out of which three species of eri silkworm, namely, *Samia ricini*, *Samia canningie* and *Samia fulva* are reported to be found exclusively in India [5]. Out of 19 species of eri silkworm, the commonly reared one is *S. ricini* which has 18 variants or eco races which are quite different from each other both in morphology and genetic traits [6].

Field trials of elite crosses of eri silkworm and identified seven eco races *viz.*, Borduar, Titabar, Khanapara, Mendi, Sillie, Dhanubanga and Nogpho besides six pure line strains *viz.*, Yellow Plain (YP), Yellow Spotted (YS), Yellow Zebra (YZ), Greenish Blue Plain (GBP), Greenish Blue Spotted (GBS), Greenish Blue Zebra (GBZ) on the basis of larval colour and body markings [7]. Ray and Rao (2010) recorded that the rearing performance of eco races of eri silkworm in winter season of Odhisha and reported that Borduar eco race performed better among other eco races.

Based on the above, to identify the behavior and potential of eco races of eri silkworm in

nontraditional areas. In this backdrop, the study has been undertaken to find out the suitable eco-race(s) and castor genotypes for large scale production of eri cocoons in Tamil Nadu condition.

Materials and Methods

a) Collection of castor genotypes and eco races of eri silkworm

Seeds of four different castor genotypes *viz*., GCH 4, GCH 7, DCH 519 and TMV 5 were procured from Tapioca and Castor Research station, Yethapur, Salem. The different castor genotypes and local castor variety were sown in the main field with spacing of 3 x 3' and the crop was raised as per recommended package of practices.

Eggs of eco races of eri silkworm were obtained from Central Muga and Eri Research Institute, Jorhat, Assam. The eco races include Barpathar, Borduar, Khanapara, Mendipathar and Titabar.

b) Rearing of eco races of eri silkworm with different castor genotypes

First and foremost step of rearing operation is proper disinfection of rearing room and appliances. Rearing appliances were disinfected with 5 per cent bleaching powder solution and kept inside the rearing room. Rearing room was disinfected with 2 per cent chlorine di oxide solution under air tight condition. Room was opened after 24 hours. The eggs of eco races of eri silkworm were maintained in the optimum environmental conditions of 25 ± 1 ºC temperature and 75 ± 5 per cent relative humidity for uniform development of embryo. The eggs were black boxed on the day of pin head stage to ensure uniform hatching. Eggs hatched in the early morning, after 9 - 10 days after oviposition under normal temperature and relative humidity condition.

Rearing was conducted by feeding the different castor genotypes such as GCH 4, GCH 7, DCH 519, TMV 5 and local castor variety from the day of brushing till cocoon spinning by maintaining three replications for each eco-race throughout the rearing. The first and second instar larvae were fed twice with tender leaves and the third instars were fed with semi-tender castor leaves thrice a day and for late age worms, five feedings were provided during per day. The experiment was designed in a Factorial Completely Randomized Design (FCRD). The average temperature and relative humidity recorded during rearing was 25.10ºC and 75.0%, respectively. The eri worms were reared in specially designed cages to prevent the mixing of larvae under each treatment and replication-wise as these worms are highly motile in later instars (Fourth and fifth).

The following larval and cocoon parameters were recorded such as matured larval weight (g), Total Larval duration (days), cocoon weight (g), cocoon yield (kgs), shell weight (g) and shell ratio (%).

c) Economic parameters

i) Larval weight (g)

Fifth instar matured larva's were selected randomly before ripening and calculated the larval weight in the following expression:

$$\text{Single Larval weight (g)} = \frac{\text{10 nos. of matured larval weight before ripening}}{10}$$

ii) Larval duration (h.)

Day of hatching to day of ripening.

iii) Single cocoon weight (g)

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

$$\text{Single cocoon weight (g)} = \frac{\text{10 nos. of live cocoon with pupa}}{10}$$

iv) Yield/400 larvae (by weight in kgs)

The yield was calculated by the weight basis.

v) 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

$$\text{Single shell weight (g)} = \frac{\text{10 nos. of cocoon shell}}{10}$$

vi) Shell ratio (%)

The shell ratio indicates the quality of the silk that can be spun from a lot of live cocoons. The cocoon weight (including live pupa,1:1 of ratio male and female) and cocoon shell weight of the same lot (without pupa) were recorded individually and the shell ratio was calculated in percentage using following expression [9]

$$\text{Shell ratio (\%)} = \frac{\text{Weight of cocoon shell without pupa}}{\text{Weight of cocoon with live pupa}} \text{ X } 100$$

Results

The results relating to economic parameters of eco races of eri silkworm fed with different castor genotypes are presented in the table and are explained below.

i) Larval weight (g)

Larval weight varied significantly among eco races of eri silkworm when reared on leaves of different castor genotypes. Matured larval weight was higher when eco races of eri silkworm reared on the leaves of GCH 4 (8.55 g) followed by DCH 519 (8.39 g) and local castor variety (8.24 g) and lowest was found in TMV 5 (7.78 g). In respect to eco races of eri silkworm, larval weight was higher on Borduar (8.87 g**)** followed by Titabar (8.76 g), Mendipathar (8.46 g) and Khanapara (7.78 g) and it was lowest in Barpathar (7.14 g). In interaction between castor genotype and eco races of eri silkworm, larval weight was maximum between GCH x Borduar (9.18 g), followed by GCH x Titabar (9.09 g), GCH x Mendipathar (8.75 g) and GCH x Khanapara (8.28 g) and lowest was recorded in TMV 5 x Barpathar (6.85 g) (Table 1).

ii) Larval duration (days)

Larval duration did not show much difference when eco races were reared on different castor genotypes. Among the castor genotypes, lowest larval duration was recorded on GCH 4 (25.60 days) followed by DCH 519 (25.79 days) and the highest larval duration was recorded in TMV 5 (26.14 days)

followed by GCH 7 (26.07) and local variety (26.0 days) which were on par with each other. In respect of eco races, larval duration varied from Borduar (25.64 days) to Barpathar (26.33 days). In interaction, larval duration ranged between 25.20 days in GCH 4 x Borduar and 26.50 days in TMV 5 x Barpathar (Table 1).

Table 1: Larval parameters of eco races of eri silkworm reared on different castor genotypes

Eco races of Eri silkworm	Matured larval weight (g)						Larval duration (days)					
	Castor genotypes						Castor genotypes					
	GCH 4	GCH 7	TMV 5	DCH 519	Local	Mean	GCH 4	GCH 7	TMV 5	DCH 519	Local	Mean
Barpathar	7.46	7.03	6.85	7.25	7.12	7.14	26.10	26.45	26.50	26.23	26.38	26.33
Borduar	9.18	8.71	8.54	9.02	8.93	8.87	25.20	25.80	25.89	25.56	25.75	25.64
Khanapara	8.28	7.53	7.27	8.02	7.84	7.78	25.76	26.15	26.24	25.89	26.04	26.01
Mendipathar	8.75	8.51	8.03	8.67	8.52	8.46	25.53	26.03	26.10	25.67	25.94	25.85
Titabar	9.09	8.70	8.24	8.99	8.82	8.76	25.45	25.93	25.98	25.60	25.90	25.77
Mean	8.55	8.09	7.78	8.39	8.24	8.20	25.60	26.07	26.14	25.79	26.00	25.92
F Value	C = 97.94** E = 100.43** C x E= 88.40**						-					

iii) Cocoon weight (g)

Cocoon weight varied considerably between castor genotypes with more being in GCH 4 (3.44 g) and the next best was observed on DCH 519 (3.34 g) and local variety (3.26 g) which were on par with each other and lowest cocoon weight of 3.14 g in TMV 5 genotypes. In respect of eco races of eri silkworm, cocoon weight was better with Borduar (3.72 g) and the next best were Titabar (3.52 g), Mendipathar (3.27 g) and Khanapara (3.13 g) and the same was lower in Barpathar (2.75 g). In the interaction between castor genotypes and eco races of eri silkworm, significantly highest cocoon weight was registered in GCH 4 x Borduar (3.86 g) followed by DCH 519 x Borduar (3.75 g), Local x Borduar (3.70 g) and GCH 4 x Titabar (3.67 g) and the lowest was recorded in TMV 5 x Barpathar (2.60 g) and TMV 5 x Khanapara (2.99 g) (Table 2)

Table 2: Cocoon parameters of eco races of eri silkworm reared on different castor genotypes

Eco races of Eri silkworm	Cocoon weight (g)						Shell weight (g)					
	Castor genotypes						Castor genotypes					
	GCH 4	GCH 7	TMV 5	DCH 519	Local	Mean	GCH 4	GCH 7	TMV 5	DCH 519	Local	Mean
Barpathar	2.98	2.65	2.60	2.84	2.71	2.75	0.36	0.29	0.27	0.32	0.30	0.30
Borduar	3.86	3.69	3.62	3.75	3.70	3.72	0.56	0.45	0.42	0.50	0.46	0.47
Khanapara	3.29	3.05	2.99	3.20	3.12	3.13	0.42	0.34	0.31	0.40	0.36	0.36
Mendipathar	3.41	3.21	3.13	3.34	3.29	3.27	0.45	0.36	0.33	0.43	0.39	0.39
Titabar	3.67	3.46	3.40	3.58	3.52	3.52	0.52	0.40	0.38	0.47	0.43	0.44
Mean	3.44	3.21	3.14	3.34	3.26	3.27	0.46	0.36	0.34	0.42	0.38	0.39
F value	C = 16.28** E = 171.93** C x E= 21.65*						C = 179.85** E = 349.03** C x E= 222.9*					

iv) Shell weight (g)

Shell weight significantly varied between castor genotypes, with higher being in GCH 4 (0.46 g) and the next best was DCH 519 (0.42 g) followed by local (0.38 g) and GCH 7 (0.36 g). The lowest shell weight recorded in TMV 5 (0.34 g). Among the eco races of eri silkworm, shell weight was significantly high in Borduar (0.47 g) and the next best was Titabar (0.44 g) followed by Mendipathar (0.39 g) and Khanapara (0.36 g) both were on par with each other and it was low in Barpathar (0.30 g). In interaction between castor genotypes and eco races of eri silkworm, significantly higher shell weight was found in GCH 4 x Borduar (0.56 g) followed by GCH 4 x Titabar (0.52 g), GCH 4 x Mendipathar (0.45 g). TMV 5 x Barpathar (0.27 g) found to be lowest in shell weight (Table 2)

v) Shell Ratio (%)

Significantly higher shell ratios were obtained when eco races of eri silkworm were reared on the leaves of GCH 4 (13.49 %) followed by DCH 519 (12.45 %), Local (11.81 %) and GCH 7 (11.40 %) and it was lower in TMV 5 (10.83 %). Among the eco races of eri silkworm, highest shell ratio were registered in Borduar (12.81 %) followed by Titabar and Mendipathar which recorded shell ratio of 12.28 % and 12.08 % respectively and were found to be on par with each other and lowest shell ratio found in Khanapara (11.65 %) and Barpathar (11.17 %). In interaction of castor genotypes and eco races, significantly more shell ratio were found in GCH 4 x Borduar (14.5 %) followed by GCH 4 x Titabar (14.16 %), GCH 4 x Mendipathar (13.96 %), GCH 4 x Khanapara (12.76 %) and it was low in TMV 5 x Khanapara (10.36 %) and TMV 5 x Barpathar (10.5 %) (Fig.1).

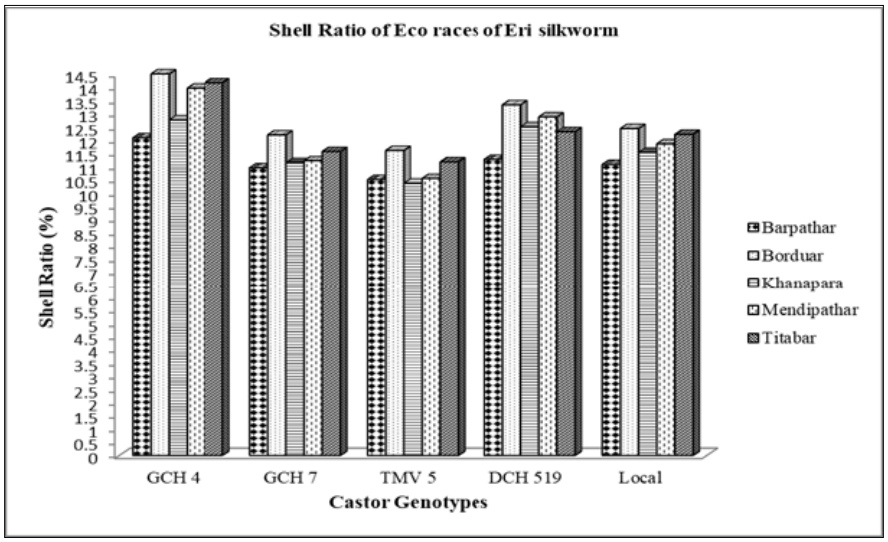

Fig 1: Shell ratio (%) of eco races of eri silkworm fed with different castor genotypes

vi) Cocoon yield (Kgs / 400 larvae)

Cocoon yield vary significantly between castor genotypes, highest being observed in GCH 4 (1.29 kg) which was on par with DCH 519 (1.26 kg) and local variety (1.24 kg) and the lowest being in TMV 5 (1.19 kg). in respect of eco races of eri silkworm, cocoon yield was significantly more in Borduar (1.35 kg) and the next best was Titabar (1.30 kg) followed by Mendipathar (1.27 kg) and Khanapara (1.24 kg). The lowest was Barpathar which recorded cocoon yield of 1.03 kg. In interaction between castor genotypes and eco races, cocoon yield significantly higher in GCH 4 x Borduar (1.40 kg) and lowest was found in TMV 5 x Barpathar (0.98 kg) (Fig.2).

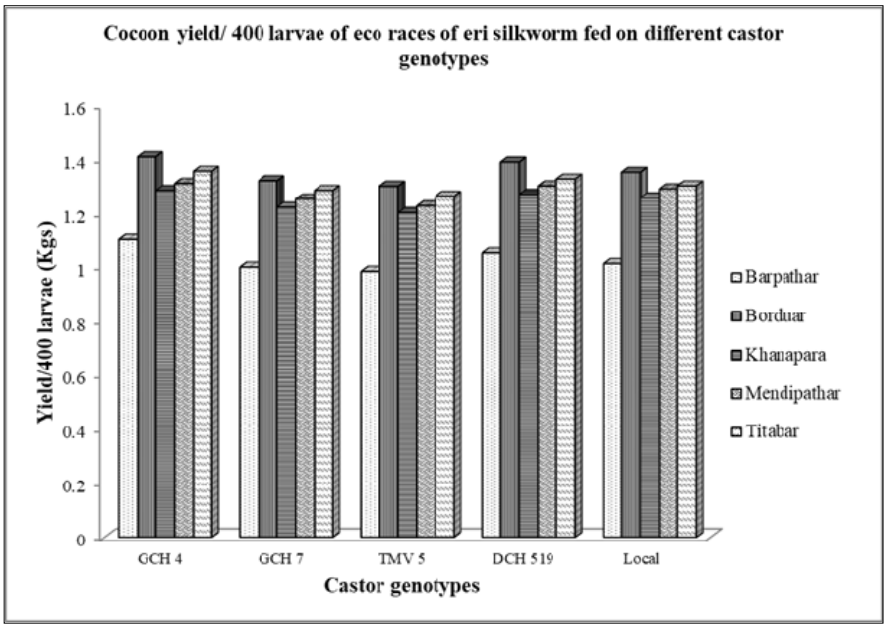

Fig 2: Effect of castor genotypes on cocoon yield of eco races of eri silkworm

Discussion

In the present study, prominence was laid out to evaluate the five eco races of eri silkworm for economic parameters such as larval weight, larval duration, cocoon weight, shell weight, shell ratio and cocoon yield using the leaves of five different castor genotypes. Among the five eco races, Borduar eco race reared on the leaves of GCH 4 genotype outshined better on the larval and cocoon parameters and next best were recorded in eco races Titabar and Mendipathar when they were reared on GCH 4 castor genotypes. Gogoi and Goswami (1998) [10] reported that the changing conditions of different seasons of the year bring profound variance in growth and development and the expression of characters in *Samia ricini*. The best rearing performance of an eco race of silkworm is largely dependent on combined action of heredity and the environment to which it is exposed during its life time [11].

Shivashankar and Chandan (2014) [12] reported that the higher percentage of larval, cocoon and shell weight and shell ratio percentage exhibited by eri silkworm fed on castor leaves may be due to higher rate of food ingestion, food assimilation and respiratory activity. Narayanamma *et al*. (2013) [13] evaluated the Castor Genotypes on Rearing and Cocoon Parameters of Eri Silkworm, *Samia cynthia ricini* and result revealed that eri silkworms nourished with leaves of PCH-111

and GCH-4 registered significantly higher effective rate of rearing (ERR) while, it was lower with control. Prasanna and Bhargavi (2017) [14] reported significant difference was noticed among the five castor genotypes in larval duration, larval weight, silk ratio, ERR, cocoon weight, fecundity, and hatchability. Among the five castor genotypes *viz*., DCH-519 and local genotype are better suited for both castor seed as well as eri silk worms rearing under rain fed conditions.

Studies have been conducted under diverse environment and climatic conditions in Uttar Pradesh to show the phenotypic variations among ecoraces in various seasons [15]. Ray *et al*. (2010) [8] studied the rearing performance of different eco-races (Borduar, Titabar and Mendipathar) of eri silkworm during winter season in Odisha. The parameters considered for the investigation includes hatching percentage, larval duration, larval weight, cocoon weight, shell weight, pupal weight, shell ratio and effective rate of rearing (ERR). These parameters were considered as the index of reproductive and commercial productivity. Among the eco races of eri silkworm, Borduar proved better than the other eco-races.

Pallavi and Sannappa (2018) [17] studied the commercial characters of selected eco-races of eri silkworm (*Samia cynthia ricini boisduval*) reared on castor hybrid/variety. The commercial parameters considered for the study includes larval weight, larval duration, cocoon weight, cocoon yield, shell weight, shell ratio, shell yield, silk productivity, fibroin and sericin content. It can be concluded that, Borduar eco-race of eri silkworm reared on the leaves of Local Pink variety of castor showed superiority for the commercial parameters and same can be exploited for maximization of eri cocoon production.

Conclusion

From the result, it can be concluded that, larval and cocoon parameters of eri silkworm varied considerably among the eco races of eri silkworm when they were reared on different castor genotypes. Among the eco race, Borduar performed better by recording superior rearing performance over other eco-races when it was reared on GCH 4 genotype and the same can be commercially exploited to maximize the eri cocoon production in non-traditional areas like Tamil Nadu.

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