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ORIGINAL ARTICLE

Effect of Temperature and Relative Humidity on Moth Emergence And Fecundity of Different Eco-Races of Eri Silkworm (*Philosamia Ricini* Donovan)

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ABSTRACT
Four eco-races of eri silkworm (Philosamia ricini DONOVAN) namely Borduar, Mendipathar, Titabar and Dhanubhanga were selected to study the effect temperature and relative humidity on moth emergence and eggs fecundity. These eco-races were subjected to different temperature and relative humidity treatments ie 15 ± 1 ºC to 21 ± 1 ºC and 56 ± 5 % to 64 ± 5 % during winter season and 22 ± 1 ºC to 28 ± 1 ºC, 65 ± 5 % to 72 ± 5 % during spring season. The effects of temperature and relative humidity were observed at different stages of moth emergence (during spring 93.50 % and during winter 96.50 %), fecundity of eggs (during spring 345 and during winter 375), larval duration (during spring 27.75 d and during winter 18.00 d), larval weight (during spring 6.15 and during winter 7.65 g), single cocoon weight (during spring 3.45 and during winter 3.52 g), single shell weight (during spring 0.48 and during winter 0.56 g) and shell ratio (during spring 14.10 and during winter 16.19 %). The present investigation clearly indicates that the effect of low temperature and low RH (%) during winter was more pronounce on moth emergence, eggs fecundity, larval duration, larval weight, single cocoon weight, single shell weight and shell ratio than spring rearing season.
***Key words**: Eco-races, silkworm, moth emergence, egg fecundity*

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INTRODUCTION

The eri silkworm, *Philosamia ricini* (DONOVAN) is domesticated and the grainage techniques are quite different from that of other non mulberry silkworms namely, tasar and muga and domestication renders the grainage operation systematic and easy [1]. The state Uttar Pradesh is highly populated with diversified climate, vegetation, topography and soil types. It is a traditional agriculture based state with maximum number of small / marginal farmers to the extent of 80 % with an average land holding of 0.89 hectare. According to the survey conducted by economic survey of India during 2003-04, about 31 % of population in Uttar Pradesh comes under Below Poverty Line category [2]. In this traditional agricultural state, the pressure of population on land based activities is increasing every day with decrease in size of the average land holding. Thus, there is a need to promote alternate option for livelihood small / marginal farmers. In the present scenario, sericulture an agro based labor intensive and environment friendly cottage industry involving maximum number of family members can become a best effective source. However, recently introduced eri culture has shown a ray of hope for underprivileged in the state.

Ericulture is more popular and being practiced in North-eastern states of India, particularly in Bihar, West Bengal and Orissa. Ericulture offers a subsidiary self-employment opportunity for castor growers of the country, particularly in non-traditional sericulture states like Uttar Pradesh. Rearing of eri silkworm, *P. ricini* provides income without significant additional investment, besides remunerative employment for the rural population. The ericulture prospective exists in Uttar Pradesh where castor and tapioca plantations are raised for oil seed and tuber productions, respectively. Ericulture has gained importance as alternate cash crop. It is important to produce good quality cocoons, in order to produce good quality raw silk [3]. The eri silkworm can be reared throughout the year to a maximum of 6-7 times a year. Eri culture in U. P. basically depends on timely supply of silkworm seeds, advanced technologies in field operation, timely assistant to farmers and availability of host plants [4].

Humidity plays a vital role in silkworm rearing. The role of humidity is both direct and indirect. In direct ways it influences the physiological activity of silkworm such as the amount of ingestion and digestion. Indirectly, humidity effect the rate of withering/drying of leaves in rearing beds, thereof affecting its suitability as a feed and consumption [5]. The ideal range of temperature for the growth of eri silkworms is from 20.0 °C to 40.0 °C, however, increase in temperature beyond 35.0 °C cause less spinning, mortality of larvae and pupae, poor moth emergence and sterility at adult stage [6,7]. The host plants have profound effect on growth and development of silkworms apart from influencing the behaviour, food intake, digestion and assimilation of the larvae. The amount, rate and quality of food consumption of larva influence the growth rate, duration of larval development, body weight, survival rate and reproductive potential of silkworms [8]. The nutrition which obtained during the feeding period influence the growth and development of eri silkworms throughout their life period [9]. The state Uttar Pradesh possesses different geographical regions such as hilly, plain and Tarai. It occupies a major portion of Indo Gangetic area with distinct seasons such as rainy, winter and summer. The climate in hills and Tarai regions favoured successful silkworm rearing [10]. Optimum environmental conditions such as temperature, relative humidity, ventilation, illumination and hygiene are required during silkworm rearing for the production of quality cocoons [11]. The present study was aimed to investigate the effect of temperature and relative humidity on moth emergence and fecundity of different eco-races of eri silkworm.

MATERIALS AND METHODS

The study was conducted in a well constructed rearing house of the Department of Applied Animal Sciences, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh during Winter 2009 and Spring 2010. The eco-races of eri silkworm, *P. ricini* such as Borduar, Mendipathar, Titabar and Dhanubhanga were selected for the experiment to evaluate their rearing performance. The eggs of various races were procured from Regional Eri Research Station (Central Silk Board), Mendipathar, Meghalya. The eggs were incubated at room temperature and undergone black boxing. Standard tray rearing method was practiced as recommended by [12]. Experiments were conducted from second moulting to harvesting of cocoon. The tender leaves of castor, *Ricinus communis* were fed four times a day until the worms become III instar larvae. Semi tender leaves and mature leaves were fed to the larvae of IV and V instars, respectively. For each experiment, sum of 400 larvae of each eco-race were maintained separately in wooden trays. A total of three replicates maintained for each eco-race. Ambient temperature and relative humidity of the experimental chamber were recorded regularly using thermometer and hygrometer, respectively. Cocoon harvesting was carried out on five or six days after started spinning. The cocoons were kept for the moth emergence. After moth emergence the male and female moths of *P. ricini* were allowed to mate at room temperature and relative humidity for 4 h. Thereafter, male and female moths were separated and the later were allowed to lay the eggs. These eco-races were subjected to different temperature and relative humidity treatments *ie* 15 ± 1 to 21 ± 1 ºC and 56 ± 5 to 64 ± 5 % during winter season and 22 ± 1 to 28 ± 1 ºC, 65 ± 5 to 72 ± 5 % during spring season. Observations on moth emergence and eggs fecundity were recorded and the data were analyzed using One Way ANOVA and ‘t’ test.

RESULTS AND DISCUSSION

The highest moth emergence (%) was recorded in Borduar eco-race (92.50) followed by Mendipathar (92.00), Dhanubhanga (91.00) and Titabar (90.50) eco-race during 2009 winter season. During the year of spring season 2010 the maximum moth emergence was observed in Borduar eco-race (98.00) followed by Mendipathar (97.50), Dhanubhanga (96.20) and Titabar (95.50) eco-race (Table 1). Though, there was no significant difference on emergence among the eco-races of eri silkworm during winter 2011 ($F_{3, 11}$= 0.82, $P > 0.05$) and spring ($F_{3, 11}$ = 0.18, $P > 0.05$) rearing. However, there was a significant difference on moth emergence between winter and spring ($t = 4.33$, $P < 0.05$).

The maximum egg fecundity (number) was recorded in Borduar eco-race (345) followed by Mendipathar (332), Dhanubhanga (317) while Titabar eco-race (298) showed a minimum during winter 2009. The highest egg fecundity was observed in Borduar eco-race (375) followed by Mendipathar (356), Titabar (345) and Dhanubhanga (332) eco-races during spring 2010 (Table 1). The egg fecundity of different eco-races of eri silkworm differed statistically during winter 2009 ($F_{3, 11}$ = 15.56, $P < 0.01$) and spring 2010

($F_{3, 11}$ = 10.38, P < 0.01) rearing. Further, the egg fecundity of different eco-races differed significantly between winter and spring rearing (t = 7.61, P < 0.05).

Minimum larval duration was observed in Borduar eco-race (27.75 d) followed by Titabar (28.50 d), Mendipathar and Dhanubhanga (29.00 d) eco-races during 2009 winter rearing. Similarly during 2010 spring rearing, the minimum larval duration was observed in Borduar (18.00 d) and maximum larval duration was recorded in Dhanubhanga (19.50 d) eco-races (Table 2). The larval duration of different eco-races of eri silkworm differed statistically during winter 2009 ($F_{3, 11}$=5.15, P < 0.05) and spring ($F_{3, 11}$ = 5.6, P < 0.05) rearing 2010. In case of larval duration of different eco-races of eri silkworm, there was a significant different between winter and spring season (t = 83.76, P < 0.05).

The larval weight of different eco-races ranged from 5.20 g to 6.10 g during 2009 winter rearing while it ranged from 6.15 g to 7.65 g during spring 2010. However, the highest larval weight was observed in Borduar eco-race both during 2009 winter and 2010 spring rearing (Table 2). The weight of larva of different eco-races of eri silkworm statistically differed during 2009 winter rearing ($F_{3, 11}$=14.48, P < 0.01) while there was no significant difference during spring ($F_{3, 11}$ = 69.33, P > 0.05) 2010 rearing. The larval weight of different eco-races of eri silkworm, differed significantly between winter and spring season (t = - 16.93, P < 0.05).

The single cocoon weight was highest in Mendipathar eco-race (3.45 g) followed by Borduar (3.19g), Titabar (3.00 g) and Dhanubhanga (2.69 g) eco-races during 2009 winter rearing, while during 2010 spring rearing the highest cocoon weight was observed in Borduar eco-race (3.52 g) followed by Titabar (3.36 g), Mendipathar (3.15 g) and Dhanubhanga (2.68 g) eco-races (Table 2). The cocoon weight of different eco-races of eri silkworm during winter 2009 and spring 2010 rearing differed statistically ($F_{3, 11}$=15.72, P < 0.01) and ($F_{3, 11}$ = 11.70, P < 0.01), respectively. Further, the cocoon weight of different eco-races of eri silkworm, differed significantly between winter and spring season (t = 0.94, P > 0.05).

The highest shell weight was recorded in Mendipathar eco-race (0.48 g) followed by Borduar (0.45g), Titabar (0.41g) and Dhanubhanga (0.36g) eco-races during 2009 winter rearing. During the year 2010 spring rearing, the highest shell weight was recorded in Borduar eco-race (0.56g) followed by Titabar (0.52g), Mendipathar (0.51g) and Dhanubhanga (0.42g) eco-races (Table 2). There was no significant difference in shell weight during winter 2009 ($F_{3, 11}$= 2.02, P > 0.05) and spring 2010 ($F_{3, 11}$ = 1.90, P > 0.05) rearing. However, there was a significant difference on the shell weight between winter and spring (t = 3.00, P < 0.05).

The highest shell ratio during 2009 winter season was observed in Borduar eco-race (14.10 %) followed by Mendipathar (13.92 %), Titabar (13.66 %) and Dhanubhanga (13.38 %) eco-races. However, the highest shell ratio was observed in Mendipathar eco-race (16.19 %) followed by Borduar (15.90 %), Dhanubhanga (15.67 %) and Titabar (15.48 %) eco-races during 2010 spring rearing (Table 2). The shell ratio of different eco-races of eri silkworm differed statistically during 2009 winter rearing ($F_{3, 11}$=27.94, P < 0.001) and 2010 spring rearing ($F_{3, 11}$ = 26.26, P < 0.001). Further, the shell ratio of different eco-races of eri silkworm, differed significantly between winter and spring season (t = 27.44, P < 0.05).

The rearing performance of different eco-races is mainly depending on the combined action of hereditary potential and environment of which they are exposed. It is well known that the dynamic environment conditions prevail at different seasons bring about profound changes in physical as well as biotic factors influencing the growth development and the expression of economic characters in different silkworm races [13]. The results of present study clearly indicate that the effect of temperature and relative humidity on moth emergence and fecundity of different eco-races of *P ricini*. The highest fecundity observed number in Titabar and minimum Dhanubhanga eco-race [14]. [15,16,17] reported that during low temperature there was less fecundity to the compared to high temperature. [18] reported highest fecundity during winter season and during spring rearing. 19] observed a maximum fecundity during high temperature and maximum fecundity during winter season. [20] studied in non-traditional state that temperature has influenced the fecundity number and observed highest fecundity during winter and less during spring season. [21] observed highest fecundity in Borduar eco-race and minimum in Dhanubhanga eco-race. [16] observed highest moth emergence during winter followed by spring season.

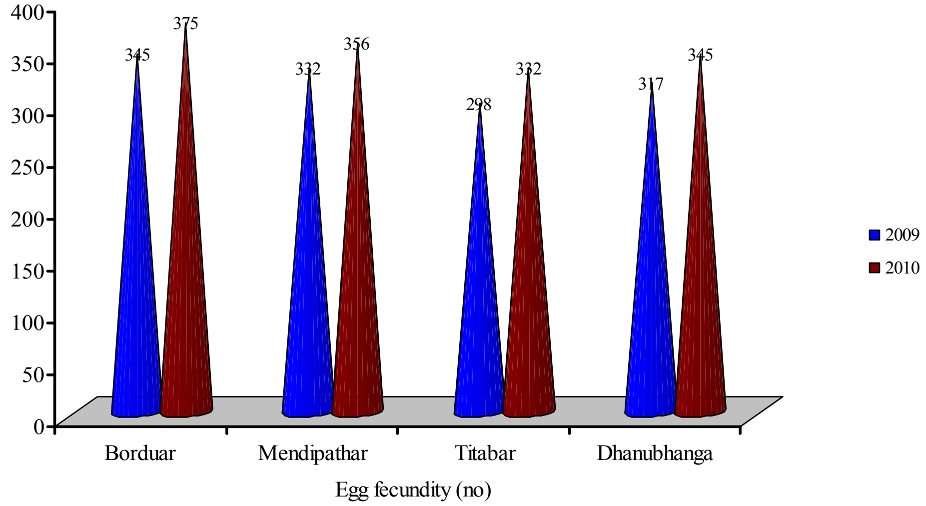

Figure1. Fecundity rate of different eco-races of eri silkworm, *Philosamia ricini* during winter 2009 and spring 2010.

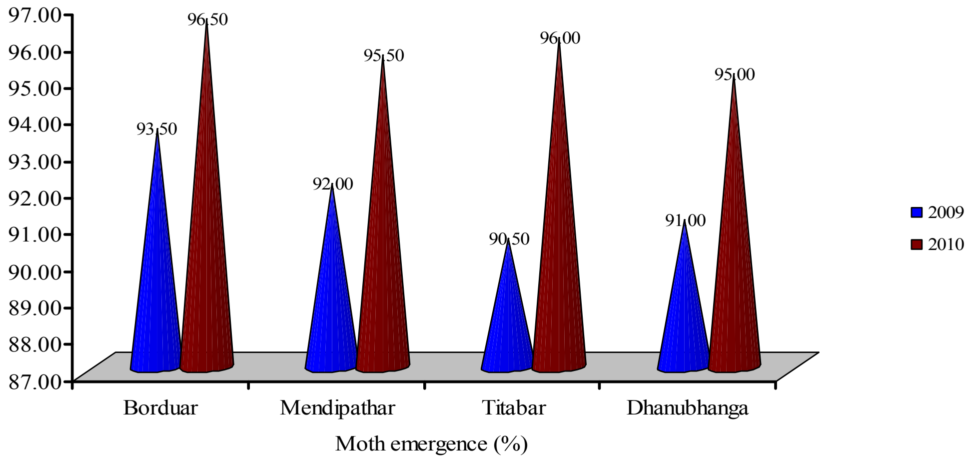

Figure2. Moth emergence of different eco-races of eri silkworm, *Philosamia ricini* during winter 2009 and spring 2010.

Table 1. Effect of temperature and relative humidity on moth emergence and fecundity of different eco-races of eri silkworm (*Philosamia ricini* DONOVAN) during winter (2009) and spring (2010) rearing.

Name of Eco-races	Moth emergence (%) (Winter 2009) (A)	Fecundity (No.) (Winter 2009) (A)	Moth emergence (%) (Spring 2010) (B)	Fecundity (No.) (Spring 2010) (B)
	(15 ± 1 to 21 ± 1 ºC and 56 ± 5 to 64 ± 5 % RH)		(22 ± 1 to 28 ± 1 ºC and 65 ± 5 to 72 ± 5 % RH)	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Borduar	93.50 ± 1.80	345 ± 4.58	96.50 ±1.80	375 ± 11.53
Mendipathar	92.00 ± 2.78	332 ± 12.16	95.50 ± 2.59	356 ± 9.53
Titabar	90.50 ± 3.12	298 ± 6.55	96.00 ± 2.69	345 ± 10.53
Dhanubhanga	91.00 ± 2.17	317 ± 10.14	95.00 ± 3.27	332 ± 6.92
F value	00.82	15.56	00.18	10.38
P value	P > 0.05	P < 0.01	P > 0.05	P < 0.01

(A) Mean temperature 18 ± 1 ºC and humidity 65 ± 5 % during winter.
(B) Mean temperature 25 ± 1 ºC and humidity 68.5 ± 5 % during spring.

Table 2. Effect of temperature and relative humidity on cocoon parameters of different eco-races of eri silkworm (*Philosamia ricini* DONOVAN) during winter (2009) and spring (2010) seasons. Values are given as mean ± SD.

Name of Eco-races	Larval duration (day)		Larval weight (g)		Cocoon weight (g)		Shell weight (g)		Shell ratio (%)	
	Mean±SD (2009) (A)	Mean±SD (2010) (B)	Mean±SD (2009) (A)	Mean±SD (2010) (B)	Mean±SD (2009) (A)	Mean±SD (2010) (B)	Mean±SD (2009) (A)	Mean±SD (2010) (B)	Mean±SD (2009) (A)	Mean±SD (2010) (B)
Borduar	27.75 ± 0.50	18.00 ± 0.50	6.15 ± 0.26	7.48 ± 0.15	3.19 ± 0.16	3.52 ± 0.20	0.45 ± 0.04	0.56 ± 0.05	14.10 ± 0.11	15.90 ± 0.07
Mendipathar	29.00 ± 0.50	19.25 ± 0.75	6..00 ± 0.24	7.25 ± 0.14	3.45 ± 0.12	3.15 ± 0.28	0.48 ± 0.08	0.51 ± 0.08	13.92 ± 0.11	16.19 ± 0.13
Titabar	28.50 ± 0.25	18.75 ± 0.25	6.10 ± 0.13	7.65 ± 0.10	3.00 ± 0.09	3.36 ± 0.07	0.41 ± 0.06	0.52 ± 0.07	13.66 ± 0.12	15.48 ± 0.09
Dhanubhanga	29.00 ± 0.50	19.50 ± 0.25	5.20 ± 0.13	6.15 ± 0.15	2.69 ± 0.16	2.68 ± 0.10	0.36 ± 0.05	0.42 ± 0.07	13.38 ± 0.05	15.67 ± 0.09
F value	5.15	5.60	14.48	69.33	15.72	11.70	2.02	1.90	27.94	26.26
P value	P < 0.05	P < 0.05	P < 0.01	P < 0.01	P < 0.01	P < 0.01	P > 0.05	P > 0.05	P < 0.01	P < 0.01

(A) Mean temperature 18 ± 1 ºC and humidity 65± 5 % during winter.
(B) Mean temperature 25 ± 1 ºC and humidity 68.5 ± 5 % during spring.

The findings of the present study are consistent with [22] which showed minimum larval duration (18 d), cocoon weight (3.80 g), shell weight (0.53 g) and highest shell ratio (14.00 %) in autumn (Sep - Oct) rearing. Many other researchers have observed highest larval duration and maximum larval weight (7.64 g), green cocoon weight (3.74 g), shell weight (0.49 g), shell ratio (13.16 %) during low temperature [23, 24, 25, 26, 27, 28, 29, 15]. [30] reported that fecundity was high in winter and low in summer season. [31] reported that low temperature adversely affect the hatching percentage of eri silkworm. It was also found that during autumn season some eco-races of the eri silkworm had prolonged larval duration because of low temperature, reduced rate of metabolism resulting in the slow growth. [22,28] reported that the larval growth period in autumn season ranged from 17.00 to 19.00 (d) compared to 16.00 to 17.00 (d) in high temperature. He also reported that highest larval weight 100 g (10 larvae) and green cocoon weight 5.1g during Sep-Oct. [26, 27] observed maximum shell weight (0.53) in Borduar and highest Shell ratio % (14.64) observed in Kokrajhar eco-races. The present investigation clearly indicates that the effect of low temperature and relative humidity (%) during winter season was more pronounce on moth emergence and eggs fecundity than spring rearing season.

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