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EFFECT OF THERMAL STRESS ON COCOON COMMERCIAL CHARACTERS OF DIFFERENT ECORACES OF ERI SILKWORM

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ABSTRACT: Eri silkworm is cold-blooded insect and temperature plays a major role on growth and cocoon productivity. *Samia ricini* (Donovan) is a only domesticated eri silkworm which is polyphagous and multivoltine in nature. Eri silkworm is reared not only for silk production but also for consumption of pupae. Tapioca is a important secondary food plant for *S. ricini*. Here, in the present study the effect of thermal stress on productivity parameters in different ecoraces viz. Borduar, Titabar and Mendipathar of eri silkworm fed on tapioca leaf was studied. Further, it was observed that the Mendipathar performed better under thermal stress than Borduar and Titabar ecoraces in all the cocoon commercial aspects.

KEYWORDS: Eri silkworm, ecoraces, tapioca, thermal stress, rearing performance.

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1. INTRODUCTION

Eri silk is a multivoltine silk from open-ended cocoon and is the product of the domesticated silkworm *Samia ricini*. The silk is used for making wraps, shawls, jackets, blankets, bed spreads, curtains, cushion covers etc. and reared for protein rich pupae. Ericulture is practiced in Assam and other North-Eastern states of India. Ecoraces of eri silkworm such as Borduar, Titabar, Khanapara, Nongpoh, Mendipathar, Dhanubhanga, Sille, Kokrajhar, Diphu and Genung are commercially exploited in the region [1-2]. The eri silkworm is polyphagous in nature, feeding on different host plants [3-11]. Tapioca or Cassava, is a suitable secondary food plant for eri silkworm [12-14]. In India the tapioca cultivation is widely grown for tubers. There are reports that 25% of leaf is sufficient to rear eri silkworm without affecting the tuber production [15-16] and a similar study also reported that approximately 30-40% of leaves can be utilized for growth and development of eri silkworm without effecting the yield of tubers [17]. Thus, ericulture can give an additional income to tapioca cultivators [18-19]. However, rearing of eri silkworm depends on biotic and abiotic factors. In India, the tropical environment prevails near sea coast where the average temperature during summer is high (35-38ºC) when compared to interior parts. Temperature required for young stage of eri silkworm is about 26-28 °C, with relative humidity of 85-90%, whereas for late age worms slightly cooler temperatures of 24-26 °C and relative humidity of 70-80% are suitable [20-21]. The high temperature affects the growth, development and cocoon commercial characters in different silkworm races [22]. Insects have adopted different biological and physiological strategies to overcome changes in their surrounding environment but lack of tolerance in domesticated eri silkworm may be responsible for poor performance. Further development and economic production of sericulture greatly depend on the metabolic homeostasis and physiological adaptability of eri silkworm. Therefore, the current study was conducted on different ecoraces of eri silkworm to evaluate their cocoon commercial characters under thermal stress conditions.

2. MATERIALS AND METHODS

Disease free laying (eggs) of *Samia ricini* namely Borduar, Titabar and Mendipathar were procured from the Central Muga Eri Research & Training Institute, Lahdoigarh, Assam. The experiment was conducted in the Department of Ecology & Environmental Sciences, Pondicherry University. A standard rearing procedure was followed as recommended [23-24]. Each ecorace was divided into two groups, one as a control maintained under standard rearing conditions (25.6 ± 2°C & RH 75.2 ± 0.7%) and the second group was subjected into thermal stress conditions (31.2 ± 1°C & RH 76 ± .5%). The Fifth instar larvae were reared at temperature stress every day for 5 hours until spinning. After the treatment, larvae were transferred to normal ambient temperature. The Fresh tapioca leaves *(Manihot esculenta)* of local variety was fed for all the instars. Cocoons were harvested 6 days later after completion of cocoon spinning and the following parameters were evaluated.

Cocoon weight

whole cocoon weight was taken individually from each group of 10 cocoons and mean cocoon weight was calculated. The weights were taken in gram units.

Shell weight

Average cocoon shell weight was calculated after removing the pupa of 10 cocoons from each group.

Shell ratio

It was calculated by using the following formula:

$$\text{Shell ratio (\%)} = \frac{\text{Weight of cocoon shell}}{\text{Weight of the whole cocoon}} \times 100$$

Further, collected data from the both control and treated groups were recorded and statistically analyzed by t-test.

3. RESULTS AND DISCUSSION

The results of the rearing performance of *Samia ricini* fed on tapioca leaves under control and treated temperature were presented in the Table 1-3 and Figure 1-3.

3.1. Borduar ecorace

The mean cocoon weight of control was 3.05 g and thermal treated was 2.72 g. The shell weight of control was 0.42g and thermal treated was 0.38g and the shell ratio of control 13.37% and thermal treated were 12.11%. The cocoon weight ($t = 2.20$, $P < 0.05$), shell weight ($t = 2.80$, $P < 0.05$) and the shell ratio ($t = 14.72$, $P < 0.05$) showed statistically significant difference in between the control and thermal treated *S. ricini* (table 1).

Table 1: Cocoon yield of Borduar ecorace of eri silkworm under control & treated temperature.

Parameters	**Control** 25.6 ± 2°C	**Treated** 31.2 ± 1°C	**t–value**	**P-value**
Cocoon wt. (g)	3.05 ± .31	2.72 ± .37	2.20	0.02*
Shell wt. (g)	0.42 ± .03	0.38 ± .03	2.80	0.00*
Shell ratio (%)	13.37 ± 0.10	11.94 ± 0.29	14.73	0.00*

The mean difference is significant at the level 0.05

*Significant $P < 0.05$

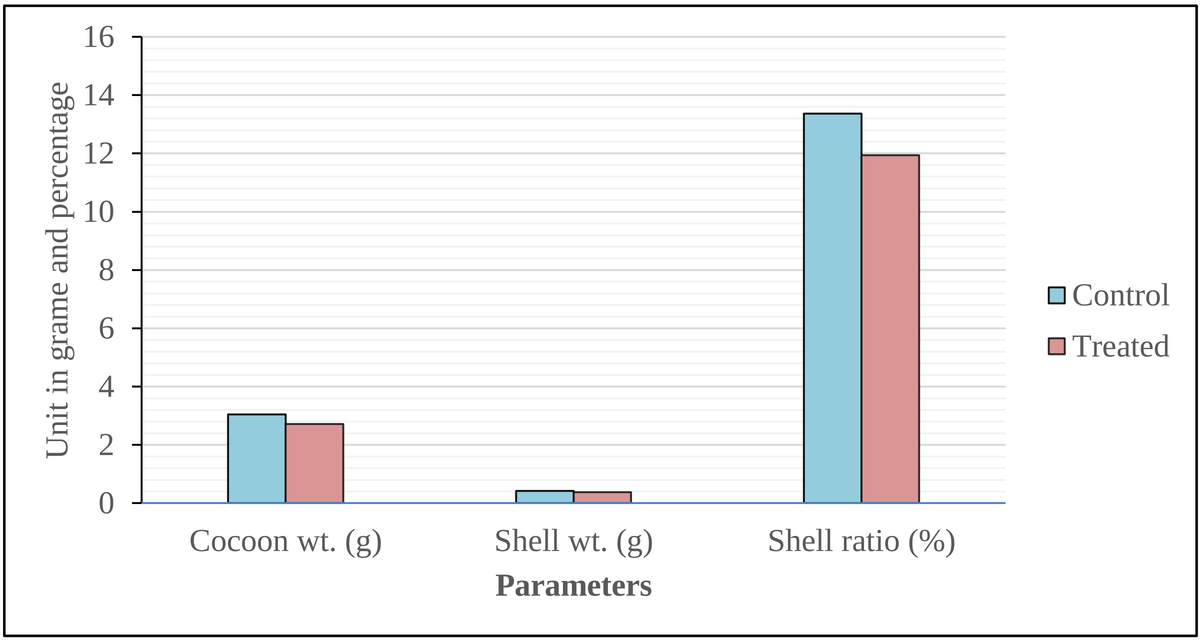

Figure 1: Performance of cocoon characters of Borduar ecorace of eri silkworm under control and treated temperature

3.2. Titabar ecorace

The average cocoon weight of control was (3.08g) and thermal treated was (2.25g) respectively and the shell weight control was (0.41g) and thermal treated was (0.29g). The shell ratio of control was 13.35 % and thermal treated was 12.18 %. There was statistically significant difference in the cocoon weight ($t = 4.30$, $P < 0.05$), shell weight ($t = 3.88$, $P < 0.05$) and the shell ratio ($t = 50.17$, $P < 0.05$) between the control and thermal treated (table 2).

Table 2: Cocoon yield of Titabar ecorace of eri silkworm under control & treated temperature.

Parameters	**Control** 25.6 ± 2°C	**Treated** 31.2 ± 1°C	**t–value**	**P-value**
Cocoon wt. (g)	3.00 ± .32	2.43 ± .27	4.30	0.00*
Shell wt. (g)	0.41 ± .03	0.35 ± .04	3.88	0.00*
Shell ratio (%)	13.35 ± .03	11.89 ± 0.09	50.17	0.00*

The mean difference is significant at the level 0.05

*Significant $P < 0.05$

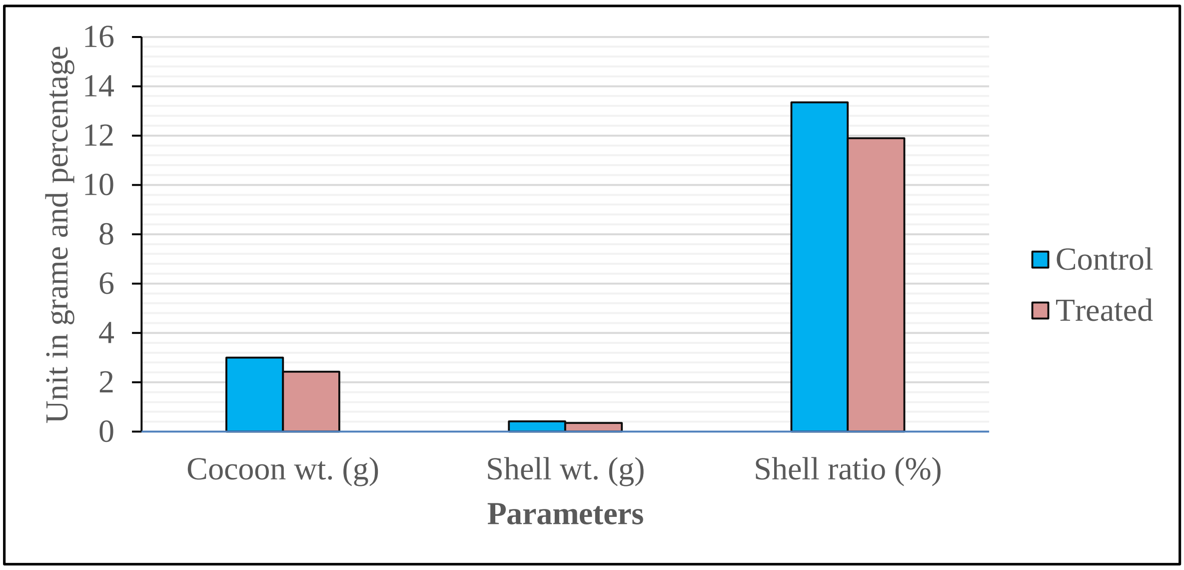

Figure 2: Performance of cocoon characters of Titabar ecorace of eri silkworm under control and treated temperature.

3.3. Mendipathar ecorace

The mean cocoon weight of control and thermal treated was 3.34g and 2.50g respectively and the shell weight of control was 0.43g and thermal treated was 0.33g. The shell ratio of control and thermal treated was 13.57% and 12.25% respectively. Statistically significant difference was observed in between the control and treated group in the cocoon weight ($t = 3.39$, $P < 0.05$), shell weight ($t = 3.79$, $P < 0.05$) and the shell ratio ($t = 10.32$, $P < 0.05$) (table 3).

Table 3: Cocoon yield of Mendipathar ecorace of eri silkworm under control and treated temperature.

Parameters	Control 25.6 ± 2°C	Treated 31.2 ± 1°C	t–value	P-value
Cocoon wt. (g)	3.13 ± .30	2.81 ± .04	3.39	0.00*
Shell wt. (g)	0.43 ± .02	0.39 ± .03	3.79	0.00*
Shell ratio (%)	13.52 ± 0.44	12.07 ± 0.12	10.03	0.00**

The mean difference is significant at the level 0.05

*Significant P < 0.05

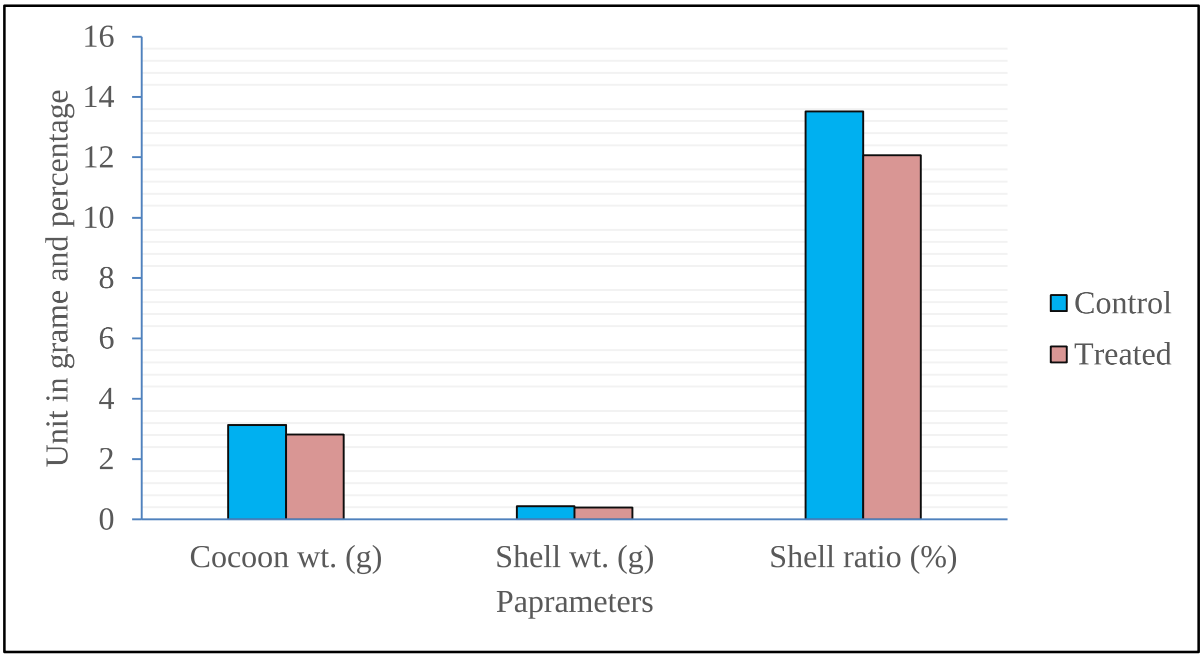

Figure 3: Performance of cocoon characters of Mendipathar ecorace of eri silkworm under control and treated temperature.

Temperature is a dominant factor for growth, reproduction and distribution of organisms [25-36]. The organisms have ability to employ diverse adjustment at a multiple levels of biological organization to deal with the fluctuating environment [37-38]. Eri silkworm is a hardy and resistant species to disease in comparison to other silk producing insects. The cocoon is the raw material of silk and the economics of the silk industry. The cocoon of eri is open mouthed and is not continuous filament. The results of the present study clearly show that there were differences in the rearing performance of different ecoraces of eri silkworm. The important commercial characters of eri cocoon is weight which shows the approximate quality of raw silk and shell weight is shell that yields silk for reeling and largest shell weight may range from 0.30g to 0.40g [39]. The ratio between the weight of silk shell and the whole weight calculated as a percentage provides the shell ratio. The average shell ratio of eri cocoon varies between 12.30% and 14.85% depending on photoperiod and host plant [40]. The mean cocoon weight (2.63g), shell weight (0.31g) and shell ratio (11.87%) was observed when *P. ricini* reared on tapioca plant (*Manihot utilisima*) [41]. Different host plant species (Castor, *Ricinus communis*; Tapioca, *Manihot esculenta;* Barera, *Jatropha curcas*) influence the growth and development of *Samia ricini* and castor exhibited maximum yield parameters whereas minimum yield was observed in papaya and the order of yield decrease was Castor>Tapioca>Barera>Papaya [42]. Feeding on the castor leaves from I-III instars and interchanging with tapioca leaves during IV and V instar of eri silkworm enhanced the economic characters of silk and larval weight [43]. Significant differences were observed in cocoon productivity in different eco races of *S. ricini* in different season [44]. Environmental conditions such as temperature, RH and other climatic conditions influence the growth, development and economic characters of different silkworm races [45]. The mean cocoon weight of 2.066g, shell weight 0.2163g and shell ratio 10.63% were reported under high temperature and low relative humidity [46]. Our results were also fall in between the range of the previous studies exhibiting that Mendipathar performed well than the Borduar and Titabar ecoraces.

4. CONCLUSION

The present experimental study showed that the Borduar, Titabar and Mendipathar ecorces performed good in all the aspects of cocoon commercial character. The average cocoon weight, shell weight and shell ratio was observed higher in Mendipathar than Borduar and Titabar ecoraces. The higher productivity performance might be due to the adaptation under the thermal stress environmental conditions and the food plant they fed on. However, further studies are needed on productivity parameters under thermal stress conditions.

CONFLICT OF INTEREST

Authors have declared there is no conflict of interest.

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REFERENCES

1. Chakravorty R, Singh KC, Sarkar BN, Neog K, Mech D, Sarmah MC, Barah A, Dutta P. Monograph - Catalogue on eri silkworm (*Samia ricini*) germplasm. Cent. M. E. Res. & Train. Inst. Lahdo. Jorh. Ass. 2008.
2. Sarkar BN, Sarmah MC, Dutta K. Screening of superior ecoraces of eri silkworm Samia ricini (Donovan) based on better economic traits in respect of rearing and grainage performance in different seasons. J. Appl. Biosci. 2012; 38 (1): 1-22.

3. Chakravorty R, Neog K. Food plants of eri silkworm (*Samia ricini* Donovan) their rearing performance and prospects for exploitation. Nation. Worksh. on eri food pla. Guw. Ind. 2006, pp. 1-7.
4. Chowdhury SN. Host plants of eri silkworm (*Samia ricini* Boiduval) their distribution economic and prospects. Nation. Worksh. on eri food pla. Guw. Ind. 2006, pp. 28-37.
5. Biswas N, Das PK. Effect of food plant species on rearing performance of eri silkworm *Samia ricini* Donovan. Bull. Ind. Acad. Seri. 2001; 5: 36-38.
6. Gogoi R, Yadav RNS. Effect of host plant on some biochemical parameters of eri silkworm *Philosamia ricini* during its development. Ind. j. exptl. Boil. 1995; 33: 372-374.
7. Devaiah, MC, Dayashankar KN. Effect of different host plants on the economc traits of eri silkworm, *Samia cynthia ricini* Biosduval (Lepidoptera: Saturnidae). In the proceedings Nat. Sem. Silk Res. Dev. Bang. 1982, pp. 152.
8. Anonymous. Studies on the comparative value of cassava leaves as food of eri silkworm as against castor leaves, its primary food. Ann. Rep. CSR&TI, Myso. 1981, pp. 186
9. Muthukrishnan TS, Radha NV. Feeding studies on eri silkworm with tapioca, castor and papaya. All Ind. symp. Seric. Sci. Bang. 1978, pp. 49.
10. Govindan R, Devaiah MC, Rangaswamy HR. Effect of different food plant on the growth of fith instar larvae and economic traits of cocoon of *Pjhilosamia ricin* Hut. All Ind. Symp. Seric. Sci., Bang.1978, pp. 49.
11. Kapil RP. Effects on feeding different host plants on the growth of larvae and weight of cocoons of *Philosamia ricini* Hut. Ind. j. Ent. 1967; 29: 295-296.
12. Sakthivel N, Qadri SMH. Utilization of cassava foliage for large scale production of eri silk. Int. J. Sci. Env.Tech. 2017; 6 (4): 2521-2534.
13. Sakthivel N. Studies on utilization of tapioca (*Manihot esculenta* Crantz) for ericulture in Tamil Nadu. Ph.D. thesis Per. Uni.TN. 2012.
14. Devaiah, MC, Rajashekhargouda R, Yelashetty S, Govindan R. Growth and silk production in *Samia cynthia ricini* Boisduval as fed on four different host plants. Ind. J. of Ser. 1985; 24 (1): 33-35.
15. Bhat GG, Umesh T, Ramakrishna N. Tapioca is an ideal root upon which to rear the eri silkworm. Ind. Sil. 199; 19-20.
16. Chaudhurry SN. Effect of leaf harvest on tapioca and economics of eri rearing on it. J. Ass. sci. Soc. 1979; 22: 58-61
17. Jayaprakash P, Rao BVS, Rao KV, Rao JVK, Sinha BRRP. Reintroduction of eri culture in Andhra Pradesh, hopes galore. Ind. Sil. 2003; 19–20.
18. Jayaprakash P, Sasikala A, Suryanarayana N. Ericulture- A tool for rural women development in Andhra Pradesh, India. The 20th Cong. of the Int. Seri. Comm. Bang. 2005, pp. 106 – 109.

19. Jayaraj S. Eri silk production in castor and tapioca plantation. Key note address at the workshop on prospects of eri culture in Tamil Nadu, Salem. CSB, Bang.Ind. 2003.
20. Sarkar BN, Sarmah MC. Eri Seed production - a user's manual. M. E. Re. and T. Ins. Lahdoigarh, Jorhat, Assam, 2012.
21. Renuka G, Shamitha G. Studies on the economic traits of eri silkworm, *Samia Cynthia ricini,* in relation to seasonal variations. Int. J. Adv. Res. 2014; 2 (2): 315-322.
22. Krishanaswami S, Asan M, Sriharn TP. Ecological studies on silkworm rearing to prevent crop losses in adverse seasons in West Bengal, India. J. Seri. 1972; 10:72-76.
23. Sarmah MC, Saskar BN, Ahmed SA, Deuri J. Eri culture- a comprehensive profile. Dire. of Seri. BTC, Kokrajhar, Assam, 2013.
24. Sarkar DC. Ericulture in Inida. CSB, Bang. Ind. 1980, pp. 21-23.
25. Rahmathulla VK. Management of climatic factors for successful silkworm (*Bombyx mori* L.) crop and higher silk production. Psyche. 2012; 1-12.
26. Biram SNM, Tribhuwan S, Beera S. Occurrence of unfertilized eggs in the mulberry silkworm, *Bombyx mori L*., (Lepidoptera: Bombycidae)," Int. J. Ind. 2009;18: 1–7.
27. Ramesha C, Seshagiri SV, Rao CGP. Evaluation and identification of superior polyvoltine crossbreeds of mulberry silkworm, *Bombyx mori* L. J. Entom. 2009; 6 (4): 179-188.
28. Willmer CW, Stone G, Johnston I. Environmental Physiology of Animals, Blackwell Science, Oxford, UK, 2004.
29. Wu DJ, Hou RF. The relationship between thermo tolerancy and heat stable esterase in the silkworm *Bombyx mori* L., (Lepidoptera: Bombycidae). Appl. Entom. and Zoo. 1993; 28: 371–377.
30. Thiagarajan V, Bhargava SK, Babu MR, Nagaraj B. Differences in seasonal performance of twenty-six strains of silkworm, *Bombyx mori* (Bombycidae). J. Lepid. Soc.. 1993; 47: 331-337.
31. Chatterjee SN, Rao CGP, Chatterjee GK, Ashwath SK, Patnaik AK. Correlation between yield and biochemical parameters in the mulberry silkworm, *Bombyx mori* L, Theoretical and Applied Genetics. 1993; 87 (3): 385-391.
32. Benchamin KV, Jolly MS. Principles of silkworm rearing. In the Proceedings Sem. on Probl. and Prosp. of Seri. S. Maha. Ed. Vellore India, 1986, pp. 63–106.
33. Tazima Y. Silkworm Moth, Evolution of Domesticated Animals, Longman, New York, NY, USA, 1984.
34. Pillai VS, Krishnaswami S. Effect of high temperature on the survival rate, cocoon quality and fecundity of *Bombyx mori* L. In the proceedings of Seri. Symp. and Sem. TN Agri. Uni. India, 1980, pp. 141–148.

35. Ueda S, Kimura R, Suzuki K. Studies on the growth of the silkworm *Bombyx mori* IV mutual relationship between the growth in the fifth instar larvae and productivity of silk substance and eggs. Bull. of the Seri. Exp. Stat. 1975; 26 (3): 233–247.
36. Matsumara, Ihizuka Y. The effect of temperature on development of *Bombyx mori* L. Representative Nagano Sericultural Experimental Station, Japan. 1929, pp.19
37. Hochachka PW, Somero GN. Biochemical adaptation Oxf. Univ. press, New York, 2002.
38. Bhatacharjee S. Triadimefon pretreatment protects early assembled membrane system and cause up-regulation of stress proteins in Salinity stressed *Amaranthus lividus* L. during early germination. Jour. of Env. Bio. 2008; 29 (5): 805-810.
39. Sarmah MC, Saskar BN, Ahmed SA, Deuri J. Eri culture- a comprehensive profile. Dire. of Seri., BTC, Kokrajhar, Assam, 2013.
40. Sannappa B, Jayaramaiah M, Govindan R, Chinnaswamy KP. Advances in ericulture. Seri Sci. Publ. 2002, pp. 66-88.
41. Das D. Rearing of eri silkworms (*Philomasia ricini* Hutt.) on tapioca (*Manihot utilisima*) during autumn season in Assam. I.J.A.R. 2015; 5: 527-528.
42. Kumar R, Gangwar SK. Impact of varietal feeding on *Samia ricini* (Donovan) in spring and autumn season of Uttar Pradesh. ARPN J. Agri. Biol. Sci. 2010; 5: 46-51.
43. Venu N, Munirajappa. Impact of independent and sequential feeding of different host plants on economic traits of eri silkworm, *Philosamia ricini* H. I.J.S.N. 2013; 4: 51-56.
44. Ray PP, Rao TV, Dash P. Comparative studies on rearing performance of some ecoraces of eri silkworm (*Philosamia ricini* H.) in different seasons. The Bio. 2010; 1:181-186.
45. Krishanaswami S, Asan M, Sriharn TP. Studies on the quality of mulberry leaves and silkworm cocoon crop production. I. J. Seric. 1970; 9: 11-25.
46. Wongsorn D, Sirimungkararat S, Saksirirat W. Improvement of eri silkworm (*Samia ricini* D.) tolerant to high temperature and low humidity conditions by continuously regime, KKU Res. J. 2015; 20 (2): 177-188.