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COMPARATIVE ANALYSIS OF INDOOR AND OUTDOOR REARING PERFORMANCE OF INDIAN TEMPERATE TASAR SILKWORM, *ANTHRAEA PROYLEI* JOLLY IN SUB-HIMALAYAN REGION

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ABSTRACT

Studies were conducted to evaluate the rearing performances of Oak tasar silkworm, *Antheraea proylei* under indoor and outdoor condition at Ahju farm, at Middle altitude (About 1600 to 3600 ft. AMSL). Experimental results have shown significant difference in case of cocoon yield per dfl between indoor and outdoor rearing. Recorded cocoon yield per dfl was 41.44 ± 0.63 in outdoor as against 23.13 ± 0.53 in indoor in Ahju farm. Similarly, 40.52 ± 0.62 in outdoor and 03.20 ± 0.28 cocoons per dfl in indoor at Chauntra farm. Further ERR was also found to be higher in outdoor conditions ($30.02 \pm 0.34\%$ @ Ahju farm and $57.73 \pm 0.47\%$ @ Chauntra farm) as compared to indoor rearing ($16.76 \pm 0.37\%$ @ Ahju farm $02.51 \pm 0.31\%$ @ Chauntra farm). Other rearing parameters like average weight of matured larvae, larval period, single cocoon weight, single shell weight and SR % were significantly different between outdoor and indoor rearing condition in both the study locations. Poor rearing performance under indoor condition was surprising, yet it might be highly due to cross infection of viral disease in indoor condition due to frequent handling and also higher humidity inside rearing house might have aggravated the viral infection.

Keywords : *Antheraea proylei*, Indoor & Outdoor, Rearing performance, cocoon yield, ERR%

Introduction

Most insects including lepidopteron are phytophagous in nature feeding upon green leaves, the degree of specificity to particular host plants varies considerably (Devi *et al.*, 2011). Oak tasar silkworm *Antheraea proylei* J is a poly-phytophagous insect thriving on a number of oak plants, though species specificity varies from region to region and altitude to altitude, because of availability of a specific species of food plant at a particular altitude range only (Jolly *et al.*, 1976; Chaudhury, 1981; Singh *et al.*, 2000; Singh and Maheswari, 2003). India is one of the major countries producing oak tasar silk in the global context. *Antheraea proylei* Jolly which is commonly known as the Indian Oak Tasar silkworm is a semi-domesticated silkworm commercially exploited for the production of silk. Oak tasar culture plays an important role in the economic uplifting of the weaker section of the society who are inhabiting in the oak belt of the sub-Himalayan region of India extending to Manipur, Nagaland, Assam, Mizoram, Meghalaya and Arunachal Pradesh in the North-East and Jammu & Kashmir, Himachal Pradesh and Uttarakhand in the North-West region of Himalaya (Singh *et al.*, 2008, Renuka, and Shamitha, 2014). The temperate species is the hybrid of *A. proylei* and *A. pereny* and their larvae are mainly feed on oak leaves and are commonly called oak tasar. It has a wide range of host plants belong to genus *Quercus* (oak) with distinct chemical constituents. *A. proylei* feeds on the food plants *viz.*, *Q. serrata*, in two locations of spring crop *viz.*, Chauntra Farm

and Ahju farm. Success of oak tasar industry largely depends on increased productivity of quality foliage per unit area and proper management practices. The greatest success has been observed in Spring crop (March-April) rearing then it declined during autumn season. The temperature and relative humidity during spring is favourable throughout the rearing and hence, rearing activities is easy & which leads to good cocoon production. It is adapted to feed *Q. serrata* exclusively on young foliage during early stages of development and on old foliage at later stages. Due to favorable climatic conditions and availability of primary food plants it is predominantly reared out door in North Eastern States of India on commercial scale. During the year 2021-22, REC, Palampur conducted complete out door rearing from brushing to cocoon harvesting in comparison with indoor rearing at two locations *i.e.*, Middle altitude region like Chauntra farm and Ahju farm of District Mandi (H.P). The present study was carried out to study the comparative analysis of Indoor and Outdoor rearing performance of Indian Temperate tasar silkworm, *Antheraea proylei* Jolly In Sub-Himalayan Region at two different locations.

Materials and Methods

The study was conducted in experimental field of Research Extension Center, Palampur farms *i.e.*, Chauntra farm & Ahju farm., for comparative analysis of indoor and outdoor rearing performance of Indian Temperate tasar silkworm, *Antheraea proylei* Jolly in Sub-Himalayan Region. Observations on larval duration, larval weight, effective rate

of rearing (ERR), cocoon yield and cocoon economic traits were made during spring crop at two locations. The 100 disease free layings for each outdoor & indoor rearing were obtained from Oak Tasar grainage section of RSRS, Bhimtal. The rearing field was disinfected seven days ahead of brushing with lime and bleaching powder (9:1) and the rearing appliances with 0.2 % sodium hypochlorite solution. The food plants of oak tasar silkmoth were pruned 3 months ahead of rearing during spring crop. The rearing was conducted by following the recommended rearing technology for oak tasar culture developed by RSRS, Bhimtal. Outdoor Rearing (Fig. 1) was conducted completely outside from brushing to cocoon harvesting stage (mean temperature & relative humidity at 26°C and 80%). Further, nylon net used for early instars up to 2nd stage and nylon net removed for the late age rearing. Whereas in case of indoor rearing (Fig. 2) was completed inside the room from brushing to cocoon harvesting period (mean temperature & relative humidity at 23°C and 85%). In case of Outdoor rearing dfls were kept in nylon net bag and tied to branch of the *Q. serrata* tree, after hatching worms will easily crawling in to the tree for feeding. In case of Indoor rearing, dfl's were kept in plastic

tray, on hatching, the hatched worms were feed on tender leave twig kept on tray. The worms were fed with the leaves suitable for each instar. When 80% of the leaves are eaten by the worms, the worms were transferred to another plant by cutting the branches with the help of secateurs. Care was taken to protect them from pest and predators by applying nylon nets up to 2nd instar. For management of diseases, the diseased worms if noticed in the rearing field were removed immediately and disposed in 0.2 % sodium hypochlorite and buried in the soil. The observations on different rearing parameters viz. effective rate of rearing (ERR) viz. total number of mature worms collected out of total number of worms brushed for control, body weight of mature larvae, cocoon weight, shell weight and silk ratio percent (SR%) were recorded in both the locations.

Formulae associated with silkworm rearing:

1. $ERR\% = \frac{\text{No. of cocoon harvested}}{\text{No. of larvae brushed}} \times 100$
2. $Shell\ ratio\ \% = \frac{\text{Weight of shell}}{\text{Weight of cocoon}} \times 100$



Fig 1: Outdoor rearing of *Antheraea proylei* during the year 2021-22 at REC, Palampur farm



Fig. 2 : Indoor rearing of *Antheraea proylei* during 2021-22 at REC, Palampur farm

Results and Discussion

The comparative rearing performance data (Outdoor & indoor) of *A. proylei* under the agro-climatic conditions of Palampur (H.P) with larval and cocoon traits as influenced by different type of rearing in both the location are presented in Table 1 & 2. During the study, disease free layings (dfls) were brushed on food plants viz. *Q. serrata* in both the location and harvested cocoons by following the standard rearing protocol of oak tasar.

Larval weight

Growth and development of the larvae was better on Indoor rearing as compared to Outdoor rearing in both the location. Observation on larval weight revealed non-significant difference between outdoor and indoor condition in case of Ahju farm (15.70±0.39 and 16.30±0.35 gms). Whereas contrasting results were obtained in case of Chauntra Farm as significant difference was observed between outdoor and indoor conditions (11.72±0.27 and 17.10±0.21, *P*-value-0.007) (Table 1). The variation between

the locations might have been influenced by microclimate prevailing and plant nutrient status as Dash *et al.*, (1990) reported that suitable host plant and the leaf nutrition of food plants enhances the growth of larvae.

Larval duration

The larval duration of silkworm, *A. proylei* fed on *Q. serrata* host plants at two locations was estimated during the rearing period and is presented in Table 1. The larva spins the cocoons after active feeding through five larval instars. The total larval span recorded was 43±0.24 days in Outdoor fed larvae & 47±0.71 days recorded in Indoor fed larvae at Ahju farm. Whereas in Chauntra farm Outdoor fed larvae 41±0.63 days required & indoor fed larvae taken 43±1.22 days. The shortest larval duration was observed in Indoor fed worms at Ahju farm and the longest duration was observed in Outdoor fed worms in Chauntra farm. Statistical analysis of the above data revealed that there was a significant difference between the outdoor and indoor rearing conditions at both of the study locations (Table 1).

Table 1: Comparative rearing performance of *A. proylei* during Outdoor and Indoor crop in different locations

Location	Avg. Larval weight (gm)		<i>P</i> -value (<i>t</i> -test)	Total larval duration (days)		<i>P</i> -value (<i>t</i> -test)	ERR (%)		<i>P</i> -value (<i>t</i> -test)	Yield/dfI		<i>P</i> -value (<i>t</i> -test)
	Outdoor	Indoor		Outdoor	Indoor		Outdoor	Indoor		Outdoor	Indoor	
Ahju farm	15.70 ±0.39	16.30 ±0.35	NS	43 ±0.24	41 ±0.63	0.01	30.02 ±0.34	16.76 ±0.37	0.001	41.11 ±0.48	23.13 ±0.53	0.001
Chauntra Farm	11.72 ±0.27	17.10 ±0.21	0.001	47 ±0.71	43 ±1.22	0.007	57.73 ±0.47	02.51 ±0.31	0.001	40.52 ±0.62	03.20 ±0.28	0.001

Effective rate of rearing

Effective Rate of Rearing (ERR), which reveals the percentage of the number of cocoons harvested to the number of larvae brushed, had shown better performance in Outdoor crop at both the location when compared with indoor crop. The effective rate of rearing of worms was highest (57.73±0.47 %) in Outdoor crop rearing at Chauntra farm followed by 30.02±0.34% ERR at Ahju farm. Least ERR (02.51±0.31%) was recorded in Indoor rearing at Chauntra farm followed by 16.76±0.37 % at Ahju farm. Comparison between the outdoor and indoor rearing showed the significant difference in both of the location (Table 1). Better rearing performance in outdoor condition might be due to better quality leaves available at outdoor condition and worms are freely crawl into the food plants and eaten their choice of leaf. In case of indoor condition worms don't have choice of leaf they bond to eat whatever leaf supplied physically. The low ERR % recorded may be due to the role of leaf quality on cocoon production has been reported by Singh *et al* (1991). In addition to this poor ERR in indoor condition might be also due to more disease incidence due to frequent handling and crowding of the larvae. Whereas, this is not the case in outdoor condition.

Yield (Cocoons/dfI)

It is the number of cocoons harvested against the number of dfI's brushed during the crop rearing. There was a significant difference was observed regarding the cocoon

yield between outdoor and indoor rearing conditions. The highest cocoons per dfI (41.11±0.48) were recorded in outdoor rearing at Ahju farm followed by 40.52±0.62 cocoon/dfIs at Chauntra farm. Whereas 16.76±0.37 cocoons /dfI and only 03.20±0.28 cocoon/dfI was observed in indoor rearing condition at Ahju and Chauntra farm respectively. It is surprising that, even though there are more difficulty faced at Outdoor rearing like attack of pest and predator, rainfall, wind velocity etc., Oak tasar Outdoor crop rearing showed good performance. It might be due to natural condition provided to the worms to feed and grow. In case of indoor condition due to more man handling and continuously rearing in Indoor condition over the year, which as negative impact on the crop performance.

Cocoon weight

Influence of rearing condition over cocoon weight was not consistent, during the present study it was observed that between outdoor and indoor conditions data was consistent. Weight of cocoon weight was more in indoor condition in Ahju farm whereas, it was more in outdoor in case of Chauntra Farm. The recorded cocoon weight was 6.82±0.16 g and 5.84±0.24g cocoon weight at both Chauntra and Ahju farm respectively. Whereas it was 6.31±0.18 and 6.22±0.31g during indoor crop rearing at both Ahju and Chauntra farm respectively (Table 2). Due to the inconsistent performance these results cannot be discussed further.

Table 2: Economic parameters of *A. proylei* reared on *Q. serrata* food plants during Outdoor & indoor crop in two different locations

Location	Cocoon wt.(g)		P-value (t-test)	Shell wt.(g)		P-value (t-test)	Shell ratio (%)		P-value (t-test)
	Outdoor	Indoor		Outdoor	Indoor		Outdoor	Indoor	
Ahju farm	5.84±0.24	6.31±0.18	NS	0.78±0.02	0.75±0.01	NS	13.35±0.54	11.88±0.26	0.02
Chauotra Farm	6.82±0.16	6.22±0.31	0.02	0.85±0.01	0.64±0.01	0.001	12.50±0.27	10.28±0.48	0.001

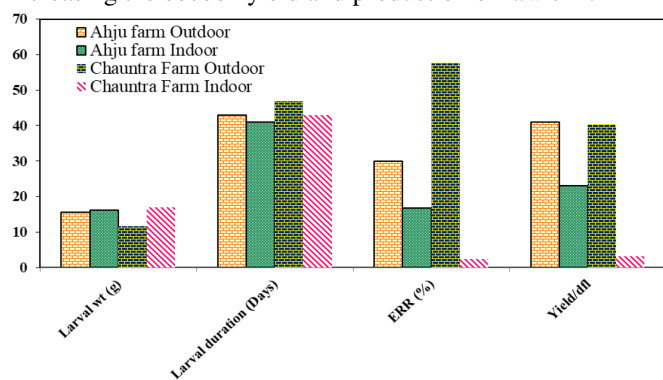
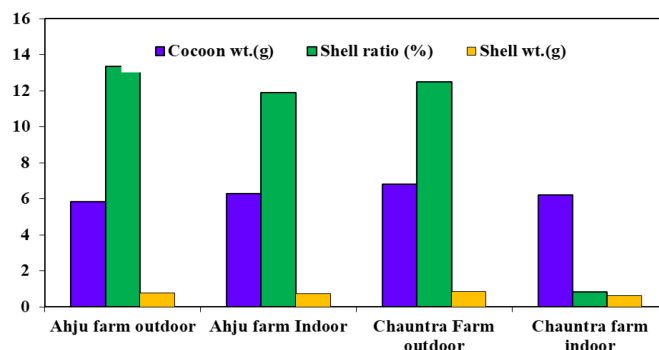
Shell weight

It is the weight of the cocoon shell which is taken after removing the pupa from the cocoon. Comparative analysis between outdoor and indoor rearing showed non-significant difference in case of Ahju farm with 0.78 ± 0.02 and 0.75 ± 0.01 g respectively. Whereas shell weight between outdoor and indoor conditions at Chauotra showed significant difference by recording 0.85 ± 0.01 g & 0.64 ± 0.01 g respectively (Table 2). In outdoor condition worms were free to move and eat their choice of leaf, which further leads to improvement in the shell weight of the cocoon. Mandal *et al.* (2021) studied the growth and development of silkworm larvae and economic characters of cocoons and opined that it is influenced largely by the nutritional quality of mulberry leaves fed to the larvae.

Shell ratio

Silk ratio of *A. proylei* cocoons reared at different condition viz, Outdoor and Indoor condition at two different locations, showed significant difference. The silk ratio was highest in Outdoor rearing fed worms at Ahju farm recorded 13.35 ± 0.54 % followed by 12.25 % at Chauotra farm. Whereas Indoor rearing fed worms indicated 11.88 % at Ahju farm followed by 10.28 % at Chauotra farm. On both locations outdoor rearing outperformed indoor rearing with respect to silk ratio.

The present study indicated that among the two-locations rearing performance and cocoon parameters were good in outdoor rearing conditions as compared to indoor rearing conditions (Fig. 3 & 4). Singh *et al.* (1991) reported that rearing of *A. proylei* prevails during March-December but the frequency of success in rearing shows remarkable variation in different months of the year. The study also revealed that feeding with *Q. serrata* leaves to *A. proylei* in outdoor conditions exhibited higher survivability as compared to indoor crop rearing in both the locations. Jena (2016) reported that insects feeding on nutritionally enriched leaves directly influence the better growth and development of silkworm larva as well as the quality and quantity of silk production, establishment of food plant specificity of the silkworm along with evaluation of the commercial parameters in each food plant which is highly essential for increasing the cocoon yield and production of raw silk.

**Fig 3:** Comparison of Outdoor and Indoor rearing of *Antheraea proylei***Fig. 4:** Comparative cocoon parameters in outdoor and indoor rearing

Conclusion

Feeding of oak tasar silkmoth, *A. proylei* in outdoor and indoor condition was studied for production, productivity of oak tasar cocoons at two locations. The cocoon productivity and effective rate of rearing was observed better with Outdoor crop rearing as compared to Indoor crop rearing in both the locations. The silk ration was recorded highest in both location in outdoor rearing as compared to indoor rearing in both the locations. Though the larva of *A. proylei* fed well in both the location in Outdoor and Indoor condition, the larval period was observed 4 to 6 extended in Outdoor rearing as compared to Indoor condition. It is due to exposure of worms to favorable natural condition and low temperature as compared to Indoor condition. The study showed that Outdoor crop rearing on favorable and natural condition have direct effect on the cocoon yield, effective rate of rearing and silk ratio and these are the contributing factors at both the locations.

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