Plant Archives Vol. 24, Special Issue (VS), 2024 pp. 98-103 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2024.v24.splecialissue.016

TROPICAL TASAR SERICULTURE: CURRENT CHALLENGES AND MANAGEMENT PRACTICES

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ABSTRACT

The tropical tasar silk, *Antheraea mylitta* is mainly practiced across ten traditional tropical states of India. The tropical tasar silkworm is susceptible to both biotic and abiotic stresses at all the stages. Mortality inflicted by these hassles incur huge loss in terms of DFLs and cocoon yield and these factors are important issues in the tasar seed sector. The non-feeding stages of tasar-silkworm *i.e.* egg, pupae and adults are confined under controlled conditions. Whereas, feeding stage (larvae) are usually reared under field conditions. Impact of biotic pressure on non-feeding stages may be managed considerably using modern techniques compared to feeding stage. Regulation of abiotic factors are highly impossible under field conditions compared to controlled condition. The changing environment i.e climate change had shown implications like erratic emergence upto 15-30%, loss of colour and crimpled wings in moths, male sterility, decreased fecundity (120-150 eggs/moth), poor hatching and shifting of brushing schedule. Moreover, fluctuations in the pest attack and disease incidence have also been observed. In order to limit the influence of both abiotic and biotic stress on growth and development of tasar silkworm under field conditions new technologies developed by Central Tasar Research and Training Institute (CTR&TI), and Basic Seed Multiplication and training Centres (BSM & TCs) are in practice. The adaptive strategies include use of green shade net, proper sorting of cocoons, opening the windows and doors to have proper ventilation in grainages for maintenance of ideal conditions, avoiding direct exposure of diapause cocoons to hot air or sunlight, keeping moth for oviposition in cool conditions (using earthen cup and placing on wet sand bed) and managing the brushing schedule. In the host plan maintenance side use of green manuring and organics have been advocated. The spacing between plant has been modified and introduced mechanization. These measures are helping in sustainable production of Basic and Nucleus dfls by Basic Tasar Silkworm Seed Organization (BTSSO) for achieving tasar raw silk production targets.

Keywords: *Antheraea mylitta*, Climate change, Dfls, Fecundity, Sustainable

Introduction

The wild silkworms are distributed in the tropical and subtropical belts that are covered with dense, deciduous and evergreen forests and produce silk for the mankind. The Tasar culture is practiced in Bihar, Jharkhand, MP, Chhattisgarh, Odisha, Andhra Pradesh, Telangana, Maharashtra, Uttar Pradesh and West Bengal. It is a minor forest produce & is being recognized as a forestry practice of the tribes. Tasar sector has the challenge is to utilize these host plant a as well as man power to bring about a balance between development and sustain livelihood of tribal families involved in rearing, reeling, weaving and making of fabric (Dimple *et al.*, 2018; Rathore and Srinivasulu 2018). In the earlier times, the tribal rearers depended on the collection of natural tasar cocoons every year for production of seed. Availability of such cocoons was neither regular, nor it was sufficient in quantity. The quality of seed prepared out of these cocoons also varied widely (Bawaskar *et al.,* 2022 and Rathore *et al.,* 2019).

The seed multiplication system in tasar is now a days well organized sector. Several multiplication levels are needed in order to produce quality silkworm seed in adequate quantity during suitable brushing period. The multi-tier arrangement of tasar seed production focuses on timely multiplication of high-quality breeds in adequate number so as to enable production of dfls for the commercial rearing at farmers' level (Nadaf *et al.,* 2022). The breeders stock or elite seed (P4) produced through research (CTR&TI, Ranchi) are multiplied to produce nucleus seed (P3) at Central Tasar Silkworm Seed Station, Kota (CTSSS), which is subsequently multiplied again as basic seed (P2) at the Basic Seed Multiplication and Training Centres (BSM & TCs). The basic seed undergoes another multiplication at State PPCs or NGOs for production of commercial seed (Rathore *et al.*, 2018a and Vishaka *et al.*, 2019). Hence, the onus of producing dfls up to basic seed level is with the Central Silk Board and the commercial seed with the Directorates of Sericulture (DOS), NGOs and Private graineurs. These commercial dfls are used by rearers for production of reelable cocoons.

During 1978-79, in order to organize seed multiplication on scientific lines, 3 tier multiplication system of tasar seed was introduced by CTR&TI, Ranchi. At times it was observed that the crop failure in certain areas was there. After proper analysis of the situation the brushing schedules for different crops were worked out and implemented. Even after following the brushing schedule the considerable loss due to erratic emergence of the moths before starting of the grainage operation was experienced, which was mainly due to different climatic conditions prevailing in different tasar growing areas of the country. This has given indication for introduction of either bivoltine or trivoltine race depending on the climatic condition of the area. Subsequently it was thought necessary to demarcate Bivoltine/ Trivoltine zones clearly so that a particular race suitable to that area may only be popularized for increased productivity and to overcome the problem of crop failure.

The Basic Tasar Silkworm Seed Organization plays a pivotal role in the production of nucleus seeds and supporting around 10% basic seed requirement of Tasar silk producing states (*Antheraea mylitta* D.). In the scenario of changing climate, it is crucial for successful grainage activities to maintain proper physical conditions, proper maintenance of host plant, disease monitoring and timely following the module for seed production.

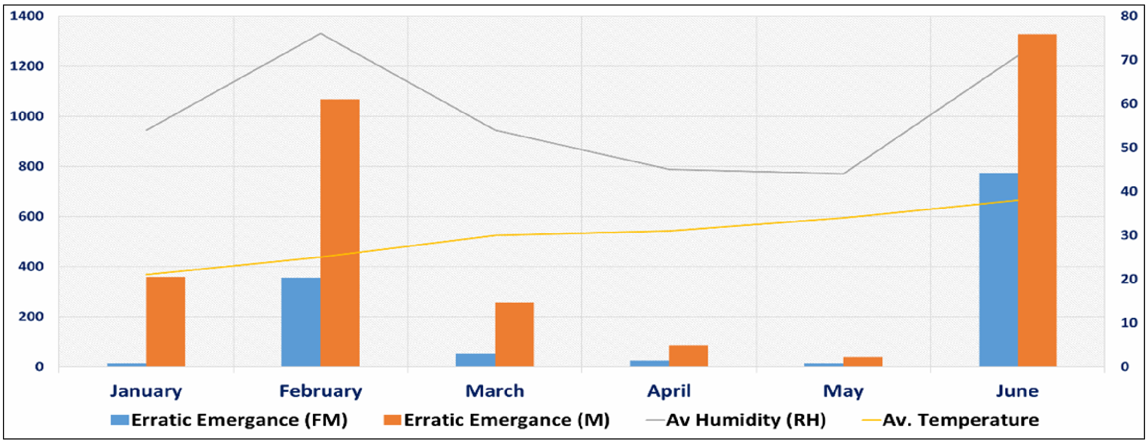
Challenges in tropical tasar seed production in present scenario

The global climate is changing at a much faster rate in contrary to predicted by environmentalists a few years back. The carbon fertilization may promote productivity in C4 crops but may limit production in some important staple cereals which are C3 (Abd Elgawad *et al.,* 2016 and Ehsan *et al.,* 2023). The increased solar and UV radiations, heat and shift in rainfall pattern has affected both plants and animal kingdom. The sea water temperature rise and melting of the glaciers all around has implications on the water cycle. All these changes in future are going to pose serious threat to global food security and environment sustainability. Sericulture sector is not an exception to this (Prashant *et al.,* 2023). As the Vanya silks are wild one, there rearing and grainage are fully dependent on the environmental conditions the loss reported are significant.

The environmental shift has resulted in erratic emergence of moth (Fig.1), changed brushing schedule, prolonged dry summer period, change in population of pest and predators and overlapping lifecycles and increased incidence of *Xanthopimpla konowi* (yellow fly), *Blepharipa zebina* (uzi fly) and predators like wasps, that attack silkworm during rearing and reduces cocoon production (Rathore *et al.*, 2018b and Chandrashekharaiah *et al.,* 2022, Reddy *et al.,* 2021).

Fig 1: Crimpled and undeveloped moth emergence and depressed eggs.

In the rainfed arears, it has caused production of low nutritive foliage, adverse effect on soil microflora and soil moisture content (Bora and Saikia, 2022 and Lokesh *et al.,* 2016). The unseasonal rains cause erratic moth emergence due to false triggering. These moths emerged do not form pairs as they are underdeveloped and the conditions are also not favourable (Fig.1; Graph 1). The erratic emergence rates range from 15-30%, decreased fecundity (120-150 eggs/moth), low hatching percentage, decreased survival of larvae in early instars results in crop loss. These adverse climatic factors not only affect the pre-cocoon sector but also the post cocoon sector. The inferior quality of cocoon will yield inferior quality of yarn. Hence, strategies need to be developed and adopted to minimize the loss in quality and quantity (Ram *et al.,* 2016).



Graph 1: Erratic moth emergence pattern month wise: male (M) and female (FM)

Management Practices

As the tropical tasar is practiced in the limited part of the country, the grainage and rearing activity needs attention to mitigate with the changing environmental challenges (Bhatia and Yousuf, 2014). BSMTCs (Basic Seed Multiplication Centres), which are prime units for the production of nucleus seeds adopt certain strategies to low down the implications of environmental challenges on crop yield. These include appropriate selection of the grainage house (green shade net), ensuring adequate ventilation through windows and doors, and regulating ideal temperature and humidity levels. One of the significant challenges faced is the occurrence of pebrine due to cross contamination, a prevalent microsporidian disease of the silkworm. Change or adjustment in brushing schedule, organic inputs in the field, adoption of water conservation strategies and management of host plant (Fig. 2). Some of the key components are highlighted below:

(i) Green Manuring and rain water harvesting:

The host plantation mainly comprises of i.e. *Terminalia arjuna* or *T. tomentosa*. Majority of plantation is done on the soils not suitable for cash crop agricultural practices. Further, the indiscriminate use of chemical inputs in the soil further poses serious implications on the soil sustainability (Gargi *et al.,* 2022 and Das *et al.,* 2020). The use of organics has increased in the decade not only in commercial agricultural crops but also in other allied sectors. Production of organic silk is also one of the key components which has good export potential. The farmers associated with tasar sericulture are not so educated and are not aware about the adverse long-term effects of chemical inputs (Doran and Zeiss, 2000). Hence, the percolation of technologies like green farming and organic agriculture is new for them. As a part of organic agriculture, Green manuring is a process of ploughing of green plant into the soil before flowering for the purpose of improving soil health status and sustenance of agriculture system (Rathore and Srinivasulu, 2018).

Following crops are advocated for green manuring in tasar host plant plantation i.e. Dhaincha (*Sesbania aculeata*) and Sunhemp (*Crotalaria juncea*), seeds are broadcasted @50kg/ha. It had shown positive effects on soil and leaf quality. The status of soil was improved as it makes the soil soft and increases water holding and water retention capacity. It increases microbial biomass which intern makes the nutrients available to plant for better growth and development. It also increases the organic carbon content of soil which is essential component for soil health sustenance and plant growth development. Further, usage of vermicompost and neem cake along with rain water harvesting methods i.e basin and rain water harvesting pits preparation can sustain quality leaf production and tasar silkworm rearing, resulting in quality cocoon production.

Fig. 2: Preparation of rain water harvesting pits/basins and application of organic manure in tasar host plants

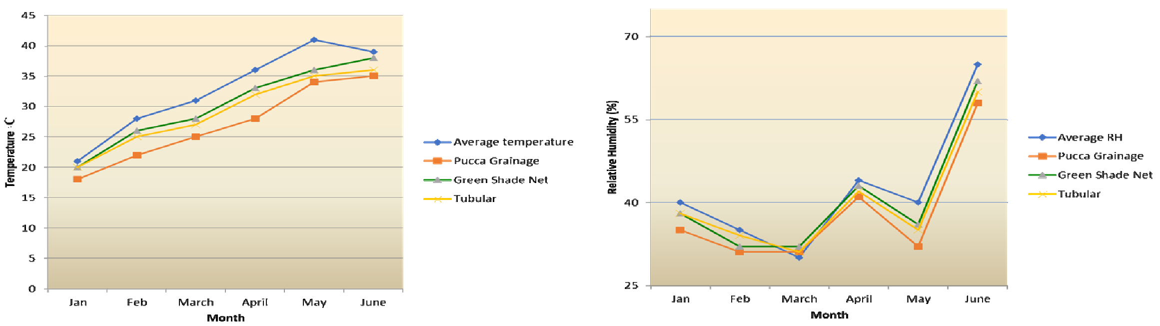
(ii) Green Shade Net Grainage Structure:

The nucleus seed cocoons of DBV are usually harvested during October-November. These are usually stored in Grainage houses during diapause for 6-7 Months. During the long period of diapause and quiescence, the cocoons have to face extremes of temperature (10-46°C) and humidity (30-80% RH) variations, which cause pupal mortality, decreased vigour of moths during grainage and erratic emergence.

All these losses during the long adverse period of diap ause and serenity have to be bought to the minimum, so that maximum utilization of seed cocoons is ensured and optimum production of disease free layings was achieved. In severe summer the percentage of dead cocoons pose a serious problem in BSMTCs (P2 stations). As normal practice, seed cocoons are preserved in different kinds of grainage houses and conditions required as per standard package and practices are applied. In a study, evaluations of *A. mylitta* DBV cocoons preservation in concrete grainage house, Tubular structure, Pucca grainage and low-cost agro-shade net grainage house was done for maintenance of optimum conditions.

Fig. 3: Green shade net grainage structure and preserved seed cocoons.

Comparative grainage behaviour of tasar silkworm in these four modes of cocoons preservation revealed highly significant differences in grainage parameters. More natural conditions, healthy pupa, less mortality, and less emergence peak was found in cocoons preserved in agro-green shade net grainage (Fig.3), in comparison to other grainage houses where; higher pupal mortality, higher fluctuations in temperature and humidity were observed.



Graph 2: Abiotic factors inside green shade net grainage structure

The emergence is 20% more recovery is more than 80% and hatching is better in comparison to conventional grainage preservation. The result indicates that, preservation of seed cocoon under low-cost shade net grainage house structure is best suitable for seed production (Graph 2; Table 1).

Table 1: Green shade net structure grainage performance

Type of Grainage Structure	Source of Daba BV Cocoons	Cocoon Preserved (Nos.)	Cocoons Processed (Nos.)	Emergence (Nos.)	Dfls Prepared (Nos.)	Cocoon Dfl ratio	Recovery %
Tubular	AR	98790	98672	97456	27163	3.64:1	111
Pucca	AR	106600	105464	99142	23854	4.5:1	90
Green Shade Net	AR	90150	90098	89170	27135	3.32:1	120

(iii) Management of abiotic factors in grainages:

As mentioned earlier, tropical tasar grainage encounter erratic emergence due to unseasonal rains. This is due to build up of sudden relative humidity (RH) in the grainage house which results in false signalling in the insect. Some times during the grainage there is sudden drop in the relative humidity and increase in temperature which leads to sub-optimal conditions inside the grainage. These factors result in emergence of crimpled (undeveloped) moths, depression of dfls and reduced pairing of moths. In order to overcome this situation, strategies like use of humidifier in grainage or desert cooler, keeping the egg laying device on wet soil, covering of windows with wet husk and use of net for increased paring are adopted (Fig.4). In extreme summer, an extra layer of green net is kept as first line of defence for preventing the hot air from entering the grainage. These small sets increase the recovery percentage and reduce mortality in dfls.

Fig. 4: Counter measures for maintaining op n conditions during grainage:
A: agro-net curtain outside the grainage to prevent heat wave
B: Putting wet *Khas* matts on the windows
C: Pairing inside mosquito net
D: Egg laying devices on wet sand to maintain humidity and temperature

Conclusion

Increasing human population around the world has put heavy demands on the resources. The traditional areas of Vanya sericulture are facing challenges of urbanization, change in land use pattern, deforestation, allocation of forest land to other sectors like mining. Adding to all, the sudden global changes in climate has pushed the sector to limited areas. The traditional belts of tasar are existing because of emotional attachment of rural/tribal people. The adoption of improved proven technologies along with recommended package of practices will help in overcome the challenges thereby sustaining the stakeholder and Industry.

Acknowledgement

Authors greatly acknowledge the infrastructural and financial support of Central Silk Board, Ministry of Textile, Government of India for the studies.

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