Plant Archives Vol. 24, Special Issue (VS), 2024 pp.39-43 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.specialissue.007

INFLUENCE OF ICHNEUMON WASP (*XANTHOPIMPLA PEDATOR* F.) ON GRAINAGE PERFORMANCE OF TROPICAL TASAR SILKWORM (*ANTHERAEA MYLITTA* D.)

D.M. Bawaskar[1*], B.Thirupam Reddy[2], C. Selvaraj[3], P.C. Gedam[4], G.R. Halagundegowda[5], S.M. Mazumdar[6], H.A. Nadaf[7], G.V. Vishaka[7], V. Singh[8], R. Gowrisankar[9] and T. Selvakumar[7]

[1]Basic Seed Multiplication and Training Centre, Central Silk Board, Balaghat – 481001, India
[2]Basic Seed Multiplication and Training Centre, Central Silk Board, Bastar – 833216, India
[3]Basic Seed Multiplication and Training Centre, Central Silk Board, Madhupur – 815353, India
[4]Basic Seed Multiplication and Training Centre, Central Silk Board, Bhandara – 441924, India
[5]Central Silk Board, Bengaluru – 560068, India
[6]Basic Seed Multiplication and Training Centre, Central Silk Board, Kathikund – 814103, India
[7]Basic Tasar Silkworm Seed Organisation, Central Silk Board, Bilaspur - 495 112, India
[8]Basic Seed Multiplication and Training Centre, Central Silk Board, Pali -495449, India
[9]Basic Seed Multiplication and Training Centre, Central Silk Board, Nabrangpur -764059, India
*Corresponding author E-mail: datta.csb@gmail.com

ABSTRACT

The male cocoon infestation by the yellow fly, *Xanthopimpla pedator* would positively affect the cocoon to DFL ratio, which is indirectly implicate that, as the infestation of male cocoon reduces the number male moths' emergence and affects the effective coupling during the mating of moth in DFL production. Further, as the male moths reduces, the number of cocoon required to produce the DFL's also increases, hence the regression shows how indirectly male cocoon infestation by the yellow fly would significantly affects the DFL production. Whereas, correlation explains the direct relation between Cocoon to DFL's ratio and cocoon infestation by the yellow fly.

Keywords: Cocoon to DFL's ratio, Tasar Silkworm, *Xanthopimpla predator,* Grainage performance.

Introduction

Tasar silkworm *Antherea mylitta* Drury is widely distributed across varied ecological conditions in India. Tasar sericulture is mainly practiced by the rural folks and tribal people in India and some Asian countries, for the silk purpose which has unique fabric qualities. Tasar silkworm rearing includes indoor grainage operations to obtain disease-free-laying (DFL) (Mohanraj *et al*., 2021) and outdoor larval rearing practice for cocoon production. Tasar silkworm is wild in nature and reared outdoor on its primary food plants *Terminalia tomentosa*, *T. arjuna* and *Shorea robusta*. Since tropical tasar silkworms are being reared in outdoor conditions, most of its health and economic performances are dependent on the climatic conditions, presence of pest, and predators in the rearing region (Gathalkar and Barsagade, 2016). In outdoor conditions, the silkworms are exposed and succumb to parasitoids like *Blepharipa zebina* (Tachinidae: Diptera) and *Xanthopimpla pedator* (Hymenoptera: Ichneumonidae) and predators like *Eocanthecona furcellata* (Pentatomidae: Hemiptera), *Sycanus collaris* (Reduviidae: Hemiptera), *Hierodula bipapilla* (Serville) (Mantidae: Dictyoptera), *Polistes herbraeus* (Vespidae: Hymenoptera) and *Vespa orientalis* (Vespidae: Hymenoptera), and these affects the cocoon yield drastically (Sen *et al*. 1970; Sahay *et al*., 2000; Singh *et al*., 2011; Mathur and Shukla 1998; Singh and Thangavelu 1991; Gathalkar and Barsagade, 2016; Chandrashekharaiah *et al*., 2018b; Selvaraj *et al*., 2020a).

Attack of yellow fly and uzi fly during the spinning stage decreases the grainage operations (Gathalkar *et al*., 2017), often suffer from various diseases causing heavy losses to the economy of the silk industry. The yellow fly, *X. pedator* is the larval pupal parasitoid of tasar silkworm *A. mylitta*. The gravid females of *X. pedator* pierce the spinning cocoon with the help of its ovipositor to lay eggs into the spinning larva or pupa of *A. mylitta*. The developing maggot consumes the entire internal body content of the pupa of *A. mylitta* and completes its life cycle in about 20–22 days (Gathalkar *et al*., 2017), resulting in pupal mortality which declines tasar cocoon production directly (Jolly *et al*., 1979; Singh and Thangavelu, 1991; Gupta *et al*., 2009; Singh *et al*., 2010; Bhatia and Yousuf, 2013; Shivakumar and Shamitha, 2013; Bawaskar *et al*., 2022). The adult parasitoid emerges through the peduncle end of the cocoon and in *X. pedator*, the adult male wasps emerge earlier than the females as also observed in other ichneumonids (Hanson and Gauld 1995). After emergence, the parasitoid (especially female) searches for a mate (Jolly *et al*., 1979, Gupta *et al*., 2009, Velide and Bhagawanulu, 2012, Shivakumar and Shamitha, 2013). Consequently, it also oviposits the unfertilized egg, in to the host body which produces the male population only (Gathalkar *et al*., 2017).

The study highlights the importance of understanding the parasitic behavior of *X. pedator* and its implications for tasar silkworm seed production. Effective management strategies need to be developed to mitigate the impact of this parasitoid on cocoon production and the silk industry.

Materials and Methods

The study was carried out in the I, II DBV and I,II, III DTV grainages during the year 2023 at Basic seed multiplication and training center, Balaghat, Madhya Pradesh. The grainage period from June to December, 2023 were considered for the present study. After completion of Grainage, Ichneumon wasp damaged cocoons were separated from the seed cocoon garlands based on exit hole of wasp on peduncle side of seed cocoons and Subsequently, the collected cocoons underwent a thorough analysis to assess the incidence of Ichneumon wasp infestation, with the percentage of damage calculated by using following formulae.

$$\text{Ichneumon wasp incidence \%} = \frac{\text{No. of cocoons in a sample damaged by the Ichneumon wasp}}{\text{Total No. of cocoons in a sample}} \times 100$$

Statistical Analysis: To analyze the impact of yellow fly incidence on tasar cocoon with the objective of effective Dfl's production, the correlation and regression analysis and the illustration of correlation and regression analysis were used.

Result and Discussion

Incidence of yellow fly in grainages

Throughout the study, a consistent trend emerged: male cocoons exhibited a higher incidence of yellow fly infestation compared to female cocoons. For instance, during the first DTV grainage (Fig. 1a), male cocoons experienced an average infestation rate of 83.30 per cent, while female cocoons showed a rate of 16.70 per cent. Similarly, in the first DBV grainage (Fig. 1b), male cocoons had an average infestation rate of 73.70 per cent versus 26.30 per cent in female cocoons. This pattern persisted in subsequent grainages, with second DTV grainage (Fig. 1c) showing 92.60 per cent infestation in male cocoons versus 07.40 per cent in female, and second DBV grainage (Fig. 1d) with 80.10 per cent infestation in male cocoons compared to 19.90 per cent in female.

The trend continued into the third DTV grainage, with 69.10 per cent infestation in male cocoons and 30.90 per cent in female cocoons (Fig. 1e).

Bhatia *et al*, 2013 also observed high proportion (85.59 per cent) of male infested pupae in total parasitization. It means, *X. pedator* apply sex specific host finding mechanism to choose between male and female spinning larvae of *A. mylitta* and this particular behaviour might have been influenced by several reasons. In bisexual insect species, male emerges before to female (Fitton and Rotheray, 1982), accordingly, the pace of growth and development in male counterpart of *A. mylitta* is always faster than female. Consequently male has shorter larval span and starts spinning wel before to female larvae, hence available first for parasitization by *X. pedator*. The literature review does not provide a definitive explanation for the intersexual host selection behavior observed in *X. pedator* or other Ichneumonidae species. However, insights from studies on pimpline, ichneumonids offer a potential rationale. According to these studies (Arthur and Wylie, 1959; Kishi, 1970), female ichneumonids exhibit a tendency to deposit their larger female eggs into larger hosts, while smaller male eggs are placed into smaller hosts. This behavior is believed to optimize resource allocation, as directing more resources towards female offspring may lead to increased egg production and greater longevity for oviposition (Charvov, 1982). While this theory provides a plausible explanation, further research is needed to fully understand the mechanisms driving intersexual host selection in *X. pedator* and related species.

Fig. 1. Incidence of yellow fly in grainages

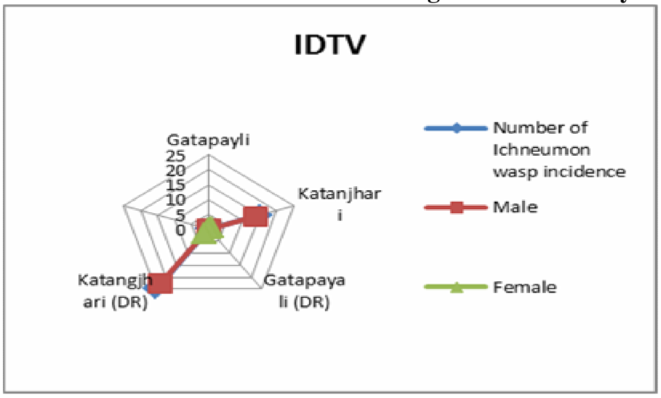

Fig. 1a. : First DTV Grainage

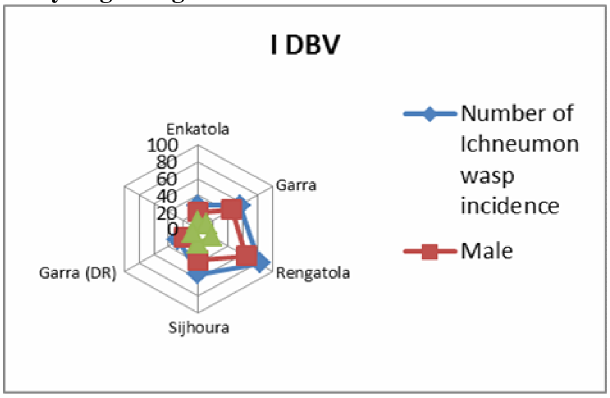

Fig. 1b. : First DBV Grainage

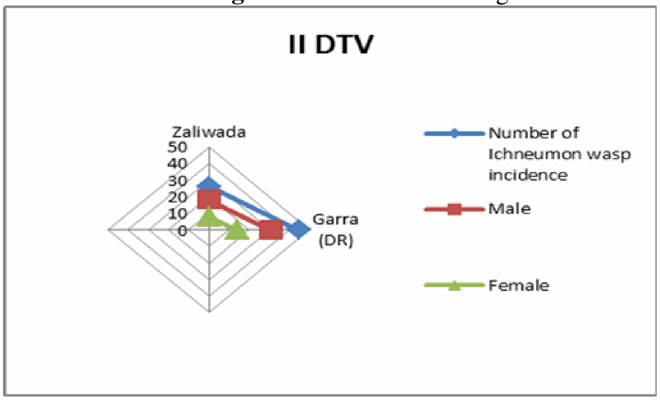

Fig. 1c : Second DTV grainage

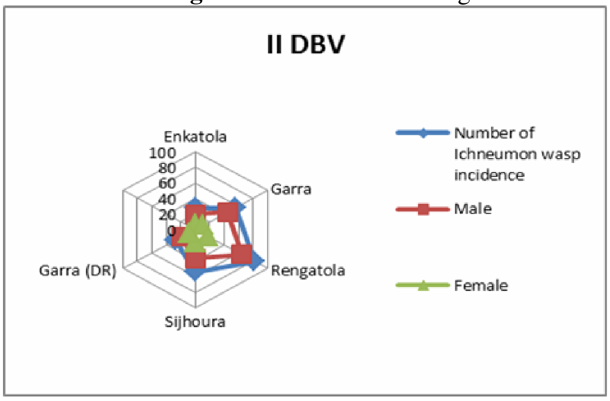

Fig. 1d : Second DBV grainage

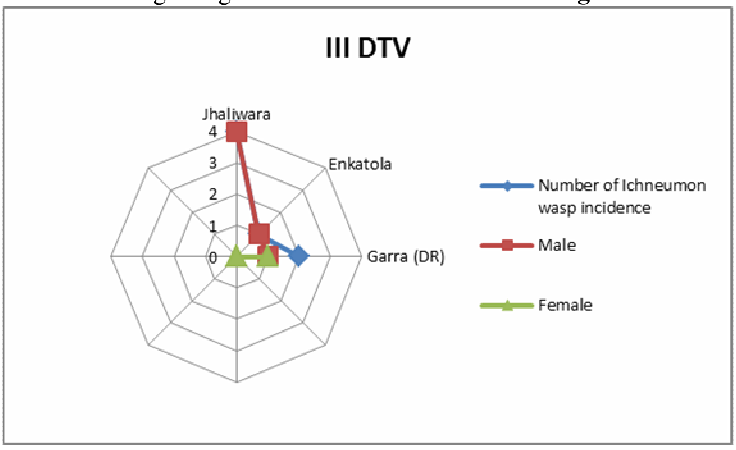

Fig. 1e. : Third DTV grainage

Table 1: Correlation and regression

Regression Coefficient								Correlation Coefficient	
Variables	**Coefficients**	**Std. Error**	**t-Value**	**P-Value**	**R-Square**	**Adjusted R-Square**	**ANOVA (F-Value)**	**Cocoon to DFL ratio v/s Male Cocoons**	**Cocoon to DFL ratio v/s Female Cocoons**
Intercept	1.730**	0.350	4.943	0.00	0.746	0.701	21.528	0.806**	0.735**
Male Cocoon	0.089**	0.005	16.481	0.00					
Female Cocoon	0.035**	0.003	12.500	0.00					

The Table 1 illustrates the Pearson's correlation coefficient between Cocoon to DFL's ratio and Male cocoon infestation, as well as the Female cocoon infestation by the yellow fly. The result of the correlation numerically quantifies the relation between Cocoon to DFL's ratio and cocoon infestation by the yellow fly, indicates that, as the number of cocoon infestation by the yellow fly increases, then naturally the cocoons required to produce DFL's also increases. The correlation only provides the direction and the intensity of the relation, where as the regression provides, direction, magnitude and causal effect of the predictor on response variable.

The table 1 also depicts the result of the least square estimates of the regression between the cocoon to DFL ratio as dependent variable and the number of male cocoons and number of female cocoons infested by the yellow fly as independent variables. Further, the regression coefficients for the predictors such as male cocoon infestation and female cocoon infestation by the yellow fly were found to be significant at 1% level of significance, quantifies positive relation on cocoon to DFL ratio. The magnitude of the regression of coefficient for the male cocoon infestation was higher than the magnitude of the regression coefficient for female cocoon infestation, that means the male cocoon infestation by the yellow fly would affect more on the magnitude of cocoon to DFL ratio rather than the female cocoon infestation. It also illustrates the, details of the model fitness (R-square & adjusted R-square) and overall model significance (ANOVA, F-test). The R-square shows 0.75, which means 75 per cent variation in the dependent variable explained by the set of independent variables, which means most of the information in the dependent variables (Cocoon to DFL ratio) explained by the predictors (Male & Female cocoon infestation). The sufficiency of the number of predictors in the model was validated by the Adjusted R-square and increases only if there are significant predictors in the model. Further, the F-value found to be significant, which means the regression sum of squares found to be significant and implies the relation was known to be statistically significant.

Conclusion

The study emphasizes the critical importance of providing support and resources to communities affected by Ichneumon Wasp infestation to safeguard their livelihoods and sustain the Tasar silk industry. It reveals the significant detrimental impact of Ichneumon Wasp infestation on Tasar silkworm grainage productivity. Infested silkworms suffer from reduced Disease-Free-Laying (DFL) production and lower-quality silk output, translating into substantial financial losses for sericulturists. These findings underscore the urgent need for effective pest management strategies to mitigate the adverse effects of Ichneumon Wasp infestation on Tasar silkworms. By implementing proactive measures such as controlling Ichneumon Wasp populations and protecting vulnerable silkworm stages, the economic viability of the silk industry can be preserved, ensuring the continuity of Tasar silk production. Supporting affected communities with access to knowledge, resources, and infrastructure for pest management and sericulture practices is paramount. Ultimately, investing in pest management and sustainable sericulture practices is vital for preserving livelihoods, bolstering rural economies and upholding the cultural and economic significance of Tasar silk production.

Acknowledgments

We express our gratitude to the Director of BTSSO, Central Silk Board, Ministry of Textiles, Government of India, Bilaspur (C.G.), for their unwavering support throughout the duration of the experiment. Their guidance and assistance have been invaluable in ensuring the success of our research endeavors.

References

Arthur, A.P, and Wylie, H.G. (1959) Effect of host size on sex ratio, development time and size of *Pimpla turionellae* (L) (Hymenoptera, Ichneumonidae). *Entomophaga* **4,** 297-301.

Bawaskar, D.M., Chowdary, N.B., Kedar, S.C., Reddy, B.T., Selvaraj, C., Rathore M.S., Srinivas, C. and Navik, O. (2022) Traditional and innovative technologies for pest management of tropical tasar silkworm, *Antheraea mylitta* (Drury) by the tribes of Eastern-Central India. *Int. J. Trop. Insect Sci*., **42**, 1737–1748.

Bhatia, N.K. and Yousuf, M. (2013) Parasitic behaviour of *Xanthopimpla pedator* (Fab.) (Hymenoptera: Ichneumonidae) on tropical tasar silkworm, Antheraeamylitta Drury (Lepidoptera: Saturniidae) reared on seven forestry host plants in Uttarakhand, India. Int. *J. Ind. Entomol*., **27 (2),** 243–264.

Chandrashekharaiah, M., Rathore, M.S., Sinha, R.B. and Sahay A. (2018b). Relationship with Cocoon Number and Grainage Performance in Nucleus Seed Production of DABA BV Race of *Antheraea mylitta* D. *Indian Hortic* J, **8**(**2** and **3**), 60–63.

Charvov, E.L. (1982). *The theory of sex allocation*. Princeton University Press, 41 William Street, Princeton, New Jersey, USA, 355p.

Fitton, M.G. and Rotheray, G.E. (1982). A key to the European genera of diplazontine ichneumon-flies, with notes on the British fauna. *Systematic Entomology*, **7,** 311-320.

Gathalkar, G.B., Barsagade, D.D. (2016). Parasites–predators: their occurrence and invasive impact on the tropical tasar silkworm *Antheraea mylitta* (Drury) in the zone of central India. *Current Science*, **111,** 1649–1657.

Gathalkar, G.B., Barsagade, D.D., Sen, A. (2017). Biology and development of *Xanthopimpla pedator* (Hymenoptera: Ichneumonidae): pupal endoparasitoid of *Antheraea mylitta* (Lepidoptera: Saturniidae). *Ann. Entomol. Soc.* Am.. http://dx.doi. org/10.1093/aesa/sax049.

Gupta, R., Chatterjee, K.K., Chakravorty, D. (2009). Yellow parasitoid menace in Tasar culture. *Indian Silk*, **48**, 22–23.

Hanson, P.H. and Gauld, I.D. (1995) The structure of Hymenoptera. In: TheHymenoptera of Costa Rica. (Eds): Hanson, P.H., Gauld, I.D., Oxford University Press, Oxford pp. 893.

Jolly, M.S., Sen S.K., Sonwalkar T.N. and Prasad, G.S. (1979). Non-mulberry silks. *Food Agric.,* Org UN Serv. Bull., **29,** 178.

Kishi, Y. (1970). Differences in the sex ratio of the pine bark weevil parasite, *Dolichomitus* sp (Hymenoptera, Ichneumonidae), emerging from different host species. *Applied Entomology and Zoology*, **5,** 126-132.

Mathur, S.K. and Shukla, R.M. (1998). Rearing of tasar silkworm. *Indian Text J*, **86**, 68.

Mohanraj, S.S., Kumar, D., Bhagavanulu, M.V.K., Chandrashekharaiah, M., Rathore, M.S. and Srinivas C. (2021). Wing and leg amputation induced oviposition pattern of tropical tasar silk moth, *Antheraea mylitta* Drury (Lepidoptera: Saturniidae) in oviposition devices–Earthen cups and paper sheets. *J Asia Pac Entomol*, **24,** 925–932

Sahay, D.N., Roy, D.K. and Sahay, A. (2000). Diseases of Tropical Tasar Silkworm, *Antheraea mylitta* D., Symptoms and Control Measures. In: Lessons on Tropical Tasar, Thangavelu, K. (Ed.). Central Tasar Research and Training Institute, Piska-Nagri, Ranchi, Pages: 104.

Selvaraj, C., Bawaskar, D. M., Chandrashekharaiah, M., Nadaf, H., Rathore, M.S. and Srinivas, C. (2020a) Damage potential of *Eocanthecona furcellata* (Wolff.) on *Antheraea mylitta* (Drury). *J Exp Zool India,* **23(2),** 1213–1217.

Sen, S.K., Jolly, M.S. and Jammy, T.R. (1970). A mycosis in the indian tasar silkworm, *Antheraea mylitta* Drury, caused by *Penicillium citrinum* Thom. *J Invertebr Pathol*, **15**, 1-5.

Shivakumar, G. and Shamitha, G. (2013). Studies on larval mortality: diseases, pest and predator menace in outdoor and indoor reared tasar silkworm, *Antheraea mylitta* Drury (Daba TV). *Res. J. Anim. Vet. Fish. Sci*., **1 (4),** 1–7.

Singh, G.P., Sinha, A.K., Kumar, A.K. and Prasad, B.C. (2011). Characterization and identification of bacteria infecting Indian tropical tasar silkworm, *Antheraea mylitta* D. *Research J Microbiol***, 6,**891–897

Singh, R.N. and Thangavelu K. (1991). Parasites and predators of Tasar silkworm- *Antheraea mylitta* has many enemies. *Indian Silk*, **29,** 33–36.

Singh, U.N., Raj, N., Chakravorthy, D. and Tripathi, P.N. (2010). Sex preference in host parasitisation of *Xanthopimpla pedator* Fabricius (Hymenoptera: Ichneumonidae), a major parasitoid of tasar silkworm, *Antheraea mylitta* Drury. *Sericologia*, **50(3**),369-378.

Velide, L. and Bhagvanulu, M.V.K. (2012). Study on infestation of *Xanthopimpla pedator* on the cocoons of tropical tasar silkworm, *Antheraea mylitta* Drury. IJPAES, **2(3),** 139-142.