



Natural Enemies of Lac Insect, *Kerria lacca* (Kerr) in Sub-humid Sutlej-Ganga Alluvial Plains of India

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Abstract: Surveys were conducted in various districts of Punjab, Delhi and Uttar Pradesh to record the diversity of natural enemies (predators and parasitoids) associated with lac insect (*Kerria lacca*) during 2019 to 2023. A total of 8 natural enemies including four predators, *Eublemma amabilis* Moore, *Pseudohypatopa pulverea* (Mayrick), *Chrysoperla zastrowi sillemi* (Esben-Peterson), *Tribolium* sp., and four parasitoids, *Aprostocetus purpureus* (Cameron), *Tachardiaephagus tachardiae* (Howard), *Tyndarichus clavicornis* (Cameron), *Eupelmus tachardiae* (Howard) were associated with lac insect. Besides these, one hyper-parasitoid, *Bracon greeni* Ashmead was also recorded. Among these, *E. amabilis* was the predominant species. The study will help in planning effective management practices to tackle these biotic stresses in lac cultivation.

Keywords: Predators, Parasitoids, Hyperparasitoid, Lac, *Kerria lacca*

Lac is natural, renewable, non-toxic, bio-degradable and eco-friendly resin, being secreted by a tiny scale insect, *Kerria lacca* (Kerr). Lac is mainly produced in tropical Asian countries namely India, Thailand, Indonesia, China, Myanmar, Philippines, Vietnam and Cambodia. Among these, India is the leading producer of lac in the world. In India, lac cultivation is an important source of income for livelihood of the forest and sub-forest inhabitants in different states like Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Odisha, Uttar Pradesh, Telangana, Andhra Pradesh, Gujarat and North Eastern states. Out of the nine genera and 99 species of lac insects reported worldwide, 2 genera and 26 species are found in India out of which *K. lacca* is the most widely available species in the country (Ahmad et al 2013). Lac insects are mostly confined to woody dicotyledonous group of Angiosperms. More than 400 plant species have been found associated with lac insects worldwide. Out of these, about 113 host species are known to be successfully infested by lac insect in India. The natural infestation of lac insect has been recorded on 15 host plants (Sangha et al 2019; Shera et al 2021).

The losses due to biotic and abiotic stresses are the major constraints that pose a substantial challenge in lac cultivation. Several natural enemies from diverse groups (predators and parasitoids) belonging to orders Lepidoptera, Neuroptera, Coleoptera and Hymenoptera have been reported against lac insect thereby causing 30-40 per cent losses to the lac yield (Sharma et al 2006, Jaiswal et al 2008). Various management strategies including cultural and physical control (Bhattacharya et al 2006), biological control

(SiMing et al 2010), and chemical control (Singh et al 2009) have been utilized to restore yield loss owing to predators and parasitoids. The present study was therefore conducted to explore the diversity of natural enemies in Punjab, Delhi and Uttar Pradesh so that an effective integrated management strategy can be devised for these natural enemies so as to achieve optimum lac yield potential.

MATERIAL AND METHODS

Surveys were conducted in various districts of Punjab, Delhi and Uttar Pradesh for five years to document the insect fauna associated with lac insect during 2019 to 2023. The lac encrusted sticks (brood sticks) were collected randomly during both rainy season (*Katki* crop) and summer season (*Baisakhi* crop), in five replications, and these samples were kept in specially designed bioagent collection cages (20 x 20 x 30 cm) fitted with glass tubes. These cages were monitored twice a week to record the emergence of parasitoids and predators from the lac sticks. The samples of parasitoids and predators were preserved in ethyl alcohol and were got identified from ICAR- National Institute of Secondary Agriculture, (NISA), Ranchi. To calculate the diversity or dominance of individual parasitoids and predators collected, the data on number of individuals were subjected to computation as per Shannon and Weiner diversity index (1963), Pielou evenness index (1966) and Southwood dominance index (1978).

RESULTS AND DISCUSSION

The total of eight natural enemies including four predators,

four parasitoids and one hyperparasitoid were associated with lac insect. Among predators, four species namely *Eublemma amabilis* Moore (23.38%), *Pseudohypatopa pulverea* (Mayrick) (12.95%), *Chrysoperla zastrowi sillemi* (Esben-Peterson) (11.33%), and *Tribolium* sp. (15.29%) were recorded. There were four parasitoids, viz. *Tachardiaephagus tachardiae* (Howard) (14.75%), *Aprostocteus purpureus* (Cameron) (11.33%), *Eupelmus tachardiae* (Howard) (1.98%), and *Tyndarichus clavicornis* (Cameron) (0.90%). Besides these, one hyper-parasitoid, *Bracon greeni* Ashmead (Braconidae: Hymenoptera) was also recorded. Among these, *E. amabilis* was the predominant species (Table 1). The number of insect parasitoids and predators belonging to order Hymenoptera, Lepidoptera, Coleoptera and Neuroptera were observed during the study. The abundance of parasitoids and predators belonging to these was: Hymenoptera (37.05%)> Lepidoptera (36.33%) > Coleoptera (15.29%)> Neuroptera (11.33%). Similarly, the relative abundance of natural enemies' families associated with lac insect were Noctuidae (24%) > Encyrtidae (18%) > Tenebrionidae (15%) > Blastopidae (13%) > Eulophidae (11%) > Chrysopidae (11%) > Braconidae (8%). The index of species diversity and index of dominance indicated that the natural population of

associated natural enemies was found to be maximum in the year 2023 and minimum in the year 2019 and 2022. Species richness and Simpson's index was found to be maximum in the year 2022. On the contrary, species evenness was highest in the year 2019 and 2022 and lowest in 2023 (Table 2).

Several predators and parasitoids have been reported to be associated with lac insect which is in agreement with the present studies. Meena and Sharma (2018) described 11 insect species from 8 families associated with *K. lacca* under which 3 were predator species (*E. amabilis*, *P. pulverea*, and *C. zastrowi*), 4 primary parasitoids (*T. tachardiae*, *A. purpureus*, *T. clavicornis*, *E. dewitzi*) and 4 hyperparasitoids (*A. fakhruhajiae*, *E. tachardiae*, *B. greeni*, *B. tachardiae*) in western plains of India. The lepidopteran predators, *E. amabilis* and *P. pulverea* have been reported to be key natural enemy of lac insect causing damage to lac encrustations across India (Rahman et al 2009; Chattopadhyay 2011; Sharma and Ramani 2011). Bhattacharya et al (2007) and Jaiswal et al (2008) also stated that *E. amabilis* and *P. pulverea* are the two dominant predators of lac insect causing 20 to 40 per cent losses to lac crop. Daharia and Katlam (2013) also reported the dominance of these two predators in Chhatisgarh state.

Table 1. Natural enemies associated with lac insect, *Kerria lacca* (Kerr) in Sub-humid Sutlej-Ganga Alluvial Plains of India during 2019-2023

Scientific name	Order	Family	Relative abundance (%)
Predators			
<i>Eublemma amabilis</i> Moore	Lepidoptera	Noctuidae	23.38
<i>Pseudohypatopa pulverea</i> (Mayrick)	Lepidoptera	Blastopidae	12.95
<i>Chrysoperla zastrowi sillemi</i> (Esben-Peterson)	Neuroptera	Chrysopidae	11.33
<i>Tribolium</i> sp.	Coleoptera	Tenebrionidae	15.29
Parasitoids			
<i>Tachardiaephagus tachardiae</i> (Howard)	Hymenoptera	Encyrtidae	14.75
<i>Aprostocteus purpureus</i> (Cameron)	Hymenoptera	Eulophidae	11.33
<i>Eupelmus tachardiae</i> (Howard)	Hymenoptera	Encyrtidae	1.98
<i>Tyndarichus clavicornis</i> (Cameron)	Hymenoptera	Encyrtidae	0.90
Hyper-parasitoid			
<i>Bracon greeni</i> Ashmead	Hymenoptera	Braconidae	8.09

Table 2. Diversity indices of arthropod fauna associated with lac insect, *Kerria lacca* (Kerr) during 2019-2023

Year	Species richness	Index of species diversity	Evenness index	Index of dominance	Simpsons index
2019	1.12	0.04	0.96	0.04	4.81
2020	1.40	0.14	0.86	0.14	5.13
2021	0.76	0.05	0.95	0.05	4.43
2022	1.45	0.04	0.96	0.04	7.02
2023	0.97	0.27	0.73	0.27	2.61
Over all	1.27	0.09	0.91	0.09	6.77

Likewise, *Chrysoperla* spp. from chrysopidae family has also been reported to be important predator of lac insect in India (Sharma et al 2006, Ramesh 2013, Rajpoot et al 2020).

Among parasitoids, *T. tachardiae* and *A. purpureus* were dominant species in the present studies (Sharma et al 2010, Chattopadhyay 2011, Monobrullah et al 2015). Yogi and Bhattacharya (2015) documented 72 parasitoids and predators, out of which predator *E. amabilis* and parasitoids *T. tachardiae* and *A. purpureus* were the dominant ones.

CONCLUSION

The present studies thus revealed a rich fauna of natural enemies associated with lac insect. There is need to adopt proper management practices to tackle these biotic stresses so as to avoid huge losses to lac cultivation.

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AUTHORS CONTRIBUTION

PS Shera and KS Sangha involved in conceptualization, planning, and manuscript editing; S Sharma and R Kaur contributed in execution of work; Arshdeep Singh, Ankita Thakur and Shasta Kalra involved in data collection, analysis and draft writing. All authors read and approved the manuscript for publication.

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