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SURVEY OF PREVELANCE AND ABUNDANCE OF NATURAL PUPOLATION OF LAC INSECT KERRIA LACCA (KERR) AND OF ITS NATURAL ENEMIES IN DIFFERENT STATES OF ARID WESTERN PLAINS ON DIFFERENT HOST PLANTS

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Survey for the presence of natural population of lac insect Kerria lacca (Kerr) on various host plants were carried out at 178 locations of 27 districts of Arid Western Plains viz., Rajasthan, Gujarat and Haryana and the presence of lac insect was recorded on hosts viz., Peepal (Ficus religiosa L.), Bargad (Ficus benghalensis L.), Ber (Ziziphus mauritiana Lam.), Babool (Vachellia nilotica L.), Gular (Ficus racemose L.) and Sitafal (Annona squamosal L.), of which Peepal (Ficus religiosa L.) was the most predominant host of natural lac recorded at total 142 locations. Among all the host plant samples, highest natural enemy emergence was recorded from the samples of Peepal (387) followed by Ber (96), Bargad (23), Babool (12) and Gular (3). Lac associated fauna emerged from different host samples comprises of both natural enemies and storage pests belonging to four orders viz., Lepidoptera, Hymenoptera, Coleptera and Pcoptera and eight families viz., Noctuidae (E. amabilis), Blastobasidae (P. pulverea), Encyrtidae (E. dewitzii & T. tachardiae), Eulophidae **ABSTRACT** (A. purpureus), Braconidae (B. greeni), Curculionidae (S. oryzae), Silvanidae (O. surinamensis) and Liposelidae (L. divinatorius). Of emerged natural enemies primary parasitoids were maximum, followed by predators and hyperparasitoids with contribution of 44.20, 38.41 and 4.73 per cent to the total natural enemy population. Lac associated fauna emerged after six weeks of storage till next VI weeks with maximum emergence in IIIrd week.

> Key words : Lac insect Kerria lacca (Kerr), host, Arid Western Plains, Peepal (Ficus religiosa L.), Ber (Ziziphus mauritiana Lam.), Bargad (Ficus benghalensis L.), Babool (Vachellia nilotica L.), Gular (Ficus racemose L.), Sitafal (Annona squamosal L.), natural enemies, primary parasitoid, predator, hyperparasitoid.

Introduction

Lac is a resin, naturally secreted by an insect (*Kerria lacca*) which feeds and thrives on the tender portion of twigs of specific host trees (Patel *et al.*, 2024; Smridhi *et al.*, 2023). Earlier only 4 species of lac host plants were known but recently more than 400 plant species have been found to be lac insect hosts, globally, which are divided into 3 categories as per their suitability and distribution *i.e.;* common, occasional, and rare. The *Flemingia* spp., Ber, Palas and Kusum host plants are

considered important for lac production (Bashir *et al.*, 2022). Distribution of lac insect is confined to subtropical and tropical areas of south and south-east Asia (Ramani *et al.*, 2007). Lac ecosystem is complex and multi-trophic web of fauna and flora. There are total of 22 species of lac predator, 30 species of primary parasites & 40 species of secondary parasites, respectively, along with fungal pathogens which represent rich biodiversity of lac associated fauna (Sharma *et al.*, 2006; Rao *et al.*, 2013). Around 35 to 40 per cent loss in lac production is caused

by predators (Glover, 1937; Jaiswal et al., 2008), while parasitoids cause 5 to 10 per cent loss (Varshney, 1976). Major lac associated fauna consists of predators, primary parasitoids and hyperparasitoids (Swami et al., 2021). Lac is the subsidiary source of income for millions of rural masses specially tribals of the country (David and Ramamurthy, 2017). Lac makes significant contribution to the foreign exchange earnings of the country and plays an important role in the economic upliftment of around 3 to 4 million tribal people (Kumar, 2002). A proper knowledge on the incidence and abundance will help with the effective management of major predators of lac insect and will also enhance lac production in the area. Therefore, the present study focuses on the survey of the prevalence and abundance of natural enemies of lac insect, Kerria lacca (Kerr) in different states of arid western plains on different host.

Materials and Methods

Extensive surveys were carried out during the month of June-July / Oct-Nov in three states of Arid Western Plains, namely, Rajasthan, Gujarat and Haryana, during 2022 under the Network Project on Conservation of Lac Insect Genetic Resources (NP-CLIGR) to study the prevalence and abundance of natural enemies of lac insect in the region.

Surveys were carried out in 10 districts each of Rajasthan, Gujarat and Haryana, during 2022. Different natural hosts of lac insect prevailing in the region were examined for the presence of population of lac insect and a detailed record of both lac host and lac insect genetic resources were maintained to generate a complete passport data of both host and lac insect resources of the region.

Samples of twigs from each host having the presence of lac (dead or live) was collected from as many possible locations of districts of three states of Arid Western Plains *viz.*, Rajasthan, Gujarat and Haryana, during 2022. The matured samples of brood lac collected were bought to laboratory and were kept in 60 mesh nylon cages for emergence of predators and parasitoids.

The samples were observed regularly for the emergence of the predators and parasitoids. The emerged individuals of natural enemies were collected for the further studies. A record of all samples from three states was maintained and the following observations were recorded-

- 1) Total number of natural enemies emerged from each sample of three states
- 2) Total number of natural enemies emerged from

host wise samples of three states

3) Data of weekly emergence profile of natural enemies and storage pest

Results and Discussion

The observations recorded at 178 locations of 27 districts of three states of Arid Western Plains in June-July/ Oct-Nov, during 2022 depicted that among six host plant species, Peepal, Ficus religiosa recorded at 142 locations was the most dominant host of lac insect in all the three states. Apart from Peepal F. religiosa other host plants viz., Ber, Ziziphus mauritiana, Bargad, Ficus benghalensis, Babool /Kikar, Vachellia nilotica, Sitafal, Annona squamosa and Gular, Ficus racemose were also recorded to harbor natural population of lac insect at 30, 12, 7, 2 and 1 location, respectively (Table 1, Fig. 1) The prevalence of lac insect on Peepal at maximum locations in the survey of three states is in line with the findings of Meena et al. (2020) and Swami et al. (2021) who during their surveys have also observed F. religiosa most frequently occurring host for Rangeeni lac during 2015-2016 and 2019-2020, respectively. In their studies they have also shown the presence of good lac encrustation on F. benghalensis, F. racemosa, Z. mauritiana, Acacia auriculiformis, A. lebbeck, A.



Fig. 1 : Location wise collection of host plant samples along with natural population of lac insect in Arid Western Plains, during 2022.



Fig. 2: Lac insect associated fauna emerged from different host plant samples collected from Arid Western Plains, during 2022.

		No. of locations]			
S. no.	States	with presence of host plant containing lac encrustation	Common Name	Scientific Name	Family	
1	Rajasthan	58	Peepal	Peepal Ficus religiosa L.		
		12	Ber	Ber Ziziphus mauritiana Lam.		
		10	Bargad	Bargad Ficus benghalensis L.		
		05	Babool	Babool Vachellia nilotica L.		
		02	Sitafal	Sitafal Annona squamosa L.		
2	Gujarat	41	Peepal	Peepal Ficus religiosa L.		
		08	Ber	Ziziphus mauritiana Lam.	Rhamnaceae	
		02	Bargad Ficus benghalensis L.		Moraceae	
		01	Gular	Ficus racemose L.	Moraceae	
3	Haryana	43	Peepal	Ficus religiosa L.	Moraceae	
		10	10 Ber Ziziphu		Rhamnaceae	
		02	Babool	Vachellia nilotica L.	Fabaceae	

 Table 1: Location wise collection of host plant samples along with natural population of lac insect in Arid Western Plains, during 2022.

 Table 2 : Lac insect associated fauna emerged from different host plant samples collected from Arid Western Plains, during 2022.

S. no.	No. of host plant	Total number of	Total		
	samples collected	Rajasthan	Gujarat	Haryana	
1	PEEPAL(140)	166	89	132	387
2	BER(27)	38	26	32	96
3	BARGAD(08)	12	11	-	23
4	BABOOL(04)	-	-	12	12
5	GULAR(1)	-	03	-	03

reticulate. F. palmate, F. benjamina, F. tsiela, Peltophorum ferrugineum, Pithecellobium dulce, Calliandra calothyrsus, Polyalthia longifolia, Prosopis cineraria, P. juliflora and Samanea saman which also supports the results of the present study carried out during 2022.

The results of the investigation on the emergence of different natural enemies and storage pests from the samples of various host plants collected during the survey from three states of Arid Western Plain reveals that the emergence of natural enemies and storage pests was maximum (387) from the collected samples of Peepal (*Ficus religiosa* L.), in all the three states *viz.*, Rajasthan, Gujarat and Haryana and was followed by Ber (*Ziziphus mauritiana* Lam.) with 96 number of storage pests and natural enemies whereas minimum (3) natural enemies and pests of storage were recorded from stored samples of Gular (*Ficus racemose* L.) and samples of Bargad

(*Ficus benghalensis* L.) and Babool (*Vachellia nilotica* L.) showed emergence of 23 and 12 number of natural enemies and storage pests, respectively (Table 2, Fig. 2). Not much studies have been done so far on the host wise emergence of natural enemies of lac insect, however the result of the present studies confers the results of the study carried out by Mohanasundram *et al.* (2018), who have attempted to find out the variation in the lac associated fauna in relation to different host plants *viz.*, ber, palas and red gram for both *Kusumi* and *Rangeeni* strain of lac and have found that the emerged population of lac associated fauna was significantly more on ber followed by palas and red gram.

The observations on lac associated insect fauna emerged from different host samples reveals that both natural enemies and storage pests emerged from lac samples. Natural enemies recorded in the investigation belong to two major insect orders *viz.*, Lepidoptera and

S. no.	Trophic level states	Fauna	Order	Individuals	Individuals per order	Family per Family	Percentage contribution
1	Predators	Eublemma amabilis Moore	Lenidoptera	73	58	Noctuidae	30.52%
	Trodutors	Pseudohypatopa pulverea Meyrick	Lepidopteru	15	15	Blastoba- sidae	7.89%
	Dimor	<i>Erencyrtus dewitzii</i> Mahd.	II	117	64	Encyrtidae	33.68%
2	parasitoid	Tachardiaephagus tachardiae Howard	nymenoptera	117	20	Encyrtidae	10.52%
		Aprostocetus (Tetrastichus) purpureus Cameron			24	Eulophidae	12.63%
3	Hyperparasitoid	Bracon greeni Ashmead			9	Braconidae	4.73%

 Table 3 : Different natural enemies and storage pests emerged from the lac samples collected from Arid Western Plains, during 2022.

Storage pests

S. no.	Fauna	Order	Individuals per order	Individuals per family	Family	Percentage contribution
1	Sitophilus oryzae Linn.	Coleoptera	55	51	Curculionidae	15.40%
2	Oryzaephilus surinamensis Linn.	Conceptina		4	Silvanidae	1.20%
3	Liposcelis divinatorius Muller	Psocoptera	276	276	Liposelidae	83.38%

Hymenoptera. In the studies two predators viz., E. amabilis (Noctuidae; Lepidoptera), P. pulverea (Blastobasidae; Lepidoptera), three primary parasitoids represented by A. purpureus (Eulophidae: Hymenoptera), T. tachardiae, and E. dewitzii (Encyrtidae: Hymenoptera) and one hyperparasitoid, B. greeni, (Braconidae; Hymenoptera) were recorded (Fig. 3.1). Among total 190 natural enemies, 64 individual belonged to Erencyrtus dewitzii Madh.(Encrytidae; Hymenoptera), 58 individuals to Eublemma amabilis Moore (Noctuidae; Lepidoptera), 24 individuals to Aprostocetus (=Tetrastichus) purpureus Cameron (Eulophidae; Hymenoptera), 20 individuals to Tachardiaephagus tachardiae Howard (Encrytidae; Hymenoptera), 15 individuals to Pseudohypatopa pulverea Meyric (Blastobasidae; Lepidoptera) and 9 individuals of Bracon greeni (Braconidae; Hymenoptera) with contribution of 33.68, 30.52, 12.63, 10.52, 7.89 and 4.73 per cent, respectively. It was recorded that primary parasitoids were most dominant and was followed by predators and a small population of hyperparasitoids. Apart from natural enemies large number of storage pests were also recorded. Storage pests recorded mainly belonged to order Psocoptera and Coleoptera. Out of total 331 storage pests, 276 belongs to Liposelidae family 51 to Curculionidae and 4 to Silvanidae family with the

contribution of 83.38, 15.40 and 1.20 per cent, respectively (Table 3, Fig. 3.1 and 3.2). The results of present study are in full agreement with the findings of Meena and Sharma (2018), Swami *et al.* (2021) who have also recorded Lepidoptera and Hymenoptera as the two major insect order of natural enemies. In their survey study in the Arid Western Plains they have also reported predators *viz.*, *E. amabilis* (Noctuidae; Lepidoptera), *P. pulverea* (Blastobasidae; Lepidoptera) primary parasitoids *viz.*, *A. purpureus* (Eulophidae: Hymenoptera), *T. tachardiae*, and *E. dewitzii* (Encyrtidae: Hymenoptera) and hyperparasitoids, *B. greeni* (Braconidae; Hymenoptera), which is similar to the results of present investigation.

The data on the weekly emergence profile of parasitoids and predators associated with lac insect was recorded for the period of six weeks from the initiation of emergence and has been shown Table 4 and depicted in Fig. 4. The emergence of natural enemies started after six weeks of lac storage and continued till next six weeks. The result shows that the emergence of natural enemies was 45 individuals in the first week which increased to maximum of 145 individuals during the third week and thereafter it declined to 62 individuals. The emergence of the major predators *viz.*, *Eublemma amabilis* and *Pseudohypatopa pulverea* was recorded during all the

Weeks after storage		Trophic Level Status							
	Predators		Primary parasite		Hyperparasite	ite Storage pests			Total
	Noctuidae	Blastobasidae	Encyrtidae	Eulophidae	Braconidae	Curculionidae	Silvanidae	Liposelidae	
Ι	9	2	16	5	0	7	0	10	49
I	8	1	22	4	0	9	1	25	70
Ш	13	3	32	9	4	15	1	68	145
IV	13	3	14	6	2	8	1	62	109
V	14	4	0	0	3	6	0	59	86
VI	1	2	0	0	0	6	1	52	62

Table 4 : Weekly emergence profile of insect fauna associated with lac insect, Kerria lacca (Kerr), during 2022.





Fig. 3 : Different natural enemies and storage pests emerged from the lac samples collected from Arid Western Plains, during 2022.



Fig. 4 : Weekly emergence profile of insect fauna associated with lac insect, *Kerria lacca* (Kerr), during 2022.

six weeks with maximum emergence during the fifth week with 14 individuals of *E. amabilis* and 4 individuals of *P.*

pulverea of Noctuidae and Blastobasidae family, respectively. Similarly, primary parasitoids emerged till fourth week of lac storage with maximum emergence during third week with 32 and 9 individuals of Encrytidae and Eulophidae, respectively. Likewise, hyperparasitoids of Braconidae family emerged till fifth week after lac storage with maximum emergence of 4 individuals during third week (Fig 4). Storage pests showed emergence upto sixth week with maximum emergence during third week with 15, 1 and 68 individulas of Curculionidae, Silvanidae and Liposelidae family, respectively. The findings of the present study are in line with the findings of Meena and Sharma (2018) who have also recorded the emergence of predators viz. E. ammabilis & P. pulveria upto upto six weeks, primary parasitoids viz., T. tachardiae, A. purpureus and E.dewitzii upto four weeks and hyperparasitoids B. greeni within five weeks during the month of June -July/ Oct- Nov from the stored lac samples.

Authors' contribution

Contribution to conception, wrote the manuscript, analysis, interpretation and acquisition of data (D.S); Drafting manuscript, contributed data or analysis tools (H.S); Analysis and interpretation of data (H.S, D.S and D.K.P); performed the analysis (D.S and D.K.P).

Declaration

The authors declare that they have no conflict of interests.

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