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RELATIVE ABUNDANCE, EMERGENCE PROFILE AND PARASITIZATION OF LAC INSECT (*KERRIA LACCA*) ASSOCIATED FAUNA IN RANGEENI CROPS

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ABSTRACT

Relative abundance, emergence profile and parasitization of parasitoids and predators associated with lac insect were recorded during rangeeni summer season (baisakhi) and rainy season (katki) lac crops on ber and palas under two different conditions viz., spray of fipronil + chlorothalonil and only chlorothalonil. It revealed that three parasitoids (*Aprostocetus purpureus*, *Tachardiaephagus tachardiae, Tyndarichus clavicornis*) and one predator *Eublemma amabilis* were abundant in both lac crops. Lac associated fauna were recorded more on lac crop sprayed with chlorothalonil only compared to fipronil + chlorothalonil on both crops on both lac hosts. Among the lac associated fauna, *A. purpureus* was recorded in more numbers in both crops and spray conditions. Maximum level of parasitization was recorded at the time of sexual maturity period (19 to 22 Weeks After Inoculation (WAI)) during baisakhi whereas in katki, at crop maturity period (16 to 19 WAI) on ber and palas.

Key words: *Kerria lacca*, lac associated fauna, fipronil, chlorothalonil, parasitization, *Aprostocetus purpureus*, *Tachardiaephagus tachardiae*, *Tyndarichus clavicornis*, *Eublemma amabilis*, rangeeni

The Indian lac insect, *Kerria lacca* (Hemiptera: Tachardiidae) are commercially important species for resin, dye and wax production. These are distributed in tropical and subtropical areas of south and south-east Asia. Based on host preference and its life cycle pattern *K. lacca* has been grouped into two strains viz. kusmi and rangeeni. Kusmi strain provides two crops per year, aghani (winter season crop) and jethwi (summer season crop) each of which have a six months duration. Similarly, rangeeni strain provides two crops per year namely katki (rainy season crop – four months) and baisakhi (summer season crop- 8 months) (Sharma et al., 2006). Lac insect is a phloem sap sucking insect and spends a complete sedentary life during its life cycle, hence they are more vulnerable to many insect predators and parasitoids, causing extensive injury to the lac crop both qualitatively and quantitatively (Singh et al., 2011). Generally, lac is cultivated in forest areas by the poor tribal farmers whose livelihood is primarily dependent on lac cultivation. Biotic and abiotic stresses are the major constraints of lac cultivation faced by farmers. Twenty-two species of lac insect predators, 30 species of primary parasites, 45 species of secondary parasites have been reported in lac insect ecosystem (Mohanasundaran et al., 2016). The losses caused to lac crop by two lepidopteran predators *Eublemma amabilis* Moore and *Pseudohypatopa pulverea* Meyr are about 30-40% annually (Jaiswal et al., 2008; Singh et al., 2009). Rahman et al. (2009) reported that *E. amabilis* is very critical to lac insect. It causes more injury to the katki crop than the baisakhi crop and damages 42-50 mature lac cells prior to pupation. Mohanasundaram et al. (2016) reported that, parasitoids alone constitute 89 to 93% population among lac associated fauna followed by predators and hyper parasitoids on ber during baisakhi crop. Among them, *A. purpureus* was significantly more abundant. Sometimes, complete mortality of lac crops was observed in earlier years but the reasons could not be identified. Parasitization at an early development stage of lac insect by *A. purpureus* leads to complete failure of the lac crop (Mohanasundaran et al., 2016). Thamilarasi et al. (2019) have also developed a PCR based method to detect the key parasitoids of lac insects. Therefore, the study was undertaken to study the relative abundance, emergence profile of parasitoids and predators associated with lac insect during rangeeni lac crops in two different spray conditions in order to ascertain the biotic factors responsible for such huge losses to the crop.

MATERIALS AND METHODS

Experiments were conducted at Institute Research Farm, ICAR-Indian Institute of Natural Resins and Gums (IINRG), Namkum, Ranchi Jharkhand. Rangeeni broodlac was cultivated during three consecutive years of summer season baisakhi crops and rainy season katki crops on ber (2015 to 2017) and for two consecutive years on palas (2016 to 2017) under two different conditions viz., sprayed with fipronil (1.5 ml per litre of water) + chlorothalonil (1 g per litre of water) (insecticide+ fungicide) and chlorothalonil (1 g per litre of water) (fungicide) only. The treatments were used judiciously as per the recommendations of ICAR-IINRG. Broodlac (baisakhi) was inoculated @ 10-15 g/m^2 on forty trees each of ber on 03-11-2015, 19-10-2016 and 02-11-2017 and palas on 03-11-2015, 19-10-2016 and 01-11-2017 during 2015-16 to 2017-18 crop period. Broodlac (katki) was inoculated @ 20-25 g/m^2 on forty trees each of ber on 02-07-2015, 07-08-2016 and 10-07-2017 and palas on 08-07-2015, 07-08-2016 and 11-07-2017 during 2015 to 2017 crop period. After one month of inoculation, lac insect samples (one meter length of encrustation) were collected from randomly selected branches and used for collection of lac associated fauna under three replications. This process was done at a fifteen days interval up to crop maturity. The samples were caged in parasitoid emergence cages fitted with glass tubes to collect parasitoids by exploiting their phototropic behavior. Lac associated fauna (parasitoids and predators) were collected from the cages on a daily basis continuously up to one month (Mohanasundaran et al., 2016). Simultaneously samples were collected for pricking and critical analysis were made under the microscope from the lac inoculated branches of the same tree on which caging was done.

The experiment was conducted in Randomized Block Design (RBD). Data were pooled followed by statistical analysis using techniques of analysis of variance. Population abundance of lac associated fauna was recorded from different host plants for each crop season and the data were subjected to analysis of variance (ANOVA) for the significance (P=0.05) using statistical package OP STAT.

RESULTS AND DISCUSSIONS

Relative abundance of lac associated fauna during rangeeni lac crops

Only three parasitoids (*Aprostocetus purpureus* (Cam.), *Tachardiaephagus tachardiae* (How.), *Tyndarichus clavicornis* (Cam.)) and one predator, *E. amabilis* were abundant in both baisakhi and katki crops. This was in accordance with the previous findings (Srivastava and Mehra 1980; Srivastava et al., 1984). Average populations of lac associated fauna were recorded and was found to be more on those sprayed with chlorothalonil only (11.58 and 17.21 Nos.) and (35.89 and 21.13 Nos.) compared to fipronil + chlorothalonil (9.45 and 10.63 Nos.) and (12.14 and 11.88 Nos.) on ber and palas during both baisakhi and katki crops, respectively. Lac associated fauna were more abundant during katki season as compared to baisakhi crop both on ber and palas host.

Among the lac associated fauna, *A. purpureus* was recorded more in numbers in crops sprayed with chlorothalonil only (32.56 and 31.67 nos.) and (100.11 and 50.00 nos.) compared to those sprayed with fipronil + chlorothalonil (26.22 and 22.83 Nos.) and (24.00 and 34.33 Nos.) on ber and palas during baisakhi and katki crops, respectively while *T. clavicornis* was of less numbers in those lac crops sprayed with chlorothalonil only and compared to fipronil + chlorothalonil and on ber and palas during baisakhi and katki crops, respectively (Table 1 and 2). Population of lac associated fauna could not be fully controlled with spray of fipronil + chlorothalonil. Sharma et al. (1997) and Sharma et al. (2008) reported that *A. purpureus* and *T. tachardiae* majorly constitute the total lac associated fauna.

Emergence profile of lac associated fauna during rangeeni lac crops

Weekly emergence profile study of lac associated fauna (Table 3-6) showed maximum population of *A. purpureus* (7.67 Nos.), *T. tachardiae* (4.56 Nos), *T. clavicornis* (0.44 Nos), in those samples which were collected 21Weeks After Inoculation (WAI), 20 WAI and 21 WAI, respectively during sexual maturity period. The present results are in conformity with the finding of Mohanasundaram et al. (2016) who reported that, *A. purpureus* alone constituted 100% population during critical/sexual maturity period causing complete lac insect mortality on ber and palas during baisakhi. Further, Mohanasundaram et al. (2018) reported that during baisakhi crop, *A. purpureus* and *T. tachardiae* were significantly higher in the month of March (4.3 and 11.9, respectively). Parasitization recorded significantly higher (9.5) on palas followed by ber and red gram and it is one of the major reasons of lac insect mortality at sexual maturity period during baisakhi crop. Our finding was similar to earlier findings as reported by Gupta and Bhattacharya (2007). However, *E. amabilis* (1.78 Nos.) collected 44 WAI during crop maturity

Table 1. Relative abundance of lac associated fauna during baisakhi crops

Lac associated fauna	Ber (Numbers per meter lac encrustation)			Palas (Numbers per meter lac encrustation)		
	Fipronil + Chlorothalonil	Chlorothalonil only	Mean	Fipronil + Chlorothalonil	Chlorothalonil only	Mean
Tachardiaephagus tachardiae	3.55	7.22	5.39	3.33	14.33	8.83
Aprostocetus purpureus	26.22	32.56	29.40	22.83	31.67	27.25
Tyndarichus clavicornis	3.78	0.56	2.17	1.17	4.50	2.83
Eublemma amabilis	4.22	6.00	5.11	15.17	18.33	16.75
Mean	9.45	11.58		10.63	17.21	
	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)
Lac associated fauna	2.42	1.12	0.79	1.88	0.87	0.61
Spray conditions	1.71	0.79	0.56	1.33	0.61	0.43
Lac associated fauna× Spray conditions	3.43	1.58	1.12	2.65	1.23	0.87

Table 2. Relative abundance of lac associated fauna during katki crops

Lac associated fauna	Ber (Numbers per meter lac encrustation)			Palas (Numbers per meter lac encrustation)		
	Fipronil + Chlorothalonil	Chlorothalonil only	Mean	Fipronil + Chlorothalonil	Chlorothalonil only	Mean
Tachardiaephagus tachardiae	16.89	25.00	20.94	7.17	13.83	10.50
Aprostocetus purpureus	24.00	100.11	62.06	34.33	50.00	42.17
Tyndarichus clavicornis	2.67	5.11	3.89	0.17	2.67	1.42
Eublemma amabilis	5.00	13.33	9.17	5.83	18.00	11.92
Mean	12.14	35.89		11.88	21.13	
	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)
Lac associated fauna	1.53	0.71	0.50	2.53	1.17	0.83
Spray conditions	1.08	0.50	0.35	1.79	0.83	0.59
Lac associated fauna× Spray conditions	2.17	1.00	0.71	3.58	1.65	1.17

period in chlorothalonil only as compared to fipronil + chlorothalonil in which maximum population of *A. purpureus* (7.56 Nos.), *T. clavicornis* (1.66 Nos) were more in samples collected during 35 WAI on ber.

Whereas in palas, maximum population of *A. purpureus* (7.50 Nos.) collected on 20WAI during sexual maturity period and *T. tachardiae* (7.67 Nos.), *T. clavicornis* (2.17 Nos) and *E. amabilis* (5.00 Nos.) collected 38 WAI, 37 WAI and 44 WAI, respectively during crop maturity period as compared to fipronil + chlorothalonil in which population of *A. purpureus, T. tachardiae* and both *T. clavicornis* and *E. amabilis* were more in samples collected during 20 WAI, 21 WAI, 37 WAI, respectively. Here, fipronil spray was effective against parasitods and minimizes the lac insect mortality during sexual maturity period on both ber and palas in baisakhi crops. Populations of lac associated fauna, two spray conditions (except *E. amabilis*) and their interactions are significantly different on both ber and palas during baisakhi crops.

In katki, maximum population of *A. purpureus* (28.00 Nos), *T. tachardiae* (5.22 Nos.), *T. clavicornis* (1.67 Nos) and *E. amabilis* (2.56 Nos.) collected 17 WAI, 16 WAI, 17 WAI and 13 WAI, respectively during on ber in chlorothalonil spray during crop maturity period as compared to fipronil + chlorothalonil whereas, in palas, maximum population of *A. purpureus* (14.83 Nos), *T. tachardiae* (3.17 Nos.), *T. clavicornis* (2.00 Nos) and *E. amabilis* (6.33 Nos.) were collected during 16 WAI, 12 WAI, 10 WAI and 13 WAI, respectively in chlorothalonil spray as compared to fipronil + chlorothalonil spray. Mohanasundaram et al. (2018) confirmed that *T. tachardiae* and *A. purpureus* population were significantly higher during the month

Table 3. Weekly emergence profile of lac associated fauna during summer rangeeni (baisakhi) crop on ber

Period	*T. tachardiae*			*A. purpureus*			*T. clavicornis*			*E. amabilis*		
	A	B	Mean	A	B	Mean	A	B	Mean	A	B	Mean
14 WAI	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-	-
15 WAI	0.00	0.33	0.17	0.00	0.00	0.00	-	-	-	-	-	-
16 WAI	0.00	0.45	0.22	0.00	0.33	0.17	-	-	-	-	-	-
17 WAI	0.00	0.11	0.06	0.11	0.89	0.50	-	-	-	-	-	-
18 WAI	0.00	0.00	0.00	1.44	2.00	1.72	-	-	-	-	-	-
19 WAI	0.00	0.11	0.06	3.11	4.00	3.56	0.00	0.00	0.00	-	-	-
20 WAI	0.78	4.56	2.67	2.78	5.55	4.17	0.56	0.00	0.28	-	-	-
21 WAI	0.56	0.00	0.28	0.33	7.67	4.00	0.55	0.44	0.50	-	-	-
22 WAI	0.67	0.11	0.39	0.11	5.22	2.67	0.11	0.00	0.06	-	-	-
23 WAI	0.11	0.00	0.06	0.44	2.56	1.50	0.00	0.00	0.00	-	-	-
24 WAI	0.00	0.00	0.00	0.11	0.22	0.17	0.00	0.00	0.00	-	-	-
25 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
26 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
27 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
28 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
29 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.06
31 WAI	0.00	0.11	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.11
32 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.22
33 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.22
34 WAI	0.11	0.00	0.06	6.33	0.22	3.28	0.89	0.00	0.44	0.11	0.00	0.06
35 WAI	0.44	0.22	0.33	7.56	0.22	3.89	1.66	0.00	0.83	0.00	0.00	0.00
36 WAI	0.33	0.11	0.22	0.78	0.00	0.39	0.00	0.11	0.06	0.44	0.00	0.22
37 WAI	0.33	0.00	0.17	0.78	0.56	0.67	0.00	0.00	0.00	1.67	0.67	1.17
38 WAI	0.11	0.00	0.06	0.44	1.55	1.00	-	-	-	0.67	0.00	0.34
39 WAI	0.11	0.22	0.17	1.44	1.11	1.28	-	-	-	0.00	0.00	0.00
40 WAI	0.33	0.78	0.55	0.44	0.33	0.39	-	-	-	0.22	0.33	0.28
41 WAI	0.00	0.11	0.06	0.00	0.00	0.00	-	-	-	0.00	1.11	0.56
42 WAI	0.00	0.00	0.00	0.00	0.11	0.06	-	-	-	0.33	0.89	0.61
43 WAI	-	-	-	0.00	0.00	0.00	-	-	-	0.22	0.22	0.22
44 WAI	-	-	-	-	-	-	-	-	-	0.33	1.78	1.06
45 WAI	-	-	-	-	-	-	-	-	-	0.00	0.00	0.00
Mean	0.13	0.25		0.87	1.09		0.20	0.03		0.25	0.35	
	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)
Lac associated fauna	0.26	0.13	0.09	0.57	0.29	0.21	0.18	0.09	0.06	0.31	0.16	0.11
Spray conditions	0.07	0.04	0.02	0.15	0.08	0.05	0.06	0.03	0.02	N/A	0.05	0.04
Lac associated fauna× Spray conditions	0.37	0.19	0.13	0.81	0.41	0.29	0.25	0.13	0.09	0.44	0.22	0.16

WAI: Week After Inoculation A: Fipronil + Chlorothalonil spray; B: Chlorothalonil spray only

Table 4. Weekly emergence profile of lac associated fauna during summer rangeeni (baisakhi) crop on palas

Period	*T. tachardiae*			*A. purpureus*			*T. clavicornis*			*E. amabilis*		
	A	B	Mean	A	B	Mean	A	B	Mean	A	B	Mean
16 WAI	-	-	-	0.00	0.00	0.00	-	-	-	-	-	-
17 WAI	-	-	-	0.50	0.00	0.25	-	-	-	-	-	-
18 WAI	-	-	-	3.33	0.50	1.92	-	-	-	-	-	-
19 WAI	0.00	0.00	0.00	4.50	3.00	3.75	0.00	0.00	0.00	-	-	-
20 WAI	0.17	1.00	0.58	5.83	7.50	6.67	0.00	0.17	0.08	-	-	-
21 WAI	1.00	1.00	1.00	0.33	2.00	1.17	0.00	1.67	0.83	-	-	-
22 WAI	0.50	0.00	0.25	0.17	4.17	2.17	0.00	0.17	0.08	-	-	-
23 WAI	0.00	0.17	0.08	0.17	3.33	1.75	0.00	0.00	0.00	-	-	-
24 WAI	0.00	0.00	0.00	0.00	0.17	0.08	0.00	0.00	0.00	-	-	-
25 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
26 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
27 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28 WAI	0.00	0.00	0.00	0.00	0.17	0.08	0.00	0.00	0.00	0.00	0.17	0.08
29 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.17
30 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.33
31 WAI	0.50	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.25
32 WAI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67	0.67	1.17
33 WAI	0.17	0.00	0.08	0.00	0.17	0.08	0.00	0.00	0.00	2.00	1.17	1.58
34 WAI	0.00	0.50	0.25	2.50	3.67	3.08	1.00	0.00	0.50	0.83	0.00	0.42
35 WAI	0.00	0.33	0.17	2.33	0.67	1.50	0.17	0.00	0.08	1.00	0.00	0.50
36 WAI	0.17	0.00	0.08	1.83	0.67	1.25	0.00	0.33	0.17	1.00	0.00	0.50
37 WAI	0.50	1.50	1.00	1.33	3.33	2.33	0.00	2.17	1.08	2.33	0.50	1.42
38 WAI	0.00	7.67	3.83	0.00	0.33	0.17	0.00	0.00	0.00	0.50	0.83	0.67
39 WAI	0.00	1.00	0.50	0.00	0.33	0.17	-	-	-	0.00	0.17	0.08
40 WAI	0.00	1.00	0.50	0.00	1.67	0.83	-	-	-	0.00	0.83	0.42
41 WAI	0.33	0.17	0.25	0.00	0.00	0.00	-	-	-	0.17	2.50	1.33
42 WAI	0.00	0.00	0.00	-	-	-	-	-	-	2.00	2.50	2.25
43 WAI	-	-	-	-	-	-	-	-	-	1.00	3.00	2.00
44 WAI	-	-	-	-	-	-	-	-	-	2.17	5.00	3.58
45 WAI	-	-	-	-	-	-	-	-	-	0.00	0.00	0.00
Mean	0.14	0.60		0.88	1.22		0.06	0.23		0.80	0.97	
	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)
Lac associated fauna	0.60	0.30	0.21	0.87	0.44	0.31	0.25	0.13	0.09	0.58	0.29	0.21
Spray conditions	0.17	0.09	0.06	0.24	0.12	0.09	0.08	0.04	0.03	N/A	0.09	0.07
Lac associated fauna× Spray conditions	0.85	0.43	0.30	1.24	0.62	0.44	0.36	0.18	0.13	0.82	0.41	0.29

WAI: Week After Inoculation A: Fipronil + Chlorothalonil spray; B: Chlorothalonil spray only

Table 5. Weekly emergence profile of lac associated fauna during summer rangeeni (katki) crop on ber

Period	*T. tachardiae*			*A. purpureus*			*T. clavicornis*			*E. amabilis*		
	A	B	Mean	A	B	Mean	A	B	Mean	A	B	Mean
6 WAI	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-	-
7 WAI	0.00	0.22	0.11	0.22	1.00	0.61	0.00	0.00	0.00	-	-	-
8 WAI	0.33	1.33	0.83	0.11	4.22	2.17	0.11	0.66	0.39	-	-	-
9 WAI	1.44	1.67	1.56	1.00	3.56	2.28	1.11	1.33	1.22	-	-	-
10 WAI	0.56	0.33	0.45	0.22	3.89	2.06	0.11	0.44	0.28	0.00	0.00	0.00
11 WAI	0.33	1.11	0.72	0.11	1.89	1.00	0.11	0.11	0.11	0.00	0.11	0.06
12 WAI	1.00	2.89	1.94	1.22	5.44	3.33	0.22	0.00	0.11	0.11	0.55	0.33
13 WAI	0.89	0.33	0.61	0.89	4.44	2.67	0.00	0.56	0.28	0.22	2.56	1.39
14 WAI	1.11	2.33	1.72	1.33	6.00	3.67	0.00	0.00	0.00	0.66	1.78	1.22
15 WAI	0.56	1.00	0.78	0.22	5.66	2.94	0.00	0.00	0.00	0.33	1.22	0.78
16 WAI	3.33	5.22	4.28	6.00	19.67	12.84	0.33	0.33	0.33	2.11	2.45	2.28
17 WAI	5.22	4.00	4.61	6.22	28.00	17.11	0.67	1.67	1.17	1.22	1.78	1.50
18 WAI	0.89	2.55	1.72	5.22	10.89	8.06	0.00	0.00	0.00	0.00	0.00	0.00
19 WAI	0.89	0.67	0.78	1.22	5.33	3.28	-	-	-	0.11	0.45	0.28
20 WAI	0.33	1.33	0.83	0.00	0.11	0.06	-	-	-	0.11	1.67	0.89
21 WAI	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	0.11	0.78	0.45
22 WAI	-	-	-	-	-	-	-	-	-	0.00	0.00	0.00
Mean	1.06	1.56		1.50	6.26		0.22	0.43		0.38	1.03	
	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)
Lac associated fauna	0.72	0.36	0.25	1.37	0.69	0.49	0.30	0.15	0.11	0.47	0.23	0.16
Spray conditions	0.25	0.13	0.09	0.49	0.24	0.17	0.12	0.06	0.04	0.18	0.09	0.06
Lac associated fauna × Spray conditions	1.02	0.51	0.36	1.94	0.97	0.69	0.42	0.21	0.15	0.66	0.33	0.23

WAI: Week After Inoculation A: Fipronil + Chlorothalonil spray; B: Chlorothalonil spray only

Table 6. Weekly emergence profile of lac associated fauna during summer rangeeni (katki) crop on palas

Period	*T. tachardiae*			*A. purpureus*			*T. clavicornis*			*E. ammabilis*		
	A	B	Mean	A	B	Mean	A	B	Mean	A	B	Mean
6 WAI	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-	-
7 WAI	0.50	0.17	0.33	0.67	1.33	1.00	-	-	-	-	-	-
8 WAI	1.33	2.17	1.75	1.33	1.50	1.42	0.00	0.00	0.00	-	-	-
9 WAI	1.00	0.83	0.92	1.17	0.67	0.92	0.00	0.17	0.08	-	-	-
10 WAI	0.33	2.83	1.58	0.50	6.50	3.50	0.00	2.00	1.00	0.00	0.00	0.00
11 WAI	0.17	1.00	0.58	0.17	2.67	1.42	0.00	0.00	0.00	0.00	0.33	0.17
12 WAI	1.50	3.17	2.33	0.00	1.00	0.50	0.00	0.00	0.00	0.17	5.67	2.92
13 WAI	0.00	0.00	0.00	0.17	2.17	1.17	0.00	0.33	0.17	1.83	6.33	4.08
14 WAI	0.50	1.50	1.00	0.17	1.83	1.00	0.17	0.00	0.08	2.17	4.67	3.42
15 WAI	0.17	0.50	0.33	0.00	1.83	0.92	0.00	0.17	0.08	0.50	0.17	0.33
16 WAI	0.00	0.00	0.00	14.50	14.83	14.67	0.00	0.00	0.00	0.83	0.67	0.75
17 WAI	0.00	0.00	0.00	8.00	8.00	8.00	-	-	-	0.33	0.00	0.17
18 WAI	1.00	1.00	1.00	6.33	6.33	6.33	-	-	-	0.00	0.00	0.00
19 WAI	0.67	0.67	0.67	1.33	1.33	1.33	-	-	-	0.00	0.00	0.00
20 WAI	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	0.00	0.17	0.08
21 WAI	-	-	-	-	-	-	-	-	-	0.00	0.00	0.00
Mean	0.48	0.92		2.29	3.33		0.02	0.30		0.49	1.50	
	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)
Lac associated fauna	0.59	0.29	0.21	1.29	0.64	0.45	0.26	0.13	0.09	0.84	0.41	0.29
Spray conditions	0.21	0.11	0.08	0.47	0.23	0.17	0.12	0.06	0.04	0.34	0.17	0.12
Lac associated fauna × Spray conditions	0.83	0.41	0.29	1.82	0.91	0.64	0.36	0.18	0.13	1.18	0.59	0.41

WAI: Week After Inoculation A: Fipronil + Chlorothalonil spray; B: Chlorothalonil spray only

of November (14.7 and 62.7, respectively) and higher in ber (50.2) during katki crop. Data of different months revealed that the incidence of lac parasitoids and predators was more abundant towards the later stage of development, and this corroborates with the earlier findings of Chowdhury et al. (1971). Populations of lac associated fauna and two spray conditions along with their interactions are significantly different on both ber and palas host plants during katki crops. Jaiswal et al. (2016) studied in vitro assay exposing to residual film of novel insecticides viz., flubendiamide, emamectin benzoate, chlorantraniliprole and fipronil against *A. purpureus*. They found that fipronil showed a quick knockdown response which varied from 67.87- 95.14%, followed by emamectin benzoate, flubendiamide and chlorantraniliprole.

Assessment of parasitization during rangeeni lac crops

Lac insect cells were collected during critical period 17 to 22 WAI and 10 to 14 WAI from field during baisakhi and katki crops and examined under microscope by pricking the cells to assess the level of parasitization. Level of parasitization was recorded more in baisakhi compared to katki on ber (56.6 and 31.6%) whereas in palas, it was more in katki compared to baisakhi (76.7 and 55.8%) crop. In the katki crop, the population of lac associated fauna was more than the baisakhi crop which conforms with observations of Pandey et al. (2008).

The maximum level of parasitization was recorded at the time of sexual maturity period on ber and palas during baisakhi whereas in katki, maximum level of parasitization was at crop maturity period on ber and palas. Srivastava et al. (1984) observed that in the katki crop, level of parasitization hits the highest point at the time of crop maturity which was in conformity with the present findings. The results were also in conformity with the previous study of Mohanasundaram et al. (2016) which reported that, *A. purpureus* alone constituted 100% population during critical/sexual maturity period causing complete lac insect mortality on ber and palas during baisakhi.

Only three parasitoids (*A. purpureus*, *T. tachardiae*, *P. clavicornis*) and one predator *E. amabilis* were abundant in both baisakhi and katki crops. Among the lac associated fauna, *A. purpureus* was recorded more in numbers in crops sprayed with chlorothalonil only compared to fipronil + chlorothalonil. But in earlier studies, many numbers of parasitoids, predators and hyper parasitoids were reported from lac crops. The maximum level of parasitization was recorded at the time of sexual maturity period on ber and palas during baisakhi whereas in katki, maximum level of parasitization was at crop maturity period on ber and palas.

Populations of lac associated fauna were recorded more on lacc rop sprayed with chlorothalonil only compared to fipronil + chlorothalonil on ber and palas during both baisakhi and katki crops.

Sometimes, especially in the baisakhi lac crop, if proper control measures are not taken during the initial crop period, the farmers may face problem of complete failure of lac crop and researchers could not complete population dynamics study of lac crops. Therefore, this study was carried out and also recorded significant differences between two spray conditions (chlorothalonil and fipronil + chlorothalonil) in both lac crops. Scientific lac cultivation should be followed to avoid complete failure of lac crop as well as production of quality broodlac.

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