



ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(7): 3699-3703
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www.thepharmajournal.com

Received: 26-05-2022

Accepted: 30-06-2022

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Comparative studies of life cycle of lac insect, *Kerria lacca* (Kerr) on different host during *Baisakhi* season

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Abstract

The present investigation on “Comparative studies of life cycle of lac insect, *Kerria lacca* (Kerr) on different host during *Baisakhi* season” was carried out in 2021-22 at lac insect gene bank cum garden situated at Department of Entomology, Rajasthan College of Agriculture, Udaipur (Rajasthan). Seven different hosts plants viz; *Ber*, *Palas*, *Flemingia*, Pigeon pea, *Kikar*, Custard apple, *Acacia* sp. were utilized to record the various life cycle parameters of the lac insect. The different parameters of the life cycle of lac insect reveals that the maximum mean initial settlement (118.00 crawlers per sq. cm) and mean final settlement (113.67 crawlers per sq. cm) were recorded on lower portion of the *Ber* host while minimum mean initial mortality of 2.99 per cent was recorded on *Flemingia* sp. on lower portion of the plant and on upper and middle portion of the plant *Ber* host recorded the minimum mean initial mortality of 3.01 and 4.35 per cent of first instar crawlers. The minimum mean duration to male emergence of 97.33 days was recorded on *Ber* at the lower portion with maximum density of cells at maturity i.e. 5.33 female cells per sq. cm at lower portion.

Keywords: Lac insect, *Rangeeni* strain, *Baisakhi* season, settlement density, male emergence, female cells

1. Introduction

Lac is one of nature's gift of immense economic importance to man. It is the only resin of animal origin, being actually the secretion of a tiny scale insect, *Kerria lacca* (Kerr) belonging to the family Tachardiidae (Kerriidae), super family Coccoidea of the order Hemiptera. Two genera and 26 species of lac insects have been observed in India and most common Indian lac insect of commercial importance is *Kerria lacca* (Kerr). Indian lac insect *Kerria lacca* (Kerr) alone contributes more than 80 per cent of total lac production. Though the lac insect culture thrives on shoots of several host trees and more than 400 plant species have been reported worldwide to be the hosts of lac insect (Roonwal *et al.*, 1958; Sharma *et al.*, 1997) [7, 8]. The life cycle of lac insect starts with the emergence of its crawlers, after settlement the nymphs undergo three successive moults to become an adult. The first instar is mobile and crawls over the tender shoot of host trees and settles to feed on phloem sap by piercing its proboscis into phloem region of shoot. (Mohanta *et al.*, 2014) [4]. Lac is cultivated on wide range of host plants viz; *Palas*, *Kusum*, Pigeon pea, *Ber* and Custard apple and is harvested from wide range of available natural host. A complete knowledge of life cycle of lac insect and lac host will bring about impetus to the lac cultivation in southern Rajasthan. Keeping all this in view there is a need to ascertain different life cycle parameters of most prevailing strain i.e. *Rangeeni* strain during *Baisakhi* season.

2. Materials and Methods

The study “Comparative studies of life cycle of lac insect, *Kerria lacca* (Kerr) on different host during *Baisakhi* season” was carried out in 2022 at lac insect gene bank cum garden situated at Department of Entomology, Rajasthan College of Agriculture, Udaipur (Rajasthan). To carry out the present study the brood lac of *Rangeeni* strain was collected from the hosts available in lac insect gene bank and natural hosts prevailing in the region bearing fully matured females. The brood lac was bundled and tied in the month of October-November on host crop at suitable place to provide succulent stem for newly hatched crawlers to settle down. The brood lac bundles were tied on 21 plants, three plants of each seven different hosts plants viz; *Ber*, *Palas*, *Flemingia*, Pigeon pea, *Kikar*, Custard apple, *Acacia* sp. The nymphs were allowed to hatch from mature females and settle for about two weeks.

The observations on the different parameters of life cycle of the *Rangeeni* strain of lac insect population for each host were recorded separately as per the standard procedure prescribed by Mohanta *et al.* (2013) [5] and Mohanta *et al.* (2014) [4].

2.1 Initial density of settlement (Number per square cm)

The initial density of settlement was recorded at 7 days after the inoculation of brood lac from the seven host plants by using magnifying glass and by placing a graph paper with one square cm area cut window on the stem of plant.

2.2 Initial mortality (Per cent)

The crawlers emergence from brood lac continues up to 2-3 weeks. The crawlers which were not able to find suitable sites for settlement die due to starvation. The observation on initial natural mortality per cent were recorded by calculating as follow

$$\text{Initial natural mortality (\%)} = \frac{\text{Initial density} - \text{Density after 21 days of settlement}}{\text{Initial density}} \times 100$$

2.3 Final density of settlement (Number per square cm)

The final density of settlement of crawlers was calculated by the following formula:

Final density of settlement = Initial density of settlement - Initial mortality.

2.4 Percent settlement

The per cent settlement of crawlers was calculated by the following formula:

$$\text{Per cent settlement} = \frac{\text{Final density of settlement}}{\text{Initial density of settlement}} \times 100$$

2.5 Duration of sex differentiation (Days)

The observations on time elapsed between date of inoculation to male and female of lac insect differentiation were recorded for the different hosts.

2.6 Duration to male emergence (Days)

The observations were recorded on date of male emergence initiation to record the duration to male emergence on the different hosts.

2.7 Density at crop maturity (Number per square cm)

To study the density of mature female cells, the numbers of surviving female cells were counted at maturity when the lac crop matures with appearance of yellow spot on female cell by placing of graph paper with one square cm cut window.

2.8 Life period of female (Days)

Time elapsed between date of inoculation and maturity of females showing yellow spot at crop harvesting stage was recorded (in days) as life period of the female cell.

3. Results and Discussion

The results obtained on investigations “Comparative studies of life cycle of lac insect, *Kerria lacca* (Kerr) on different host during *Baisakhi* season 2021-22. Various parameters of life cycle of lac insect have been presented in Table 1-2 and discussed in the light of available literature. The role of developmental parameters on various hosts have been discussed earlier by various workers (Kumar *et al.* 2007, Mohanta *et al.* 2014) [2, 4].

3.1 Initial density of settlement (Number per square cm)

The gravid female lays eggs inside encrustation and first instar larvae hatch out which crawls and settle at suitable sites on succulent stem of host plant. The settlement of the first instar crawlers takes place within a period of a week or two of the hatching. The observation recorded on mean initial density of settlement (Table-1) reveal that the maximum mean initial density of first instar crawler's settlement was recorded on *Ber*, with mean initial density of settlement of 118.00, 115.00 and 110.33 crawlers per sq. cm at lower, middle and upper portion of the plant. *Ber* was observed to be most suitable host for initial settlement of crawlers followed by the *Acacia* sp. and *Palas* host which recorded mean initial settlement of 110.00, 107.00 and 107.33; 109.00, 106.67 and 104.33 crawlers per sq. cm at lower, middle and upper portion of the plant, respectively. The next suitable host were *Flemingia* and Pigeon pea which exhibited the mean initial density of 98.67, 96.00 and 92.67; 95.33, 93.67 and 91.00 crawlers per sq. cm at lower, middle and upper portion of the plant, respectively. Among the seven hosts the minimum mean initial density of crawlers were recorded on *Kikar* and Custard apple on which 81.33, 82.00 and 75.00; 83.33, 80.00 and 76.00 crawlers per sq. cm were recorded at lower, middle and upper portion of the plant, respectively. The results of present investigations are in alignment with the findings of Mohanta *et al.* (2014) [4] who reported that initial density of settlement of crawlers ranged between 105.57-118.32 crawlers per sq. cm of *Rangeeni* strain on *Palas* host during *Baisakhi* season.

3.2 Initial mortality (Per cent)

The first instar crawlers which are unable to find suitable sites for settlement on host plant, could not survive and dies due to starvation within a week or two of its emergence. The observations recorded on mean initial mortality on seven hosts (Table-1) reveal that *Ber* host recorded the minimum mean initial mortality of 3.01 and 4.35 per cent of first instar crawlers at upper and middle portion of the plant; whereas, *Flemingia* recorded the minimum mean initial mortality of 2.99 per cent at lower portion of the plant. The mean initial mortality of first instar crawlers recorded on seven hosts was 3.65, 4.35 and 3.01; 3.63, 5.01 and 4.78; 2.99, 4.85 and 5.36; 3.11, 4.61 and 5.48; 4.03, 8.41 and 7.47; 3.51, 5.85 and 6.53; and 5.44, 4.95 and 4.03 per cent on lower, middle and upper portion of the plant of *Ber*, *Palas*, *Flemingia*, Pigeon pea, *Kikar*, Custard apple and *Acacia* sp., respectively during *Baisakhi* season of 2021-22. The maximum mean mortality on lower portion was recorded on *Acacia* sp. whereas, the maximum mean mortality on middle and upper portion was recorded on *Kikar*. The results of Swami *et al.* (2021) [10] are in conformity with the present results who reported that *Ber* host recorded the minimum mean per cent mortality *i.e.* 8.84 per cent mortality of first instar crawlers and was found superior to all other host. It was at par with *Babool* on which 9.39 mean per cent mortality was recorded, followed by *Palas*, Custard apple, *Flemingia macrophylla* and *Kikar* which recorded 9.51, 9.92, 11.40 and 14.61 per cent mean mortality of first instar crawlers, respectively. While the highest per cent mortality (15.64) was recorded on *Flemingia semialata*. Similarly Kalahal *et al.* (2017) [9] reported that the mortality percentage ranged from 6.46-12.57 per cent in *Rangeeni* strain of lac insect in Pigeon pea crop in *Katki* season.

3.3 Final density of settlement (Number per square cm)

The first instar crawlers after finding a suitable site on host plant settle down and the remaining crawlers which could not find sites for settlement die due to starvation within a fortnight of the emergence from the female cells. The final density of settlement of lac insect which finds space on plant for lac secretion was recorded by subtracting the density of crawlers in initial settlement and initial mortality. The observation presented in Table 1 reveals that the maximum mean final density of crawlers settlement was recorded on *Ber*, with mean final density of settlement of 113.67, 110.0 and 107.00 crawlers per sq. cm at lower, middle and upper portion of the plant. *Ber* was observed to be most suitable host with a higher final settlement of crawlers followed by the *Acacia sp.* and *Palas* host with 104.00, 101.67 and 103.00; 105.0, 101.33 and 99.33 crawlers per sq. cm at lower, middle and upper portion of the plant, respectively and were statistically at par with each other. The next suitable host were *Flemingia* and Pigeon pea which exhibited the mean final density of 95.67, 91.33 and 87.67; 92.33, 89.33 and 86.00 crawlers per sq. cm at lower, middle and upper portion of the plant, respectively and were at par to each other. Among the seven different hosts the minimum mean final density of crawlers were recorded on *Kikar* and Custard apple with 78.00, 75.00 and 69.33; 80.33, 75.33 and 71.00 crawlers per sq. cm at lower, middle and upper portion of the plant and were found statistically at par to each other. Swami *et al.* (2021) [10] also reported that the maximum mean final density of settlement was recorded on *Ber* host *i.e.*, 106.03 crawlers per sq. cm and it was superior to all other host. It was found at par with *Babool* (103.07 crawlers per sq. cm), followed by *Palas* with 89.30 crawlers per sq. cm. The next best host was *Flemingia macrophylla* (80.37 crawlers per sq. cm), followed by Custard apple and *Kikar* which recorded mean final density of settlement of 78.03 and 58.53 crawlers per sq. cm, respectively. While the lowest mean final density settlement was recorded in *Flemingia semialata i.e.* 54.70 crawlers per sq. cm which also supports the findings of the present investigation.

3.4 Per cent settlement of crawlers

The data reveal that the per cent settlement of crawlers was influenced by the type of host. The data recorded on mean percent settlement of lac insect crawlers tabulated in Table 1 reveals that among seven host, *Ber* recorded the maximum mean per cent settlement of 95.65 and 96.99 per cent of crawlers on middle and upper portion of the plant respectively, whereas, *Flemingia* recorded the maximum mean per cent settlement of 97.01 per cent on lower portion of the plant. The mean per cent settlement of crawlers recorded on seven hosts was 96.35, 95.65 and 96.99; 96.37, 94.99 and 95.22; 97.01, 95.15 and 94.64; 96.89, 95.39 and 94.52; 95.97, 91.59 and 92.53; 96.49, 94.15 and 93.47 and 94.56, 95.05 and 95.97 per cent at lower, middle and upper portion of the plant of *Ber*, *Palas*, *Flemingia*, Pigeon pea, *Kikar*, Custard apple and *Acacia sp.*, respectively during *Baisakhi* season of 2021. The present findings are in close conformity with the results of Regar *et al.* (2021) [6] who recorded mean settlement per cent from 88.32 to 92.28 per cent on Pigeon pea in *Baisakhi* season.

3.5 Duration of sex differentiation (Days)

Lac insect after settlement on host undergoes pre-sexual stages before attaining male and female stages which in turn

decides the fecundity and quantity of lac produced. The data presented in Table 2 reveal that the mean duration of sex differentiation of *Rangeeni* strain of lac insect on lower, middle and upper portion of *Ber* host was 46.00, 47.33 and 48.33 days, respectively which was the minimum mean duration of sex differentiation. It was followed by *Acacia sp.* and *Palas* which recorded 53.33, 55.00 and 56.33; 55.67, 57.33 and 59.67 days of sex differentiation on lower, middle and upper portion of the plant, respectively. The next in order for mean duration of sex differentiation hosts were *Flemingia* and Pigeon pea which recorded 57.67, 59.00 and 61.00; 60.33, 61.67 and 62.67 days of sexual differentiation on lower, middle and upper portion of the plant, respectively. The maximum mean duration of sexual differentiation was recorded on *Kikar* and Custard apple with 72.00, 73.67 and 74.00; 68.00, 69.67 and 69.33 days; on lower, middle and upper portion of the plant, respectively during *Baisakhi* season of 2021-22. The results of Swami *et al.* (2021) [10] also confirms the present findings who reported that *Ber* host had lowest mean duration of sex differentiation *i.e.* 48.47 days, while the highest duration of sex differentiation was recorded on *Flemingia semialata* which was 50.07 days. Similarly, Swami *et al.* (2017) [9] reported that the mean duration of sex differentiation lasts 48.36 days from the inoculation of broodlac *Rangeeni* strain of lac insect in Pigeon pea crop in *Katki* season.

3.6 Duration to male emergence (Days)

The male lac insect generally emerges 6-7 weeks after the settlement. The life span of males is very short as it fertilizes the females and dies. The longevity of male lac insects determines the fertilization of females for producing next generation. The results clearly indicate that in normal behavior lac insect takes longer time for male/female differentiation during *Baisakhi* season in comparison to *Katki* season. According to the figure enumerated in Table 2 showing mean duration to male emergence (Days) reveal that the mean minimum duration to male emergence of lac insect on lower, middle and upper portion was recorded on *Ber* host of 97.33, 99.00 and 103.00 days, respectively. It was followed by *Acacia sp.* and *Palas* with 101.33, 103.00 and 104.67; 108.33, 109.67 and 113.67 days on lower, middle and upper portion of the plant, respectively. The host plants next in order of mean duration to male emergence (Days) were *Flemingia sp.* and Pigeon pea with 114.33, 115.67 and 118.00; 115.00, 116.33 and 119.67 days on lower, middle and upper portion of the plant, respectively. The maximum mean duration to male emergence was recorded on *Kikar* and Custard apple with 119.33, 121.33 and 125.00; 117.33, 119.00 and 120.67 days; at lower, middle and upper portion of the plants, respectively. The results are in line with the findings of Mohanta *et al.* (2013) [5] who reported that the mean duration to male emergence was 111 days in *Rangeeni* strain of lac insect during *Baisakhi* season on *Palas (Butea Monosperma)*. The longevity of emerged male of *Rangeeni* strain during the *Baisakhi* season were recorded to be from 2-4 days and was observed that initially wingless form of male emerged and subsequently the winged form of male emerged during the *Baisakhi* season on all the hosts. Jaiswal and Sharma (2011) [3] also observed that longevity of males as only 2 days in *Rangeeni* strain during *Katki* crop which also confirms the result of present finding.

3.7 Density of mature female cells (Number per square cm)

The lac cells are exposed to several biotic and abiotic stresses during life period on the host hence also affect the density of female cells at crop maturity and vary widely from initial density of settlement. The data recorded on mean density of mature female cells per sq. cm tabulated in the Table 2 reveal that the maximum mean density of mature female cells of lac insect on lower, middle and upper portion of different host was recorded on *Ber* having 5.33, 4.33 and 4.00 cells per sq. cm respectively. It was followed by *Acacia sp.* and *Palas* with 4.67, 4.00 and 3.67; 4.33, 3.67 and 3.33 cells per sq. cm on lower, middle and upper portion of the plants, respectively. The next effective hosts were *Flemingia* and Pigeon pea with 4.00, 3.33 and 3.00; 3.67, 3.00 and 2.67 mean mature female cells per sq. cm of mature female on lower, middle and upper portion of the plants, respectively. The minimum mean density of mature female cells was recorded on *Kikar* and Custard apple with 3.33, 2.33 and 2.00; 3.67, 2.67 and 2.33 cells per sq. cm at lower, middle and upper portion of the plants, respectively. The results of present investigation are in full alignment with the findings of Mohanta *et al.* (2014) [4] who also recorded average higher density of female cells at crop maturity as 3.38-12.67 cells per sq. cm on *Palas* plant for *Rangeeni* strain of lac insect.

3.8 Life period of female (Days)

The duration of longevity or life period of female of lac insect depends on various factors such as species, strain, season of development and climatic conditions of area. The total life period for female is longer in *Baisakhi* season as compared to the *Katki* season lac crop. The data recorded on life period for female in days is tabulated in Table 2 reveal that the shortest mean life period for female of lac insect on lower, middle and upper portion was recorded on *Ber* host of 201.33, 205.33 and 219.67 days, respectively. It was followed by *Acacia sp.* and *Palas* with 211.00, 214.00 and 221.67; 215.67, 219.33 and 225.33 days of total life period of female on lower, middle and upper portion of the plants, respectively. The next hosts in order were *Flemingia* and Pigeon pea with 218.67, 224.33 and 227.00; 222.67, 229.33 and 228.67 mean days of life period of female cells on lower, middle and upper portion of the plants, respectively. The longest mean life period of female was recorded on *Kikar* and Custard apple with 228.33, 236.00 and 235.67; 226.67, 234.33 and 231.67 days on lower, middle and upper portion of the plants, respectively. The present result is in conformity with the findings of Mohanta *et al.* (2013) [5] who reported that *Rangeeni* strain on *Palas* (*Butea monosperma*) took 8 month 5 days to complete their life cycle during *Baisakhi* season.

Table 1: Effect of different host on settlement of lac insect (*Rangeeni* strain) during *Baisakhi* season, 2021-22

Lac host	Mean initial density of settlement (per sq. cm)			Mean final density of settlement (per sq. cm)			Mean per cent settlement (%)			Mean initial percent mortality (%)		
	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper
<i>Ber</i>	118.00	115.00	110.33	113.67	110.00	107.00	96.35	95.65	96.99	3.65	4.35	3.01
<i>Palas</i>	109.00	106.67	104.33	105.00	101.33	99.33	96.37	94.99	95.22	3.63	5.01	4.78
<i>Flemingia</i>	98.67	96.00	92.67	95.67	91.33	87.67	97.01	95.15	94.64	2.99	4.85	5.36
Pigeon pea	95.33	93.67	91.00	92.33	89.33	86.00	96.89	95.39	94.52	3.11	4.61	5.48
<i>Kikar</i>	81.33	82.00	75.00	78.00	75.00	69.33	95.97	91.59	92.53	4.03	8.41	7.47
Custard apple	83.33	80.00	76.00	80.33	75.33	71.00	96.49	94.15	93.47	3.51	5.85	6.53
<i>Acacia sp.</i>	110.00	107.00	107.33	104.00	101.67	103.00	94.56	95.05	95.97	5.44	4.95	4.03
SEm±	3.24	1.65	1.81	2.30	1.65	1.27	1.84	2.26	1.81	1.84	2.26	1.81
CD at 5%	6.95	3.54	3.88	4.92	3.54	2.73	3.95	4.86	3.89	3.95	4.86	3.89

Table 2: Effect of different host on life stages of lac insect (*Rangeeni* strain) during *Baisakhi* season 2021-22

Lac host	Mean duration of sex differentiation (Days)			Mean duration to male emergence (Days)			Mean density of mature female cells (per sq. cm)			Mean life period of female (Days)		
	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper
<i>Ber</i>	46.00	47.33	48.33	97.33	99.00	103.00	5.33	4.33	4.00	201.33	205.33	219.67
<i>Palas</i>	55.67	57.33	59.67	108.33	109.67	113.67	4.33	3.67	3.33	215.67	219.33	225.33
<i>Flemingia</i>	57.67	59.00	61.00	114.33	115.67	118.00	4.00	3.33	3.00	218.67	224.33	227.00
Pigeon pea	60.33	61.67	62.67	115.00	116.33	119.67	3.67	3.00	2.67	222.67	229.33	228.67
<i>Kikar</i>	72.00	73.67	74.00	119.33	121.33	125.00	3.33	2.33	2.00	228.33	236.00	235.67
Custard apple	68.00	69.67	69.33	117.33	119.00	120.67	3.67	2.67	2.33	226.67	234.33	231.67
<i>Acacia sp.</i>	53.33	55.00	56.33	101.33	103.00	104.67	4.67	4.00	3.67	211.00	214.00	221.67
SEm±	1.98	1.53	1.62	2.07	1.98	2.38	0.93	0.91	0.64	1.60	2.34	1.41
CD at 5%	4.26	3.29	3.48	4.44	4.26	5.10	1.99	1.95	1.38	3.44	5.03	3.03

4. Conclusion

The Comparative studies of life cycle of lac insect, *Kerria lacca* (Kerr) on different lac hosts prevailing in Southern Rajasthan of arid western plains showed that the most preferred host was *Ber* followed by *Acacia sp.*, *Palas*, *Flemingia*, Pigeon pea, Custard apple, *Kikar*, respectively.

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