Indian Journal of Entomology 85(Special Issue) May 2023: 35-39 eRef. No. NWRABNRG08 DoI. No.: 10.55446/IJE.2023.1157

COLLECTION AND PERFORMANCE OF LOCALLY COLLECTED *KERRIA LACCA* STRAIN ON DIFFERENT HOST PLANTS IN JAMMU REGION

Suheel Ahmad Ganai*, R K Gupta, Kamlesh Bali and Ramandeep Kour

Division of Entomology, Faculty of Agriculture, Main Campus Chatha, SKUAST, Jammu 180009, Jammu and Kashmir, India
*Email: suhail_jalib@yahoo.com (corresponding author): https://orcid.org/0000-0001-6539-474X

ABSTRACT

Explorative surveys were conducted to detect the natural occurrence of *Kerria lacca* in the union territory of Jammu and Kashmir on its natural hosts Ber (*Zizyphus mauritiana*), Palas (*Butea monosperma*), Kikar (*Acacia nilotica*) Khair (*Acacia catechu*) and Pipal (*Ficus religosia*). The natural occurrence of the insect was found to be highly threatened due to summer mortality, parasitism by natural enemies and human interventions. Over the period of survey, a total of 9 strains were recovered and conserved ex-situ in the gene bank. On the basis of productivity linked parameters the 'Gol Market' strain was found to be the most promising in terms of higher initial settlement (172.8 crawlers/ cm^2), lower mortality (43%), greater fecundity (225 larvae per cell) and dense female cells (11.32/ cm^2). Further, this strain was inoculated on three different hosts viz., *Flemingia semialata, Ziziphus mauritiana* and *Butea monosperma* to study the productivity linked parameters. The productivity linked parameters like cell and resin weight (19.83 and 8.15 mg) were also found to be highest in this strain. The data recorded on mean initial and final density of settlement, density at crop maturity, weight of female cell, resin output and fecundity were significantly higher on *F. semialata* followed *by Z. mauritiana* and *B. monosperma*, respectively. Initial mortality (%) showed significant difference among different hosts with minimum mortality of 24.79% on *F. semialata* followed by 46.80% and 71.94% mean mortality on *Z. mauritiana* and *B. monosperma*, respectively.

Key words: *Kerria lacca*, rangeeni, *Flemingia semialata*, *Ziziphus mauritiana*, *Butea monosperma*, productivity linked parameters, lac diversity, ex-situ conservation, lac insects, summer mortality

The lac insect *Kerria lacca* (Hemiptera: Kerriidae) is a scale insect which occurs naturally on various host plants (Vikram et al*.,* 2020). Lac is nature's gift to humankind as it is natural, biodegradable, non-toxic, odourless, tasteless hard resin and non-injurious to health. Since Vedic period, it has been in use in India. Its earliest reference is found in Atherva Veda (Lalita, 2020). In India, the major lac producing states are Jharkhand, Chhattisgarh, Madhya Pradesh, Maharashtra and West Bengal, which contribute around 96% of the total lac production. For tribal populations living around forests, it's a highly remunerative crop, sustaining their livelihood. As a natural bio resource its cultivation and collection add to the foreign exchange to the country through exports (Yogi et al*.,* 2015). It also generates employment for men and women in forest and sub forest areas of Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Maharashtra, Odisha and parts of Uttar Pradesh, Andhra Pradesh, Gujarat and NEH region (Jaiswal et al*.,* 2006). Unfortunately, in the current scenario, the lac insect genetic resources available throughout the country are under threat due to the disappearance of a substantial number of local populations. This is because many lac insects and associated fauna have been abandoned or its habitat destroyed (Mohanta et al*.,* 2014). Its conservation therefore is a serious concern especially in regions where traditional collection and cultivation is practiced. In view of the rapid agricultural change, eroding indigenous stocks and adoption of disrupting farming methods, conservation of lac insect genetic resources is being promoted throughout the country. Areas where climatic extremes or particular parasitic conditions have resulted in unique local stocks which are able to survive under extreme conditions should be a high priority target for conservation. Jammu & Kashmir is one such green zone where conservation efforts are particularly important (Gupta et al*.,* 2020). The exploratory survey for local strains was therefore carried out to conserve and identify the most promising genetic population for future conservation and cultivation.

MATERIALS AND METHODS

Surveys were conducted in various districts of Jammu region namely, Jammu, Samba, Kathua Udhampur, Reasi, Rajouri, Poonch, Ramban, Doda and

Kishtiwar for exploring lac insect (*Kerria* sp.; Kerriidae: Hemiptera) in naturally infected trees in outer plains and mid hill regions from 2017 to 2019. Infested branches were located and detail regarding the same was recorded carefully while marking the specific tree and branch using tags. Data regarding the maturational phase of lac insect and the host trees were noted carefully.

All experimental trials were conducted at Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu (32°39'13" N Lat., 74°48'16" E Long., 300 m asl) which is about 6 km from the city of Jammu.

Plants of *Flemingia semialata* were raised in a nursery for rearing Lac insects for the purpose of conservation. About one thousand seedlings of *F. semialata* were planted and raised in optimum protected natural condition. Broodlac sticks were wrapped in muslin cloth bags and were inoculated on the succulent branches of one year old substitute experimental host i.e. *F. semialata* both in nursery and in pots as well. 'Phunki' were removed after complete emergence and settling of lac insect crawlers on the branches.

The lac insect samples collected from the different lac hosts from different localities were inoculated on *F. semialata* plants at SKUAST- Jammu. After inoculation the emergence and settlement data were recorded for each sample of lac insect on host plants. To prevent the infestation of lac insects with different natural enemies and fungi, different pesticides were sprayed on host plants at different stages of lac insect development. The different strains collected from different areas of Jammu region were screened on the basis of different parameters viz., settlement rate of crawlers, mortality, fecundity, female cells, cell weight and resin weight. On the basis of these parameters the most promising strain was selected for further study.

The present study was carried out in the 'katki' season of 'rangeeni' strain of *K. lacca* on *Flemingia semialata*, *Ziziphus mauritiana* and *Butea monosperma* at lac insect gene bank cum garden situated at Entomological Research Farm, Division of Entomology, SKUAST-Jammu. The broodlac of 'rangeeni' strain was collected from the mature crop prevailing in the region on natural hosts bearing fully matured females. The broodlac were bundled and tied on new host plants to provide succulent stem for crawlers to settle down. The nymphs were allowed to emerge from mature females for about two weeks. After the emergence of newly hatched nymphs the phunki lac stick bundles were removed from host plants. To study the productivity linked parameters of rangeeni strain lac insect on different hosts, the regular observations on productivity linked parameters viz., initial density of settlement, initial mortality, final density of settlement, density at crop maturity, weight of female lac cell, fecundity and yield were recorded on ten plants. Culture method was adopted as per Indian Institute of Natural Resins and Gums (IINRG), Ranchi. The observations were recorded as per the standard procedure prescribed by Mohanasundaram et al. (2016) as detailed below:

The initial density of settlement (number / cm^2) were recorded 7 days after the inoculation of broodlac on 10 tagged plants in each set of plot where one square cm area was selected randomly and numbers of lac crawlers settled were counted visually by using magnifying glass by placing a graph paper with one square cm area cut window on the stem of plant and three such sites were selected at lower, middle and upper part of plant and average was taken as initial density of settlement (number/ cm^2).

Observations on initial density were repeated at 21-days after inoculation of broodlac following the same procedure as described earlier. The process of crawler emergence continues up to two weeks. The crawlers which are not able to find suitable sites for settlement die due to starvation. Observation at this stage is the true indication of the number of crawlers actually settled and that have started feeding. The initial mortality (%) was calculated by the following formula.

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

The final density of settlement (number of crawlers/ cm^2) of crawlers was calculated by the following formula i.e. final density of settlement = Initial density – Initial mortality

To study the density of lac insect at crop maturity (number of female cells/cm^2), the numbers of surviving female cells were counted at maturity when the lac crop matures with the appearance of yellow spot on cell. The number of mature females per square cm was counted by following the procedure of placing a graph paper with one square cm window.

Weight (mg) of individual female lac insect was recorded after completion of larval emergence using electronic balance and the resin produced by an

individual female cell was recorded after removing the dead insect body from cells.

To record the fecundity of lac insect, the mature female cells were placed individually into glass vials plugged with cotton for about a month and the total number of emerged larvae per female were counted and taken as fecundity of the female lac insect.

RESULTS AND DISCUSSION

Selection of promising strain

On the basis of productivity linked parameters, the Gol market strain was found to be the most promising in terms of higher initial settlement (172.8 crawlers/ cm^2), lower mortality (43%), greater fecundity (225 larvae per cell) and dense female cells (11.32/ cm^2), differences being significant with respect to all other strains. The productivity linked parameters like cell and resin weight (19.83 and 8.15 mg) were also found significantly higher in this strain (Table 1).

Initial density of settlement (number of crawlers/ cm^2)

The data recorded on mean initial density of settlement of first instar crawlers showed significant differences with highest settlement rate in *F. semialata* (Table 2). The initial density of crawlers which ranged from 132.0-136.8, 108.4-117.9 and 59.5-67.9 crawlers/ cm^2 with a mean initial density of settlement of 133.23, 112.97 and 65.53 on *F. semialata, Z. mauritiana* and *B. monosperma*, respectively. Kalahal et al. (2017) reported that the initial density of settlement of first instar crawlers varied in different parts of the plant which ranged from 20-121 crawlers per sq.cm. Some researchers have studied the initial density of settlement of larvae in kusmi strain, but no studies on this aspect of 'rangeeni' strain have been revealed by the researchers. However, the results of present investigations are in alignment with the findings of Mohanta et al*.,* (2014) who reported that initial density of settlement of larvae ranged between 92.58-126.74/ cm^2 and 93.12-109.62/ cm^2 of kusmi strain on Kusum and Ber trees respectively.

Initial mortality (%)

The results on initial mortality of first instar crawlers of rangeeni strain of lac insect in 'katki' crop season recorded at 21 days after inoculation of broodlac on *F. semialata, Z. mauritiana* and *B. monosperma* (Table 2)

Table 1. Comparative strain wise productivity linked parameters of lac insect

Population/strain	Settlement rate crawlers/ cm^2	Mortality (%)	Fecundity (Larvae per cell)	Female cells/ cm^2	Cell weight (mg)	Resin weight (mg)
Gol Market	172.8f	43.00a	225.00d	11.32c	19.83c	8.15b
Bantalab	168.3f	44.76a	218.20d	10.98bc	18.81bc	7.67a
Purkhoo	107.5cd	44.98a	193.50c	10.23bc	17.22bc	7.45a
Udheywala	92.8c	53.12b	160.00b	8.08b	13.25b	6.47a
Kathua	123.7d	50.19ab	182.18c	9.31b	15.08b	7.50a
Canal Road	32.9a	70.93c	103.20a	6.54a	9.33a	5.67a
Nagrota	58.5 b	69.43c	101.23a	5.98a	9.04a	5.25a
Cherni Pahari	150.6e	55.23b	150.98b	7.87ab	11.76ab	6.05a
Chi Chi Mata	141.2e	59.08b	163.16b	7.98ab	12.98ab	6.18a

Table 2. Comparative host wise productivity linked parameters of lac insect (pooled)

Productivity linked parameters	Hosts		
	F. semialata	*Z. mauritiana*	*B. monosperma*
Mean initial density of settlement (number per square cm)	133.23c	112.97b	63.53a
Initial mortality (%)	24.79a	46.80b	71.94c
Final density of settlement (number per square cm)	103.39c	66.17b	17.98a
Density at crop maturity (number of female cells per square cm)	14.67c	9.00b	4.50a
Weight of the female cells (mg)	17.56c	14.37b	8.82a
Resin output (mg)	4.61b	4.31b	2.99a
Fecundity (number of young ones produced by the female insect)	315.73c	209.00b	183.10a

revealed significant difference among different hosts with minimum mortality of 24.79% on *F. semialata* followed by 46.80% and 71.94% mean mortality on *Z. mauritiana* and *B. monosperma*, respectively. The results of the present investigation are in agreement with Divakara (2013) who recorded more than 50% mortality on *F. macrophylla*. However, the present results contradict with Swami et al. (2021) who reported *Z. mauritiana* as superior host with 8.84% mortality and *F. semialata* as least preferred host with 15.64% mortality.

Final density of settlement (number/cm^2)

The observations on final density of settlement of first instar crawlers on 10 randomly selected plants of *F. semialata, Z. mauritiana and B. monosperma* are presented in Table 2 and showed significant differences with highest density of settlement on *F. semialata* (103.39) followed by *Z. mauritiana* (66.17) *and B. monosperma* (17.98), respectively in 'katki' season during 2017-2019. The final density of crawlers ranged from 98.73-110.57, 59.65-70.35 and 13.39-23.09/ cm^2, respectively. The mean final density of settlement of first instar larvae was recorded by subtracting the density of larvae in initial and initial mortality (number). The findings of present investigation reveal that maximum final density of settlement recorded was 103.39 crawlers/ cm^2 on *F. semialata*, while minimum final density of settlement of 'rangeeni' strain of lac insect was 17.98/ cm^2 on *B. monosperma* in 'katki' season. The observations made by Divakara (2013) also supports the results of present investigation who recorded maximum density (77.8/ cm^2) of insect settlement in *F. macrophylla* as intercrop with *Dalbergia sisso* at 21 days after inoculation of broodlac.

Density at crop maturity (number of female cells/ cm^2)

The results on average number of female cells per sq.cm of rangeeni strain of lac insect in katki season during 2017-19 presented in Table 2 revealed that the mean density of female cells was 14.67, 9.00 and 4.50/ cm^2 on *F. semialata, Z. mauritiana and B. monosperma*, respectively. The density of female cells ranged from 13-15, 7.4-10.8 and 3.9-5.4/ cm^2 on *F. semialata, Z. mauritiana and B. monosperma*, respectively. The maximum density of female cells of *rangeeni* strain of lac insect on *F. semialata* during katki season recorded during the present investigation was 14.67 cells/ cm^2 and minimum density recorded was 4.50 cells/ cm^2 on *B. monosperma*. The results of present investigation are in full alignment with the findings of Mohanta et al. (2014) who also recorded average density of living female cells at crop maturity as 3.38- 12.67 cells/ cm^2 on palas plant for 'rangeeni' strain of lac insects.

Weight (mg) of the female cell and resin output

The results presented in Table 2 revealed that the mean weight and mean resin output of female cells from *F. semialata* (17.56 and 4.61)*, Z. mauritiana* (14.37 and 4.31) and *B. monosperma* (8.82 and 2.99) showed significant differences. The minimum and maximum mean weight of the female cell recorded was 8.44 mg and 18.98 mg respectively on *B. monosperma*. Similarly, the minimum resin weight of the female cell recorded was 2.12 mg and maximum resin weight of the female cell recorded was 5.56 mg, respectively on *B. monosperma* and *F. semialata*. The present results are in conformity with the findings of Kumar et al. (2007) who evaluated 7 host plants of lac insect with reference to the cell weight and found that it was ranging from 10.12-14.21 mg in ber and 9.40-13.60 mg in pigeon pea (baisakhi). The results of present study are also in full alignment with the findings of Kong et al. (1984) who also evaluated the productivity of Indian lac insect on *F. semialata* and *F. macrophylla* in terms of dry cell weight and recorded 8-19 mg and 9-18.83 mg cell weight on two hosts respectively. The results are in conformity to the findings of Sharma et al. (2007) who studied the resin production efficiency of *rangeeni* strain of *K. lacca* on different hosts and recorded resin weight on *A. auriculiformis* (9.09 mg), followed by *B. monosperma* (8.76 mg), *F. macrophylla* (7.49 mg) and *C. moschata* fruits (6.00 mg).

Fecundity (number of young ones produced by the female insect)

The mature 10 female cells from each plant were kept in separate glass vials plugged with cotton individually up to 1 month duration and emerged crawlers were counted. The results were presented in Table 2 which revealed that the average number of crawlers emerged from female cells of 'rangeeni' strain of lac insect from host *F. semialata, Z. mauritiana and B. monosperma* in 'katki' season during 2017-19 were 315.73, 209.00 and 183.10, respectively and maximum fecundity recorded was 327.50 whereas minimum fecundity recorded was 162.30 crawlers per female, differences being significant. Kong et al. (1984) also reported that the reproductive potential of *Kerria lacca* ranged from 224-307 eggs in 1st generation and 160-240 eggs in 2nd generation. Similarly, the findings of

Mishra et al. (1999) who evaluated the productivity of Indian lac insect on *F. semialata* and *F. macrophylla* in terms of fecundity and found that the fecundity varied from 253-565 and 297-477 crawlers per female cell respectively on the two hosts under study which also confers the results of present investigation.

On the basis of the results recorded in the present investigation and the discussions in the light of the earlier works carried out, it could be inferred that the 'rangeeni' strain of lac insect completes all the stages of life cycle on the *F. semialata, Z. mauritiana* and *B. monosperma* host and thrives well till maturity. The different productivity-linked parameters studies also showed positive results; but its commercial cultivation is not in practice due to lack of knowledge about the biology and host preference of lac insect. Thus, the result of the present findings will not only help in understanding the life stages of lac insect during lac cultivation but will also provide an opportunity for further research in this subject.

ACKNOWLEDGEMENTS

Authors are thankful to the Director, ICAR-IINRG Ranchi and Project Coordinator Network project on Conservation of Lac Insect Genetic Resources (NP-CLIGR) for providing financial assistance.

REFERENCES

Divakara B N. 2013. Exploration of Lac Cultivation on non-traditional host *Flemingia macrophylla* (Willd.) Kuntze Ex Merr and its possibility in under storey plantations of *Dalbergia sisso* Roxb. International Journal of Forest Soil and Erosion 3(4): 129-133.

Gupta R K, Bali K, Ganai S A. 2020. Natural occurrence of lac insect, *Kerria lacca* and its conservation in Jammu and Kashmir. Journal of Entomology and Zoology Studies 8(1): 689-695.

Jaiswal A K, Sharma K K, Kumar K K. 2006. Importance of Lac in the socio-economic life of tribal's in Ranchi District (Jharkhand). Journal of Non Timber Forest Production 13: 47-50.

Kalahal C, Swami H, Lekha. 2017. Productivity-linked parameters of the rangeeni strain Lac Insect, *Kerria lacca* (Kerr) on pigeonpea *Cajanus cajan* Linn. at Rajasthan. Journal of Entomology and Zoology Studies 5(3): 1745-1751.

Kong B O, Hong G J, Yang X C. 1984. Studies on the biology of lac insect *Laccifer lacca* (Kerr) TARG. Chinese Academy of Forestry Sciences 27(1): 70-79.

Kumar A, Kumawat M M, Lekha, Meena N K. 2007. Lac host plants recorded from southern Rajasthan and their relative performance. Entomology 32(2): 129-132.

Lalita. 2020. Lac production technology in India and its role in Indian economy. Journal of Entomology and Zoology Studies 8(4): 1457-1463.

Mishra Y D, Sushil S N, Bhattacharya A, Kumar S, Mallick A, Sharma K K. 1999. Intra -specific variation in host plants affecting productivity of Indian lac insect, *K. lacca* (Kerr). Journal of non Timber Forest Production 6(3/4): 114-116.

Mohanasundaram A, Monobrullah Md, Sharma K K, Meena S C, Ramani R. 2016. Lac insect and associated fauna-A practical manual. ICAR-Indian Institute of Natural Resins and Gums, Ranchi (Jharkhand). 01-42 pp.

Mohanta J, Dey D G, Mohanty N. 2014. Studies on lac insect (*Kerria lacca*) for conservation of biodiversity in Similipal Biosphere Reserve, Odisha, India. Journal of Entomology and Zoology Studies 2(1): 1-5.

Sharma K K, Kumari K, Lakhanpaul S. 2007. Super parasitism in Indian lac insect, *Kerria lacca* (Kerr.) and its implication on fecundity and resin producing efficiency of its two strains. Entomology 32(1): 33-39.

Swami H, Lekha G C, Kumawat K. 2021. Comparative studies of productivity linked parameters of Lac insect, *Kerria lacca* on different lac hosts prevailing in Southern Rajasthan. The Pharma Innovation Journal 10(10): 1338-1341.

Vikram, Lekha, Swami H, Chhangani G, Sharma K. 2020. Bio-efficacy of eco-friendly pesticides against major predators of lac insect, *Kerria lacca* (Hemiptera: Kerriidae). Journal of Entomology and Zoology Studies 8(2): 732-735.

Yogi R K, Bhattacharya A, Jaiswal A K, Kumar A. 2015. Lac, Plant Resins and Gums Statistics 2014: At a glance. ICAR-Indian Institute of Natural Resins and Gums, Ranchi (Jharkhand), India. Bulletin (Technical) 07: 01.

(Paper presented: February, 2021;
Peer reviewed, revised and accepted: April, 2022; Online Published: May, 2023)
Online published (Preview) in www.entosocindia.org and indianentomology.org (eRef. No. NWRABNRG08)