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EXPLORATION OF NATIVE PLANTS OF ASSAM FOR HOST PREFERENCE OF LAC INSECT *KERRIA CHINENSIS*

Tanjil Rahman*, Purnima Das, L K Hazarika[1], Surajit Kalita, K K Sharma[2] and A Mohanasundaram[2]

Department of Entomology, Assam Agricultural University, Jorhat, 785013 Assam, India
[1]Assam Women's University, Jorhat, 785013, Assam, India
[2]ICAR-Indian Institute of Natural Resins and Gums, Ranchi, 834010, Jharkhand, India
*Email: tanjilrahman6766@gmail.com (corresponding author)

ABSTRACT

Field and laboratory experiments were carried out at the Assam Agricultural University, Jorhat during October, 2018 to April, 2019 to study the host plant preference of local lac insect *Kerria chinensis* on eight native plants of Assam viz., *Flemingia semialata, F. strobilifera, Indigofera teysmannii, Ficus religiosa, Zizyphus mauritiana, Litchi chinensis, Hibiscus rosa-sinensis* and *Cajanus cajan*. Results indicated that the maximum productivity of broodlac (0.31± 0.01kg) and longest lifecycle duration (171.92± 2.08 days) was recorded in *F. semialata.* Study on morphological parameters revealed that the girth of the bark of the plants possesses significant negative correlation with the settlement density of crawlers as well as production of lac. However, trichome density of the bark was found to possess positive but non-significant correlation with the settlement density of crawlers as well as production of lac.

Key words: *Kerria chinensis*, Assam, productivity, morphology parameters, native plants, *Flemingia semialata*, trichome density, girth, broodlac, life cycle, settlement density of crawlers, production of lac

Lac insects of *Kerria* spp. have been commercially cultivated since ages for their economically important secretion called lac. It is the only naturally occurring resin of animal origin. The lac insects provide three important by-products *i.e.* resin (65-70%), dye (1%), wax (4-6%) and about 25% insect/ wood debris. India is the leading lac-producer, processor and exporter of lac with an annual production of 18746 mt (Yogi et al., 2018).The lac insect mainly thrives and derives all its nutrition from the sap of succulent shoots of specific plant species, called host plants. The earliest record of lac host plants dates back to Laksha Suktha of Atharva Veda and also in certain ancient Ayurvedic literature. The palas tree has been mentioned as Lakshataru in Sanskrit literature (Krishnaswamy, 1962). Kerr (1782) included four host species viz., *Ficus religiosa* L., *F. indica* L., *F. bengalensis, Butea monosperma* Lam. and *Zizyphus mauritiana* Lam. from Patna, Bihar as the first scientific record of lac host plants. A list of 56 host plants, which include seven common and 49 less common hosts was prepared by Watt (1901). Roonwal et al. (1958) listed 113 hosts; 14 common, 14 occasional and 85 rare hosts from Indian sub-continent (India, Pakistan, and Burma). Another 217 plant species were compiled by Varshney and Teotia (1967) as lac hosts from different parts of the world. Sharma et al. (1997) further added a list of 31 host plants making the total number to about 400 species under 210 genera and 64 families. Lac production is confined to a few Southeast and East Asian countries in the tropical forest region. In the present scenario, lac is a promising source of income nationally as well as internationally because of its various applications. For increased productivity and profitability, proper and efficient use of native lac host plants has to be done. Morphological characteristics are known to contribute to the plant response on insect. Morphology of the plant have effects through their physical interference with the mechanism of host selection, feeding, ingestion, digestion, mating and oviposition (Chiang and Norris, 1983). Hence, knowledge about the role of morphological characteristics of the host plants in host preference will provide us an insight in exploration of more new lac host plants. Keeping this in view, the present study was taken up.

MATERIALS AND METHODS

The evaluation study was done on eight plants viz. *Flemingia semialata* Roxb., *F. strobilifera* (L.) W T Aiton, *Indigofera teysmannii* L., *Ficus religiosa* L., *Zizyphus mauritiana* Lam., *Litchi chinensis* Sonn., *Hibiscus rosa-sinensis* L. and *Cajanus cajan* L. during October, 2018 to April, 2019 at the Regional Lac

Insect Field Gene Bank, Department of Entomology, Assam Agricultural University, Jorhat. The laboratory experiments were carried out in the Department of Entomology and Department of Biochemistry and Agricultural Chemistry, Assam Agricultural University, Jorhat. The experiment was laid out in Randomized Block Design (RBD), with three replications during October, 2018. The gross area was divided into three blocks which was further divided into eight equal plots. An interspacing of 1m each between block and plots was maintained in the experimental area. The native plants were well maintained in the already established Gene Bank of AAU, Jorhat following all the required agronomic package and practices. Lac insects taken for inoculation were collected from broodlac harvested from the previous crop and cut to a length of standard size of 15 cm. Broodlac bundles weighing 80g were wrapped into 60 mesh nylon net pouches and tied with the host plants following the interlaced method of inoculation. The inoculated broodlac bundles (after complete emergence of crawlers from the broodlac) were removed from the host plants after twenty one days.

Observations on biological parameters were taken two or three days after settlement of crawlers, as per standard procedure prescribed by Mohanasundaram et al. (2016). The following biological parameters were chosen for the study- initial density of settlement (no./ cm^2), mortality %, duration of pre sexual stages (days), male emergence, life period of the female cell (days), weight (mg) of individual female, fecundity and total yield (g) of broodlac. Morphological characteristics of the host plants viz., trichome density and girth of the stem were recorded. For recording the trichome density, trichome/ cm^2 from three canopies viz. lower, middle and upper of barks were sampled under a light microscope and replicated thrice. Girth of the plants was measured with the help of a caliper. Data recorded on various parameters were tabulated and subjected to statistical analysis. Treatment significance was tested using 'F' test. The significance among treatment means was judged (p=0.05). RBD was employed for statistical analysis of data for field experiment and CRD for statistical analysis of data for laboratory analysis. A simple correlation analysis was made between the final density of crawler settlement as well as production of lac with the morphological parameters i.e., girth and trichome density.

RESULTS AND DISCUSSIONS

The mean values for initial as well as final density of crawlers' settlement was recorded on the lower, middle and upper part of the native plants and are presented in Table 1. The results indicate that *F. semialata* recorded the highest density of crawler settlement in all the three canopies (96.82, 89.16 and 83.21 crawlers/ cm^2

Table 1. Cawler settlement density and mortality of *K. chinensis* on host plants

Plants	Settlement (crawlers/cm^2)						Mean % mortality/ cm^2		
	Initial			After 21 days of settlement					
	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper
Flemingia semialata	111.68 (82-116)	102.36 (80-105)	99.49 (77-110)	96.82 (77-100)	89.16 (76-96)	83.21 (75-94)	27.69±1.94	23.98±2.04	18.78± 1.04
Flemingia strobilifera	84.66 (70-99)	85.25 (70-87)	78.14 (68-88)	79.01 (62-83)	80.30 (56-83)	75.43 (59-85)	25.70±2.60	22.07±1.01	20.73± 2.00
Indigofera teysmannii	45.98 (42-83)	37.80 (30-76)	29.84 (24-79)	Insect did not survive			43.35±1.07	40.28±1.67	37.87± 0.88
				Insect did not survive					
Ficus religiosa	80.56 (53-90)	75.79 (51-87)	69.26 (57-91)	69.33 (54-80)	67.35 (53-78)	67.23 (49-78)	29.54±2.26	27.46±1.57	24.02± 2.26
Litchi chinensis	73.64 (61-87)	82.21 (55-89)	71.38 (64-82)	72.19 (55-84)	69.64 (58-81)	65.85 (47-86)	25.90±1.91	21.08±1.15	19.46± 2.53
Zizyphus mauritiana	84.18 (75-90)	80.66 (76-99)	80.90 (72-99)	79.71 (65-87)	79.32 (54-79)	79.04 (66-88)	30.89±1.94	29.95±2.76	25.26± 0.82
Hibiscus rosa-sinenesis	82.18 (63-85)	70.81 (49-88)	65.02 (45-79)	80.31 (54-82)	60.69 (49-71)	57.10 (47-75)	24.59±0.72	20.96±1.09	17.76± 1.12
Cajanus cajan	102.12 (81-116)	92.36 (76-99)	95.91 (87-115)	96.21 (79-99)	88.27 (77-93)	82.45 (76-97)	30.63±0.56	30.32±1.47	27.05± 0.39
S.Ed (±)	3.24	2.89	2.61	3.14	2.43	2.66	0.93	0.84	0.83
CD (p=0.05)	6.94	6.21	5.59	6.74	5.22	5.70	1.99	1.81	178

N= 45; Figures within parentheses ranges

in lower, middle and upper canopies, respectively). Initial mortality (%) recorded in upper part was highest in all the host plants. Results drawn from the present study with respect to initial density of settlement as well as mortality were also found to support the records provided by the Indian Lac Research Institute, Ranchi (Anonymous, 1998 and 1999). Kalahal et al. (2017) published an article on the productivity-linked parameters of the rangeeni strain of lac insect, *Kerria lacca* (Kerr.) on pigeonpea, *Cajanas cajan* L. at Rajasthan college of Agriculture, MPUAT in rainy season (katki crop) and reported that the initial density of settlement of first instar crawlers on a plant varied in different parts of plant which ranged from 20-121 crawlers/ cm^2 and with a mean initial density of settlement of 92.60, 84.10, 60.00; 86.70, 91.60, 71.00 and 67.40, 64.70, 61.00 crawlers/ cm^2 at lower, middle and upper parts of plants in three plots. The mean final density of settlement first instar crawlers ranged from 17-114 crawlers/ cm^2 with mean of 85.50, 78.20, 53.10; 80.20, 85.90, 65.00 and 61.90, 57.30, 54.60 crawlers/ cm^2 on lower, middle and upper portion of plant in three plots, respectively. These results for initial density of settlement corroborate the findings of Kalahal (2017), and the data recorded for final density of settlement are in partial agreement. The slight variation in result may be due to difference in season, host plant, strain and species of lac insect inoculated.

The lifecycle parameters i.e. pre-sexual maturity period, duration of male emergence and female longevity (Mean in days± S.E) of *K. chinensis* are presented in Table 2. Data with respect to pre-sexual maturity period reveal that the lac insect attained pre-sexual maturity in all plants within more or less same time duration. The present findings are in agreement with those of Sharma (1991) who also recorded 6 to 7 weeks duration for the cell differentiation in Rangeeni strain of *K. lacca* after its settlement. Male emergence was observed after 6-7 weeks and lasted for about 12-15 days. Significant differences were found in the duration of male emergence among the native plants. Sharma (1991) recorded the male emergence in Rangeeni strain at 6-7 weeks after its inoculation while Jaiswal and Sharma (2011) observed longevity of males as only 2 days in Rangeeni strain during Katki crop. The survival of *K. chinensis* at harvest of the lac crop varied in different host plants; and it took maximum number of days to complete its lifecycle on *F. semialata* (171.92± 2.08 days) and lowest duration on *H. rosa-sinensis* (151.89± 0.44 days). According to Sharma (1991) Rangeeni strain of lac insect took 120-137 days to mature. The mean cell weight recorded showed that the cell weight ranged between 18.66± 0.72 to 33.62± 0.72 mg with maximum weight recorded on *F. semialata* (33.62± 0.72 mg). Female cell weight recorded by Mishra et al. (1999) varied from 8.00 to 19.00 mg on *F. semialata* and 9.33 to 18.83 mg on *F. macrophylla*. Sharma et al. (2007) recorded cell weight (mg) of rangeeni strain with values of 10.94, 8.74, 8.91

Table 2. Lifecycle parameters of *K. chinensis*

Plants	Pre sexual maturity period	Duration of male emergence	Female longevity	Cell weight (mg)	Fecundity	Broodlac yield (kg)	Broodlac ratio (0utput/ input)
Flemingia semialata	49.34±2.62	14.92± 0.66	171.92± 2.08	33.62 (26-38)	304.58 (88-370)	0.31 (0.18-0.32)	4.21:1 (3:1-5:1)
Flemingia strobilifera	46.02±1.58	12.67± 1.46	159.33± 1.39	23.44 (22-35)	270.85 (59-278)	0.27 (0.14-0.29)	3.63:1 (2:1-4:1)
Indigofera teysmannii	Insect did not survive						
Ficus religiosa	47.55± 0.59	14.04± 1.82	158.65±2.25	28.66 (23-33)	279.31 (53-283)	0.29 (0.20-0.31)	3.12:1 (2:1-4:1)
Litchi chinensis	46.50± 0.45	15.17± 0.87	160.46±1.41	18.66 (15-23)	252.26 (60-262)	0.26 (0.19-0.28)	3.58:1 (2:1-4:1)
Zizyphus mauritiana	47.31± 1.81	12.23± 1.08	161.44±3.79	23.17 (20-33)	255.26 (52-266)	0.25 (0.21-0.27)	3.10:1 (2:1-4:1)
Hibiscus rosa-sinenesis	48.59± 2.83	14.40± 0.24	151.89±0.44	24.44 (21-35)	250.59 (38-257)	0.16 (0.14-0.17)	2.14:1 (1:1-3:1)
Cajanus cajan	47.40± 2.32	9.27± 1.13	157.85±2.97	29.04 (26-37)	298.42 (81-309)	0.28 (0.16-0.30)	3.87:1 (2:1-4:1)
S.Ed (±)	0.73	0.55	0.91	0.72	7.74	0.01	0.04
CD (p= 0.05)	1.57	1.18	1.95	1.55	16.60	0.02	0.08

N= 45; Figures within parentheses provide range

and 10.55 mg on *A. auriculiformis, F. macrophylla, C. moschata* and *B. monosperma*, respectively; whereas, cell weight from kusmi and rangeeni strain varied between 19.51 and 10.01 mg. Slight variation of results may be attributed to different host plants, climatic condition, strain and species of lac insect used.

Table 2 depict the data on fecundity, and as per the reports of the Indian Lac Research Institute, Ranchi (Anonymous, 1998 and 1999), fecundity was 276.2-747.6 crawlers/ female which supports the present findings. Mishra et al. (1999) conducted a study on productivity of Indian lac insect, *K. lacca* in terms of fecundity, live cell weight and dry cell weight of mature female lac was evaluated on *F. semialata* and *F. macrophylla*. On *F. semialata*, fecundity varied from 253 to 565 crawlers on *F. semialata*, whereas on *F. macrophylla* it was from 297 to 477. Results of the present study get support from these observations, and data reveal that all the plants showed significant yield of broodlac. Broodlac production capability varies widely due to inter and intra host differences. These were found to be in conformity with Kumar et al. (2007) who conducted a survey evaluating the relative performance of *K. lacca* with respect to productivity parameters on seven host plants. Sharma et al. (2005) found that though a single lac insect (*K. lacca*) has a potential to multiply 250 times in one generation, but the actual seed (broodlac) to yield (lac-produced) ratio is very low which is in contrast with the results of the present study. However, Patel et al. 2014 recorded the broodlac to raw lac ratio was 1:11.40 (T1), 1:8.00 (T2), 1:7.71 (T3) and 1:5.33 (T4) in four treatments while conducting an experiment on comparative performance of kusmi and rangeeni lac on *Zyziphus mauritiana* under conditions of Madhya Pradesh, similar to the present study.

The data on girth measurements as well the trichome density of the host plants *i.e, F. semialata, F. strobilifera, I. teysmannii, F. religiosa, Z. mauritiana, L. chinensis, H. rosa-sinensis, C. cajan* are presented in Table 3. Correlation coefficients shows that the girth of the stem exhibits significant negative correlation (r=-0.935** and -0.892**) with the settlement density of crawlers as well as production of lac. Regression equation y = -29.95x + 90.45 and y = -0.095x + 0.298 expresses the magnitude of the relationship between girth of the stem and settlement density of crawlers as well as production of lac, respectively. The presence or absence of trichomes on the bark of the native plants depicted no significant correlation on the settlement as well as production of lac. Youssef (2015) investigated

Table 3. Morphological characters of bark of plants and association with density of settlement and production of lac by *K. chinensis*

Plants	Girth (cm± S.D.)	Trichome density (trichomes/ cm^2± S.D.)	
Flemingia semialata	0.30± 0.04	226.7± 33.24	
Flemingia strobilifera	0.57± 0.41	133.33± 23.01	
Indigofera teysmannii	3.08± 0.14	4.83± 0.80	
Ficus religiosa	0.75± 0.41	1.23± 1.23	
Litchi chinensis	0.55± 0.19	7.15± 0.64	
Zizyphus mauritiana	0.42± 0.67	2.54± 0.40	
Hibiscus rosa-sinenesis	0.51± 0.06	20.56± 3.42	
Cajanus cajan	0.44± 0.31	59.6± 4.04	
S.Ed(±)	0.15	7.65	
CD (p=0.05)	0.31	16.40	
Association of morphological characters plants vs. density of settlement/ production of lac			
Morphological characters	Statistical parameters	Density of settlement	Production of lac
Girth	R	-0.935**(S)	-0.892**(S)
	Y	y = -29.95x + 90.45	y = -0.095x + 0.298
Trichome	R	0.471 (NS)	0.414 (NS)
	Y	-	-

Data based on three replications/ plant; Sample size- n= 45; r = Pearson Correlation; Y="Expected Y" of regression equation Y=a+bx; *= Significance at p=0.05;**= Significance at p=0.01; S=significant; NS=non-significant

morphological and histological changes in pear trees due to the infestation with *Cacopsylla pyricola* (Foerster) (Hemiptera: Psyllidae) and found that the girth of the stem was less in infested trees than in non infested ones. This finding was found to confirm with the present investigation. Kaushik et al. (2012) reported *K. lacca* is a phytophagous (sap-feeding) insect thriving on mostly woody dicotyledonous plants and suggested that architecture of the plant tissue might be a crucial factor for these sap feeders, because for successful establishment, the insect has to pierce the plant tissue to reach the feeding site, viz., the phloem or the xylem tissue. Simmons et al. (2003) conducted a study on trichomes of *Lycopersicon* spp. and their effect on *Myzus persicae* (Sulzer) (Hemiptera: Aphididae) and established the role of foliar pubescence in resistance to the aphid. Valverde et al. (2001) in a study on the defensive role of leaf trichomes in resistance to herbivorous insects in *Datura stramonium* observed that the leaf trichome density was strongly positively correlated to resistance. Contradictory results were obtained in the present study, and the trichome density was found to possess no role in settlement of the crawlers which might due to dependence of the crawler on stylet penetration rather than trichomes for settlement. However, Bjorkman in 2005 also reported that leaf trichome density do not possess any effect on the efficiency of two polyphagous insect predators, which supports the present observations.

Field and laboratory findings have clearly shown the suitability of some hosts for growth of lac insect *K. chinensis* in preference to others. The various plants experimented upon differed in their ability to maintain and develop the insect, and also in resin secretion and to reproduce a virile insect progeny. Based on all the factors, *F. semialata* was recorded as the best lac growing host for the species of insect under study whereas the insect could not maintain itself on *I. teysmannii*. The other hosts were found to help the insect to build up appreciable quantities of resin and as such can be considered as good hosts. Among morphological characters selected for study, correlation studies showed that the girth of the stem was found to possess significant negative correlation with the settlement density of crawlers as well as production of lac. However, trichome density of the bark showed positive but non-significant correlation with the settlement density of crawlers as well as production of lac. This study has enabled the identification of few hosts for cultivation of lac insect, *K. chinensis* and has provided future scope for further research in this area.

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REFERENCES

Anonymous. 1998. Annual report. Indian Lac Research Institute, Ranchi. p. 31.

Anonymous. 1999. Annual report. Indian Lac Research Institute, Ranchi. p. 22.

Bjorkman C, Ahrne K. 2005. Influence of leaf trichome density on the efficiency of two polyphagous insect predators. Entomologia Experimentalis et Applicata 115: 179-186.

Chiang H S, Norris D M. 1983. Morphological and physiological parameters of soybean resistance to agromyzid bean flies. Environmental Entomology 12: 260-265.

Kerr J. 1782. Natural history of the insect which produces the gum lacca. Philosophical Transactions of the Royal Society of London 2: 374- 382.

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: 1745-1751.

Kaushik S, Pushker, A K, Lakhanpaul S, Sharma K K, Ramani R. 2012. Investigations on some of the important host plants of *Kerria lacca* with reference to phloem distance. Eurasia Journal of Biosciences 6: 32-33.

Kumar A, Kumawat M M, Meena K. 2007. Lac host plants recorded from southern Rajasthan and their relative performance, Trivandrum, India. Entomon 32: 129-132.

Krishnaswami S. 1962. Lac through the ages. A monograph on lac. Mukhopadhyay B, Muthana M S (eds.). Indian Lac Research Institute, Namkum, Ranchi, Bihar, India. 1-13 pp.

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 Products 6: 114-116.

Mohanasundaram A, Monobrullah Md, Meena S C, Ramani R, Sharma K K. 2016. Lac Insect and associated fauna– A Practical Manual. ICAR–Indian Institute of Natural Resins and Gums, Ranchi (Jharkhand), India. Bulletin (Technical) No.14: 1-42.

Patel B, Janghel S, Thomas M, Pachori R, Nema S, Sharma H L. 2014. Comparative performance of kusmi and rangeeni lac on *Zyziphu smauritiana* under conditions of Madhya Pradesh. JNKVV Research Journal 3: 319-328

Roonwal M L, Raizada M B, Chatterjee R N, Singh B. 1958. Descriptive account of the host plants of the lac insect, *Laccifer lacca* (Kerr) and the allied plants in the Indian region (Part 1 & 2), Indian Lac Cess Committee, Ranchi. 140 pp.

Sharma K K. 1991. Laboratory rearing of *Kerria lacca* Kerr on fruit of pumpkin. Current Science 61: 544-545.

Sharma K K, Kumari K, Kumar M. 2005. Analysis of factors responsible for low yield of lac in India. Journal of Applied Zoological Researches 1: 95-96.

Sharma K K, Kumari K, Lakhanpaul S. 2007. Host plant mediated variations in resin producing efficiency of Indian lac insect, *Kerria lacca* (Kerr.) (Homoptera: Coccoidea: Tachardiidae). Entomon 32: 203-207.

Sharma K K, Ramani R, Mishra Y D. 1997. An additional list of host plants of lac insects. *Kerria* spp. (Tachardiidae: Homoptera). Journal of Non Timber Forest Products 4: 151-155.

Simmons A T, Gurr G M, Mc Grath D, Nicol H I, Martin P M. 2003. Trichomes of *Lycopersicon* spp. and their effect on *Myzus persicae* (Sulzer) (Hemiptera: Aphididae). Australian Journal of Entomology 42: 373-378

Varshney R K, Teotia T P S. 1967. A supplementary list of the host-plants of lac insects. Journal of the Bombay Natural History Society 64: 488-511.

Valverde P L, Fornoni J, Nunez-Farfan J. 2001. Defensive role of leaf trichomes in resistance to herbivorous insects in *Datura stramonium.* Journal of Evolutionary Biology14: 424-432.

Watt G. 1901. *Tachardia* (*Carteria*) *lacca*, Kerr (Syn. *Coccus lacca*); Lac (lakh) and the lac industries. Agricultural Ledger (Ent) 9: 181-343.

Yogi R K, Kumar A, Singh A K. 2018. Lac, plant resins and gums statistics 2016: At a Glance. ICAR-Indian Institute of Natural Resins and Gums, Ranchi (Jharkhand), India. Bulletin (Technical) No. 19: 1-80

Youssef A S. 2015. Morphological and histological changes in pear trees due to the infestation with *Cacopsylla pyricola* (Foerster) (Hemiptera: Psyllidae). Egyptian Journal of Agricultural Research 94: 17-21.

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