Indian Journal of Entomology 84(1): 24-28 (2022) DoI.: 10.55446/IJE.2021.29

BROODLAC QUALITY ASSESSMENT AND FORECASTING OF CRAWLER EMERGENCE IN INDIAN LAC INSECT *KERRIA LACCA*

Mohanasundaram A*, Sharma K K, Verma Sweta, Anees K[1] and Mishra Rashmi

ICAR- Indian Institute of Natural Resins and Gums, Ranchi 834010, Jharkhand, India
[1]ICAR- Indian Institute of Spices Research, Kozhikode 673012, Kerala, India
*Email: mohaniinrg@gmail.com (corresponding author)

ABSTRACT

Assessment of quality and freshness of broodlac produced by the Indian lac insect *Kerria lacca* (Kerr) is an important parameter in its pricing. The present study provides an assessment of broodlac quality with 25, 50, 75 and 100% of lac encrustation harvested from summer (baisakhi), rainy (katki) on palas, winter (aghani) on ber, and summer season (jethwi) on kusum. The curve fitting model based on the rate of weight reduction can be used for prediction of freshness. Among the four lac crops, maximum rate of reduction was observed with summer kusmi (jethwi) and rangeeni (baisakhi) crops, and a good quality of broodlac was observed with katki crop on palas. Crawler emergence, stages of yellow spots and number of days for actual crawler emergence varied in different seasons. The present study differentiates the embryonic development into six stages with yellow spots through microscopic images. This reveals that the stage 1 coincides with earlier defined stage 2 and 3, and stage 2, 3, 4 and 5 are of stages 4, 5, 6 and 7 and 8, respectively.

Key words: *Kerria lacca*, broodlac, freshness, lac encrustation, crawler emergence, forecast, yellow spot, baisakhi, jethwi, katki, aghani, palas, ber, kusum, model, weight reduction, embryonic development, yellow spots, stages

Indian lac insect *Kerria lacca* (Kerr) is broadly distinguished as two strains i.e. kusmi and rangeeni which differ by host preference, lifecycle pattern, the quality and amount of lac produced. In case of two crops of kusmi strains are: summer season/ Jethwi (harvested in June/July) and winter season/ Aghani (harvested in January/ February) while that of Rangeeni, are: rainy season/ Katki (harvested in October/ November) and summer season/ Baisakhi (harvested in May/ June). Quality of brood used is an important criterion for raising the lac crop, as it affects the yield significantly. This broodlac quality is influenced by a number of factors such as predator population in the brood, degree of parasitization (Chowdhury et al., 1971), thickness of encrustation, extent of settlement, choice of the host plant on which lac grows and various climatic factors like temperature, rainfall, humidity, wind etc. (Nicholsan, 1925). Of the climatic factors, temperature is most important affecting broodlac production (Bhagat and Mishra, 2002; Sharma, 2007). Beside this, productivity and broodlac quality is also influenced by the pest incidence that includes lepidopteron predators viz., *Eublemma amabilis* Moore and *Psuedohypatopa* (*Holcocera*) *pulverea* Meyr. and an array of species of parasitoids. It is estimated that associated harmful fauna causes 50% loss (Malhotra and Katiyar, 1979).

Encrustation thickness is also an important parameter to evaluate the broodlac quality. Assessment of quality and freshness of broodlac is crucial to control its pricing and yield of next crop. It is related to density of living females and thus a good indicator of number of lac larvae/ unit brood weight/ length. Male population varies greatly depending upon level of crowding (Purkayastha and Krishnan, 1964) and even with site of inoculation. Biological parameters *viz.*, yield of resin, fecundity, sex ratio varied significantly both quantitatively and qualitatively (Mishra et al., 2000). Studies on broodlac quality in relation to thickness of host branch and lac encrustation are documented (Ghosal et al., 2011). Ghosal and Meena (2019) also reported that many factors influence the quality of broodlac viz., source of broodlac, % coverage by encrustation, and compactness of encrustation. Besides maintaining good broodlac quality, the knowledge of crop maturity and forecast of larval emergence has special importance in lac cultivation. Early harvested lac crop results in under developed or weak first instar larvae that die soon whereas late harvested lac crop results in quick emergence of larvae so that the farmer does not get sufficient time to inoculate other trees (Jaiswal and Sharma, 2010). The knowledge of crop maturity and forecast of crawler emergence has special

importance in lac cultivation. Therefore, this study using different quality of broodlac for quality assessment and to devise an accurate method for forecasting of crawler emergence.

MATERIALS AND METHODS

Study was undertaken using the both strains (rangeeni and kusmi), with different quality of broodlac depending on the degree of lac encrustation, from palas, ber and kusum viz., 25 (T_1), 50 (T_2), 75 (T_3) and 100% (T_4) lac encrustation, harvested during baisakhi 2015-16 and 2016-17 (palas), katki 2015 and 2016 (palas), aghani 2015-16 and 2016-17 (ber) and jethwi, 2016 and 2017 (kusum) for two consecutive years. Equal quantities (1 kg) of broodlac were taken from the four categories of treatments in the Borosil glass beaker and covered with muslin cloth and kept for crawlers emergence. The broodlac was observed for weight reduction and quantity of crawler emergence on daily basis up to one month. Forecast study was conducted using both strains (rangeeni and kusmi) in different crop seasons (baisakhi, katki, aghani and jethwi) for two years, i.e. 2015-16 to 2016-17. Lac insect female cells were collected and grouped into six stages (Stage 0, 1, 2, 3, 4 and 5) based on appearance of yellow spot. Images of female cell with yellow spot appearance were taken and developing embryo in the mother cells was observed under microscope. Time lag relation (in days) between initiation and number of days for crawler emergence were analyzed statistically and different stages of yellow spot appearance were correlated with embryonic development and actual crawler emergence for improved and accurate forecasting. The study was conducted in the Genetics and Breeding Laboratory at ICAR-Indian Institute of Natural Resins and Gums, Namkum, Ranchi. Data of two years were pooled for statistical analysis using techniques of ANOVA (Panse and Sukhatme, 1967). Data of forecasting of crawler emergence was analyzed by one factor while the data of broodlac quality assessment study were analyzed by two factor ANOVA in complete randomized block design (CRBD) using OPStat Package. The significance among treatment means were judged by critical difference (CD, p=0.05).

RESULTS AND DISCUSSION

Broodlac quality study with different quality of broodlac viz., 25, 50, 75 and 100% lac encrustation harvested from baisakhi, katki on Palas, aghani on ber and jethwi on kusum revealed significant difference in crawler emergence. Maximum lac crawlers (1.69 and 0.49 g) emerged on 4th day after harvesting (DAH) of broodlac in T_4 (100 %), respectively followed by 5th and 6th DAH of broodlac in T_3 (75 %) and T_2 (50 %). Among the four treatments, maximum crawlers (2.84 g crawlers) emerged in T_4 (100 %) followed by T_3 (75 %), T_2 (50 %) T_1 (25 %). Crawler emergence started from 2nd DAH and continued up to 25th DAH of broodlac. Most of the crawlers emerged up to 16th days after harvesting of broodlac. Crawler emergence varied from 0.48 to 1.69, 0.13 to 0.37 and 0.01 to 0.09 gram during 1 to 7, 8-16 and 17-25 days, respectively of kusum broodlac during jethwi crops. In Aghani crop, lac crawlers emerged significantly more (1.13 g) on 10th DAH of broodlac followed by 6th and 9th DAH of broodlac. Quality of broodlac was poor in baisakhi crop than other three lac crops based upon emergence of crawlers. Crawler emergence started from 3rd DAH of broodlac and maximum quantity of crawlers recorded up to 10th DAH of broodlac. Similarly, for katki crops crawler emergence started from 3rd DAH of broodlac and continued up to 26th DAH of broodlac. Crawler emergence varied from 0.01 to 0.57 g between 13 to 26th DAH of broodlac. Maximum quantity of lac crawlers (1.12 g) were collected on 11th DAH of broodlac followed by 12th (1.11 g) and 10th (0.95 g) DAH of broodlac during katki crops. Quality of broodlac was good based upon more quantity emergence of crawlers (1.84 g) as recorded in katki crops (Table 1). Ghosal et al. (2011) found that diameter (thickness) of 85% of lac sticks of host were within the range 0.5-0.8 cm in case of kusum trees; lac sticks with diameter of 0.6 to 0.8 cm produced good quality broodlac and also found that thickness of broodlac encrustation was the most important factor for lac insect settlement. Ghosal and Meena (2019) observed that length of lac insect settlement was 73% and reduced significantly due to long hours of transportation and poor packaging, leading to poor broodlac quality.

To address the freshness assessment of the broodlac, the rate of weight reduction was taken as an index. Rate of reduction in weight in categories viz., 25, 50, 75 and 100% lac encrustation was calculated and observed that in kusum (2.72, 2.86, 3.44 and 3.59%/ day with R^2 value of 0. 94, 0.96, 0.95 and 0.92, respectively); and in jethwi crops, ber (1.16, 1.29, 1.55 and 1.59 %/ day with R^2 value of 0.95, 0.90, 0.95 and 0.86, respectively) during aghani crops, palas (2.42, 2.01, 1.63 and 2.03%/ day with R^2 value of 0.88, 0.90, 0.84 and 0.92, respectively) during baisakhi crops and palas (1.31, 1.24, 2.08 and 1.90%/ day with R^2 value of 0.87, 0.90, 0.82 and 0.75, respectively) during katki crops

Table 1. Crawler emergence of different quality of broodlac in different season

Days	Quality of broodlac on different host plant																			
	Kusum during Jethwi					Ber during Aghani					Palas during Baisakhi					Palas during Katki				
	25	50	75	100	Mean	25	50	75	100	Mean	25	50	75	100	Mean	25	50	75	100	Mean
1	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	
2	0.15	0.46	0.76	1.43	0.7															
3						0.02	0.09	0.14	0.11	0.09	0.06	0.07	0.12	0.14	0.1	0.55	0.86	1	1.26	0.92
4	0.62	1.35	1.94	2.84	1.69	0.04	0.22	0.34	0.49	0.27	0.05	0.07	0.21	0.16	0.12					
5	0.59	0.82	1.43	1.73	1.14						0.04	0.11	0.17	0.22	0.13	0.28	0.42	0.71	1.11	0.63
6	0.42	0.83	1.24	1.57	1.02	0.57	0.56	1.11	1.3	0.88	0.18	0.34	0.36	0.54	0.35	0.3	0.35	0.62	0.85	0.53
7	0.23	0.47	0.54	0.69	0.48	0.59	0.42	0.78	0.76	0.64	0.05	0.14	0.17	0.19	0.14					
8	0.2	0.35	0.53	0.41	0.37	0.58	0.54	0.81	1.15	0.77	0.1	0.11	0.09	0.12	0.11	0.52	0.58	0.93	1.45	0.87
9	0.14	0.21	0.38	0.27	0.25	0.63	0.76	0.71	1.32	0.86										
10	0.08	0.26	0.26	0.19	0.2	0.61	0.92	1.07	1.94	0.13	0.05	0.09	0.08	0.22	0.11	0.53	0.49	1.14	1.63	0.95
11	0.11	0.16	0.24	0.23	0.19						0.02	0.03	0.02	0.03	0.03	0.66	0.85	1.35	1.61	1.12
12	0.07	0.1	0.16	0.2	0.13	0.34	0.54	0.63	1.16	0.67	0.02	0.01	0.01	0.01	0.01	0.28	0.94	1.17	2.05	1.11
13	0.08	0.12	0.19	0.18	0.14	0.35	0.64	0.74	1.24	0.74	0.01	0.01	0.01	0.01	0.01	0.15	0.26	0.53	1.15	0.52
14	0.09	0.1	0.12	0.14	0.11	0.08	0.16	0.17	0.3	0.18	0.01	0	0.01	0.01	0.01	0.24	0.36	0.59	1.07	0.57
15						0.07	0.1	0.06	0.25	0.12	0.01	0.01	0	0	0.01	0.15	0.25	0.4	0.59	0.35
16	0.12	0.1	0.14	0.2	0.14	0.05	0.08	0.05	0.19	0.09	0.01	0.01	0.01	0.01	0.01					
17	0.05	0.09	0.1	0.12	0.09						0	0.01	0.01	0.01	0.01	0.11	0.17	0.37	0.44	0.27
18	0.04	0.08	0.08	0.09	0.07											0.1	0.13	0.21	0.38	0.2
19	0.04	0.07	0.06	0.09	0.07	0.05	0.07	0.08	0.13	0.08										
20	0.04	0.09	0.06	0.1	0.08											0.05	0.12	0.12	0.17	0.11
21	0.04	0.05	0.05	0.09	0.06	0.01	0.01	0	0.04							0.04	0.04	0.07	0.07	0.06
22						0.01	0	0	0.02							0.01	0.04	0.06	0.05	0.04
23	0.01	0.01	0.08	0.12	0.06															
24	0	0.01	0.01	0.05	0.02															
25	0.01	0	0.01	0.01	0.01											0.01	0.03	0.04	0.04	0.03
26																0	0.01	0.02	0.02	0.01
Mean	0.14	0.26	0.38	0.49		0.22	0.28	0.37	0.58		0.04	0.06	0.08	0.1		0.22	0.33	0.52	0.77	
	A	B	A×B			A	B	A×B			A	B	A×B			A	B	A×B		
C.D	0.039	0.039	0.185			0.057	0.121	0.243			0.011	0.021	0.042			0.09	0.191	0.382		
SE(m)	0.02	0.047	0.094			0.02	0.043	0.087			0.005	0.011	0.021			0.046	0.097	0.193		

*A- Quality of broodlac; *B –Days; *C- Quality of broodlac (A)× (B)

(Figs. 1 to 4). The study also revealed that the rate of reduction in broodlac weight became near constant after 11, 15, 10, 14 days during jethwi, aghani, baisakhi and katki crops, respectively. This curve fitting model based on the rate of weight reduction can be used for prediction of freshness of broodlac. Time lag relation (in days) between initiation of crawler emergence and different stages of yellow spots varied greatly. Number of days for actual crawler emergence also varied in different seasons. The number of days for actual crawler emergence was maximum during aghani season crop for stage 0 (18.80± 2.62) as the crop maturity time (January/ February) falls during winter months. During katki season crop, the lowest number of days was observed for actual crawler emergence in different stages of

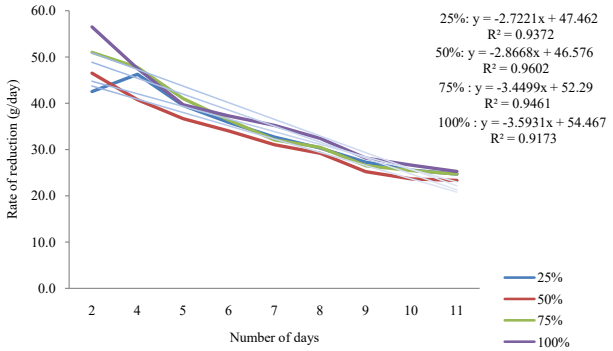

Fig. 1. Weight reduction vs quality of kusum broodlac (jethwi crop)

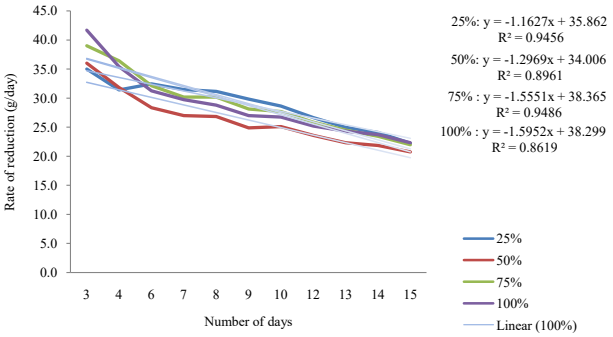

Fig. 2. Weight reduction vs quality of ber broodlac (aghani crop)

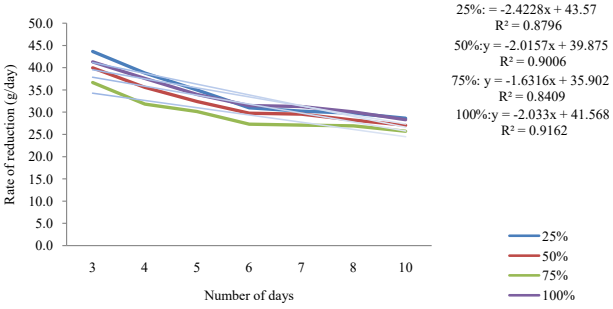

Fig. 3. Weight reduction vs quality of palas broodlac (baishaki crop)

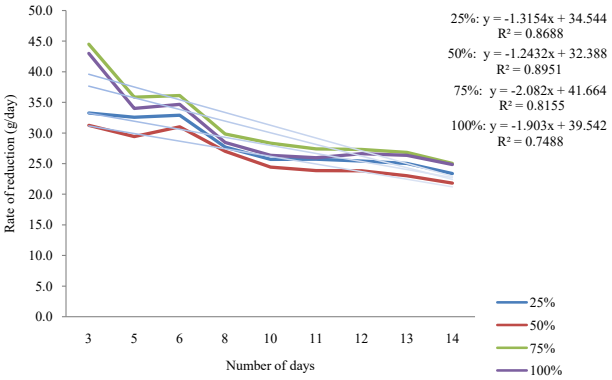

Fig. 4. Weight reduction vs quality of palas broodlac (katki crop)

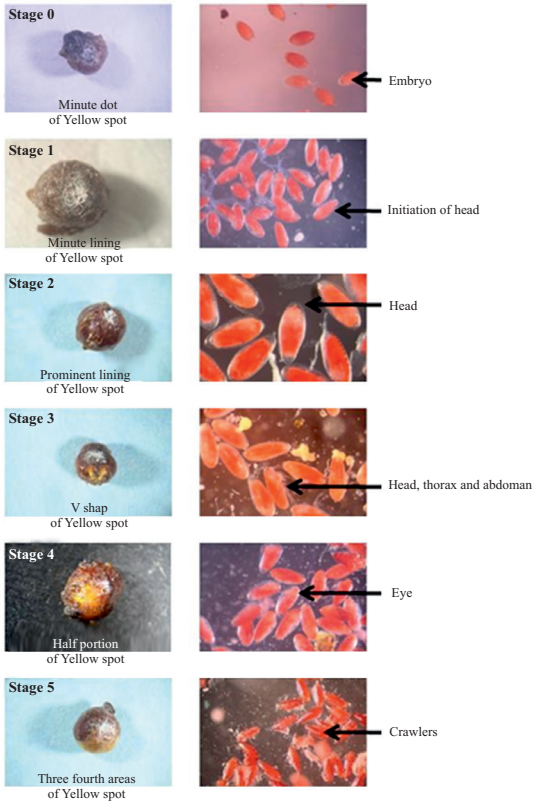

Fig. 5. Stages of yellow spots and embryonic development of lac crawlers

Table 2. Time lag correlation - stages of lac insect vs. no. of days taken before initiation of crawler emergence

Stages	No. of days taken before initiation of crawler emergence			
	Baisakhi	Katki	Aghani	Jethwi
Stage 0	13.13± 3.06	9.33± 1.60	18.80± 2.62	11.24± 1.82
Stage 1	6.97± 1.29	7.14± 1.08	13.12± 2.22	8.89± 1.87
Stage 2	5.45± 1.63	6.33± 1.56	12.28± 1.52	6.50± 2.56
Stage 3	3.90± 1.06	4.53± 0.99	5.30± 1.42	5.33± 1.66
Stage 4	2.67± 0.74	2.84± 0.88	4.91± 1.33	3.85± 1.09
Stage 5	1.68± 0.43	1.39± 0.40	1.93± 0.66	1.30± 0.50
C.D.	0.82	0.547	0.806	0.892
SE(m)	0.294	0.196	0.289	0.319

yellow spots that varied from 9.33± 1.60 (stage 0) to 1.39±0.40 (stage 5) due to short duration (four months) of lac crop (Table 2).

Different stages of embryonic development and female cell with yellow spot appearance are depicted in Fig. 5. Elongated embryos were observed at stage zero and initiation of head begins by Stage 1. Head of the embryo was distinctly visible and body formation began in stage 2. Head, thorax and abdomen were clearly visible in stage 3. The eyes became distinct at stage 4. Fully developed crawlers which were enclosed by a membrane were clearly visible at Stage 5. Previous study of embryonic development by Jaiswal and Sharma, (2010) reported nine stages of embryonic development and yellow spots in hand drawn diagram whereas in present study embryonic development is differentiated into six stages and yellow spots through microscopic images. Present study of stage 1 coincides with earlier study of stage 2 and 3. Similarly, stage 2, 3, 4 and 5 are as like in stage 4, 5, 6 and 7 and 8 of previous study by Jaiswal and Sharma (2010).

Lac insect crawler emergence profile is directly related to quality of broodlac. Broodlac which harbors very less quantity of crawlers due to lesser encrustation and/or high pest infestation will have direct impact on next crop productivity. In the present study, good quality of broodlac reported during katki season on palas. The curve fitting model based on the rate of weight reduction can be used for prediction of freshness of broodlac samples. Among the four lac crops, maximum rate of reduction in weight of broodlac was calculated in summer kusmi (jethwi) and rangeeni (baisakhi) crops than kusmi winter (aghani) and rangeeni rainy (katki) season crop**.** Beside this, as all the lac cells even on the same twig are not found in the same stage of development, results of this study revealed that the broodlac used for next season inoculation should be harvested from tree after cells have reached at least the stage 4 in baisakhi, katki and jethwi whereas in aghani should be harvested in stage 5 (when crawler emergence starts) as depicted in photographic image developmental stage. It would result in maximum emergence of crawlers without affecting the vitality of majority of the insects and their young ones resulting in better performance and higher lac yield.

ACKNOWLEDGEMENTS

The authors thank the Director, ICAR- Indian Institute of Natural Resins and Gums, Ranchi for providing facilities. This work was financially supported by Network Project on Conservation of Lac Insect Genetic Resources, Indian Council of Agricultural Research, New Delhi.

REFERENCES

Bhagat M L, Mishra Y D. 2002. Abiotic factors affecting lac productivity. Kumar K K, Ramani R, Sharma K K (eds.). Recent advances in lac culture. pp.64-68. Indian Lac Research Institute, Namkum, Ranchi.

Chowdhury M K, Sen P, Bhattacharya A. 1971. Studies on the relationship between the density of lac insect, *Kerria lacca* (Kerr) (Homoptera: Coccidae) and chalcid parasitization. Indian Journal of Entomology 33(2): 180-182.

Ghosal S, Meena S C. 2019. Factors affecting lac insect settlement. Indian Forester 145(12): 1212 -1213.

Ghosal S, Ramani R, Mishra Y D. 2011. Influence of thickness of branch, *phunki* scrap weight, weighted living cell and *kusmi* encrustation thickness on broodlac quality. Annals of Entomology 29(1): 1-5.

Jaiswal A K, Sharma K K. 2010. Forecast of larval emergence and crop harvesting. K K Sharma, R Ramani (eds.) recent advances in lac cultures. ICAR-Indian Institute of Natural Resins and Gums, Ranchi, pp. 57-62.

Malhotra C P, Katiyar R N. 1979. Chemical control of the lac predator *Eublemma amabilis* Moore II. Relative toxicity of the various insecticides against the predatory caterpillars. Indian Journal of Entomology 41: 187-190.

Mishra Y D, Sushil S N, Bhattacharya A, Kumar S. 2000. Variability in lac productivity and related attributes of *Kerria* spp. (Homoptera: Tachardiidae) on Ber (*Z. mauritiana*). Journal of Entomological Research 24(1):19-26.

Nicholson J W. 1925. Some notes on lac cultivation. Indian Forester 51(10): 483-498.

Panse V G, Sukhatme P V. 1967. Statistical methods for agricultural workers. 2nd Edn. ICAR New Delhi. 381 pp.

Purkayastha B K, Krishnan Y S. 1964. Determination of optimum amount of broodlac requirement for crop inoculation and proper time of harvesting for maximizing yield on palas in *baisakhi* season. Indian Agriculture 8: 55-60.

Sharma K K. 2007. Lac insect-host plant interaction: Implications on quantity and quality of lac. Bhattacharya A, Jaiswal A K, Prasad N, Pal G (eds.). Model training course on advanced lac production, storage and application technology for employment and income generation. Indian Lac Research Institute, Namkum, Ranchi. pp. 41-48.

(Manuscript Received: December, 2020; Revised: March, 2021;
Accepted: March, 2021; Online Published: July, 2021)
Online published (Preview) in www.entosocindia.org Ref. No. e20423