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Influence of thickness of branch, *phunki* scrap weight, weighted living cell and *kusmi* encrustation thickness on broodlac quality

by

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Abstract

Lac, a bio-degradable natural resin is obtained from lac insect (*Kerria lacca* Kerr.). Quality broodlac should be ensured for production of lac crop. Two experiments were conducted at Regional Field Research Station, Purulia and Institute Research Farm, Ranchi during 2006 and 2008 respectively, to identify factors governing production of quality broodlac. Results indicated 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. In another experiment it was visualized through regression analysis that thickness of broodlac encrustation is the most important factor governing settlement of lac insect, followed by *phunki* (empty broodlac) scrap weight and weighted living cell weight.

Key words:Kerria lacca, lac encrustation, shoot diameter

Introduction

Indian lac insect (*Kerria lacca*) is broadly distinguished as two strains *i.e. kusmi* and *rangeeni*. *Kusmi* lac insect thrives on *kusum* trees and *rangeeni* insect on *palas* trees, while *ber* tree can sustain both the strains of insect.

Kusmi broodlac is mostly produced from *kusum* and *ber* trees. Since *kusmi* broodlac production in summer season is difficult on *ber* trees, *Kusum* tree is assumed to be a dependable source for *kusmi* brood production, in general.

For raising the lac crop, quality of brood used is an important criterion as it governs yield significantly. Brood quality can be influenced by a number of factors such as predator population in the brood, degree of parasitization (Chaudhury *et al*, 1971), thickness of encrustation, extent of settlement, size of twig on which lac grows etc.

Encrustation thickness is related to density of living females and thus a good indicator of number of lac larvae per unit brood weight/ length. Male population varies greatly depending upon level of crowding (Purkayastha and Krishnan, 1964) and even with site of inoculation. The proportion of males in lac insect is normally around 30%. But it can vary markedly. Thus if the proportion of male is high, then number of females per unit area will be reduced leading to less larval output. Similarly, if size of female cell is less then the larval output also decreases accordingly. The present study was undertaken to assess the brood quality in relation to thickness of host branch and lac insect encrustation, in order to develop a non-destructive methodology for broodlac quality assessment.

Materials and Methods

Two separate experiments were conducted for the study and details are given below.

A. Broodlac quality in relation to host branch thickness (diameter)

In 2006, 144 *phunki* (empty broodlac) sticks (0.4-1.0 cm thickness) from broodlac of winter crop (*aghani*) of *kusum* trees were collected from farmers' field at Regional Field Research Station of the Institute at Purulia and were stratified into six class intervals (0.4-0.49, 0.5-0.59, 0.6-0.69, 0.7-0.79, 0.8-0.89 and 0.9-1.0 cm thickness) for thickness of host twig carrying broodlac (Table 1). Whole lot of *phunki* was divided into good, medium and bad quality based on visual observation as per following criteria.

1. Good *phunki* : Brood possessed coverage of encrustation throughout the lac stick (80-100% coverage) and encrustation being smooth.
2. Medium quality *phunki*: Brood possessed coverage on one side of lac stick (40-80% coverage), encrustation being rough or smooth.
3. Bad quality *phunki*: Brood possessed sporadic coverage and rough encrustation (< 40% coverage).

Frequency of occurrence of *phunki* and mean encrustation thickness under each class were worked out separately under good, medium and bad quality brood.

B. Broodlac quality in relation to lac insect parameter

For assessing the quality of brood lac, 27 bundles of *kusmi* brood each weighing 100 g were inoculated on *ber* trees during winter season (*aghani*) of 2008 at Institute Research Farm, Ranchi. All the *phunki* were collected and *phunki* scraped weight of stick of each bundle was grouped separately under good, medium and bad quality (as stated above) and data on different parameters (*phunki* scrap weight, weighted mean of encrustation thickness and weighted living cell weight) were recorded and computed for statistical analysis.

Average *phunki* encrustation thickness was calculated for each group under each bundle. Based on thickness of encrustation, under each group and weight of respective group (good, medium and bad) weighted thickness of bundle was worked out as per following formula for proper comparison of insect settlement in respect to encrustation thickness.

$$W\,M\,T = \frac{\sum_{i=1}^{n} W_i T_i}{\sum W_i}$$

W and T are weight and thickness of *phunki* scrap, respectively

W.M.T: Weighted Mean Thickness of encrustation

Since broodlac is heterogeneous for the quality, living cell weight (LCW) of each bundle was calculated by multiplying living cell percentage of each fraction (good, medium and bad) of bundle and corresponding *phunki* scrap weight as estimated by sampling method (by counting number of living cells out of total cells on the exposed surface of the broken encrustation). The estimate gives an average figure of the bundle pertaining to living cell weight. Living cell weight (LCW) was estimated by the formula given below.

$$L.C.W = \sum_{i=1}^{n} L_i W_i$$

Where, L_i = living cell % of respective fraction of encrustation, W_i = weight of encrustation of respective fraction

For evaluating performance of each bundle, lac settlement was also recorded in the corresponding inoculated branches. Frequency distribution of length of settlement and other parameters is given in Table 3. Multiple regression was worked out assuming the length of settlement as dependent variable and other three variables as independent variable.

Results and Discussion

Results of the first experiment showed that 85% *phunki* sticks fall within the diameter range of 0.5-0.8 cm. Good and bad quality *phunki* were observed to be associated with branches of 0.6-0.8 cm and 0.5-0.7 cm diameter, respectively, while the same for medium quality *phunki* was found to be broader *i.e* 0.5-0.8 cm. Good quality brood always showed a tendency to have higher encrustation thickness as compared to other two qualities and the mean encrustation thickness for three types of brood were computed to be 0.56, 0.47 and 0.41 cm respectively. The study throws light on optimal branch thickness for good broodlac production. Thus, *kusum* trees with maximum number of branches of 0.5-0.8 cm diameter would produce best quality broodlac.

Results of the second experiment described the importance of thickness of lac encrustation in production of broodlac. Brood value of any broodlac is best judged by the length of settlement of the larvae emerged there from. Total *phunki* scrap weight is directly proportional to amount of resin secreted by the lac insect. The better the growth of lac insect the better will be resin production which will also reflect on fecundity of the insect. As a result, length of settlement increases.

Correlation coefficient between different parameters has been worked out (Table 2). All the three correlation coefficients between length of settlement, *phunki* scrap weight, weighted encrustation thickness and weighted living cell weight were found significant. Range of variation in thickness is very narrow *i.e*. 0.41- 0.58 cm which could be the reason for having relatively lesser coefficient values though it emerged to be the most important factor in regression analysis.

An effort was also made to establish relationship between length of lac settlement with respect to *phunki* scrap weight, weighted encrustation thickness and weighted living cell weight through regression analysis. Following equation was obtained through multiple regressions.

$Y= 6.06X_1+2.85X_2+1373.45X_3 -334.4$ (with R-square value 0.27)

Y= Lac insect settlement (cm); X_1= Total *phunki* scrap weight (g); X_2= Weighted living cell weight (g); X_3= Weighted encrustation thickness (cm)

The equation suggested that thickness of broodlac encrustation was the most important factor governing settlement of lac insect followed by *phunki* scrap weight and weighted living cell weight.

The gravid females are full of eggs. Quantum of living lac larvae is governed by living cell percentage in the encrustation. The more the living cell percentage in an encrustation, the better will be production of lac larvae. Similarly, fecundity of lac insect is dependent on the size of the cell which, in turn is proportional to the cube of increase in thickness of the encrustation (as volume is proportional to the cube of radius of the sphere). As a result, a marginal increase in lac cell diameter will lead to increase in production of lac larvae tremendously which in turn influence settlement significantly. Higher cell size of lac insect is associated with higher encrustation thickness and increased fecundity due to increased size of lac cell has already been documented by Chauhan (1967) and Mazumder *et al* (1968). Besides, Gokulpure and Mehra (1971) confirmed that fecundity of lac insect is directly proportional to the size of lac female insect.

Since significant correlation existed between total *phunki* scrap weight and weighted living cell weight (Table 2), step down methodology was adopted to slash down number of factors with a minimum sacrifice of R^2 values.

Stepwise, following equations were obtained.

$Y= 8.37X_1+1564X_2-440.03$ (R^2 value 0.26)

$Y= 13.53X_1 + 136.94$ (R^2 value 0.21)

$Y= 2549.62X_3 – 585.39$ (R^2 value 0.21)

Therefore, weighted living cell weight can be excluded to be a factor, as R^2 value is least affected. Out of the rest two factors, each is having similar weightage in predicting settlement. Since, prediction through measuring encrustation thickness is non-destructive, it can be adopted before inoculation for broodlac quality assessment

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Table 1: Phunki stick thickness (diameter) and kusmi brood quality

Class interval of *phunki*stick thickness (cm)	*Phunki* with 80-100% coverage		*Phunki* with 40-80% coverage		*Phunki* with < 40% coverage	
	Frequency	Mean encrustation thickness	Frequency	Mean encrustation thickness	Frequency	Mean encrustation thickness
0.4- 0.49	1	0.61	3	0.41	5	0.41
0.5-0.59	6	0.6	18	0.5	19	0.49
0.6- 0.69	15	0.63	16	0.48	16	0.5
0.7-0.79	15	0.55	18	0.51	3	0.25
0.8- 0.89	3	0.38	0	—	2	0.4
0.9- 1.0	4	0.6	0	—	0	—

Table2: Correlation coefficient between different parameters

	Length of settlement (cm)	Total *phunki* scrap wt (g)	Weighted encrustation (thickness cm)	Living cell wt (g)
Length of settlement (cm)	1			
Total phunki scrap wt (g)	0.461*	1		
Weighted Encrustation thickness (cm)	0.459*	0.623*	1	
Living cell wt (g) (weighed)	0.419*	0.635*	0.529*	1

*Significant at 5% level

Table2: Frequency distribution of length of settlement and associated parameters of broodlac

Length of settlement (cm)			Mean *phunki* scrap wt (g)	Mean weighted Encrustation thickness (cm)	Mean weighted living cell wt (g)
Class interval	Number	Mean			
0-250	2	170 (35.5)	40.5 (3.5)	0.45 (0.01)	21.28 (15.3)
251-500	2	437.5 (31.8)	24.5 (24.7)	0.47 (0.06)	17.6 (18.5)
501-750	10	591.7 (46.4)	41.2 (4.3)	0.51 (0.04)	29.8 (7.8)
751-1000	10	862.9 (90.7)	46.1 (6.5)	0.51 (0.05)	35.7 (20.5)
1001-1250	2	1079 (45.2)	46 (5.6)	0.53 (0.01)	37.6 (6.8)
1251-1500	1	1353	55	0.55	41.2

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