The Bioscan 10(2): 661-666, 2015
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

PREDATOR MANAGEMENT OF TWO DIFFERENT STRAINS (*KUSMI* AND *RANGEENI* LAC) OF *KERRIA LACCA* (KERR) ON *ZIZYPHUS MAURITIANA*

BHAGIRATH PATEL, SANDEEP JANGHEL* AND MONI THOMAS
Directorate of Research Services, Jnkvv Jabalpur - 482 004, Mp
e-mail: sandeepthkr43@gmail.com

KEYWORDS
Lac cell
Predators and
Parasitoids
Pesticides

Received on :
16.11.2014

Accepted on :
07.04.2015

***Corresponding author**

ABSTRACT
The predator management of two different strains (*Kusmi* and *Rangeeni* lac) of *Kerria lacca* (Kerr) on *Zizyphus mauritiana* was studied in the field of 10 lac growers in Kachana village Barghat Block, Seoni District, Madhya Pradesh, from July 2012 to December 2012. A combination of two sprays of Cartap hydrochloride and Mancozeb (T_1 and T_3), Control (Lac growers practices *i.e.,* no use of pesticides) T_2 and T_4. Were the two set of treatments in both Lac strains. Application of pesticides reduced predator infestation in both strains over Lac growers practices. *Rangeeni* strain was more susceptible parasitoids than the *Kusmi* even in pesticides treatment. Pesticide applications significantly reduced the mean number predators and parasitoids infested lac cells at harvest per 30 cm sticklac. It was in (44.00) in case of T_4 followed by T_3 (29.50), T_2 (22.50) and T_1 (20.50) at harvest.

INTRODUCTION

Lac production induces stress on the host plant (Thomas *et al.,* 2012, Ghosh *et al.,* 2014). Resin, wax and lac dye obtained from lac is of commercial importance (Kapoor, 2002, Ghosal, 2013). The mean annual lac production in India from 2007-08 to 2011-12 was 16,249 metric tons (Meena *et al.,* 2014). Madhya Pradesh is the third largest producer of lac in the India (Sharma and Jaiswal, 2011, Thomas, 2011) and Seoni district is the largest producer in MP (Thomas *et al.,* 2010a, Ramani *et al.,* 2010).

In recent times, *Baisahki* lac production in Seoni is experiencing a low production (Thomas, 2010b). Among the production constraints identified, biotic stress due to three major predators of *K lacca* predators of *Eublemma amabilis*, *Psuedohypatopa pulverea* and *Chrysopa spp*. are predominant (Ramesh, 2013, Khobragade *et al.*, 2012a). Yield losses of lac due to predators have been reported widely (Jaiswal *et al.,* 2008). The loss varied from 30 to 40 per cent (Jaiswal *et al.*, 2008, Khobragade *et al.*, 2012b).

Among the chemical pesticides recommended for management of these predators are Dichlorvos, Cartap hydrochloride and Ethofenprox, Endosulfon and Cartaphydrochloride. (Singh *et al.,* 2009). Application of pesticides Insecticides Cartap hydrochloride and Emamectin benzoate are safer for population density of *K. lacca* and increases the Brood lac production per plant and its reduces the avoidable loss by 26.19 per cent in case of Emamectin benzoate and 12.67 per cent in Cartap hydrochloride over control (Janghel *et al.,* 2014 a). Insecticide application on *Katki* lac crop reduced the incidence of *E. amabilis* and *P. palverea* by 90 and 86.18 per cent (Janghel *et al.,* 2014b). Lac grower prefers to spend money for good returns (Tewari, 1994). Unfortunately predator management is not followed in Seoni, as a result *Kusmi* and *Rangeeni* lac produced on *Zizyphus mauritiana* in Seoni district suffers heavy economical loss hence the present study was under taken to know the bio-efficacy of pesticides against predators of *K. lacca* and percent reduction in predator infested lac cells.

MATERIALS AND METHODS

The present research work was carried from July 2012 to December 2012 in Kachana village Barghat Block, Seoni District, Madhya Pradesh.

Location of study area

Seoni district lies Agro-climatically in Zone IV (Kymore Plateau and Satpura Hill Zone) of Madhya. Seoni has an geographical area of 8758 sq km, and is located between 21º35´ and 22º58' N latitudes and 79º12' and 80º18´ E longitudes, 756m above sea.Only 43.22 per cent of the total land is under agriculture, of which only 11.93 per cent has assured irrigation.

Kachana village has a geographical area of 397.08 ha, of which 338.17 ha is under cultivation. The village with a population of 1885 has 165 Lac growers .There about 2000 *Z. mauritiana* and 3000 *Butea monosperma* trees in the village. The annual Lac production in the village is about 71q *Baishaki* crop of *Rangeeni* lac constitute 55q .The village lies in Barghat development Block of Seoni district.

Experimental details

The study was planned under RBD, with 10 replications (10 lac growers) and four treatments. The details are the mentioned in Table 1

Criteria for selection of

Lac growers

Lac growers having *Z mauritiana* trees in their field and willing to participate in the research were selected for the study.

Trees

Z mauritiana trees, which are over five years old, healthy, pruned and possessing sufficient succulent branches were selected for the study.

Operations

There were the following four major operations during the experiment (Table 2).

Broodlac inoculation

The process of Brood lac inoculation had following three operations

Brood inoculation

Transfer of crawling larvae of *K lacca* from brood lac to branches of host trees is known as Brood lac inoculation (BLI). Healthy Broodlac weighing 500 to 600 g were used per *Z. mauritiana* tree. Depending on the size of the tree, the brood lac were divided into six to seven bundles and inoculated between 19th July to 22nd July 2012 on identified *Z mauritiana* trees.

Shifting

The Broodlac bundles were shifted carefully to different branches on the same tree after 7- 8 days of its inoculation. This was to ensure uniform distribution of the brood on branches where there was no or insufficient lac larval settlement.

***Phunki* removal**

Larvae (crawlers) of lac insect from Broodlac settled on the tree in three weeks from the date of its inoculation. Once the crawlers leave the broodlac and settle on the twigs of the host, the remains of the Broodlac bundle is called *Phunki*. *Phunki* is infact sticklac. *Phunki* usually consists of predators, was removed after 21 days of Broodlac inoculation and scrapped to recover raw lac, and in this process the predators were removed.

Spraying of pesticides

Application of pesticides for predator management is an essential process in the Lac production.

Equipment and items

The spraying operations were carried by Foot sprayer. Plastic bucket, drum, face mask, goggles and soap were other items that were used during the spraying operations.

Preparation of pesticides solution

The solution of pesticides were prepared by adding its desired quantity (1g of Cartap hydrochloride per litre of water + 1g Mancozeb per litre of water) in a small container followed by brisk stirring with a piece of stick. This concentrate solution obtain was further diluted with clean water to make the spray solution.

Spraying

Two persons operated the Foot sprayer, one pumped the peddle of the foot sprayer while other holding the lance of the sprayer sprayed the solution on the *Z. mauritiana* tree.

Spraying schedule

Spraying of pesticides was carried out at 30 and at 65 days after Broodlac inoculation.

Harvesting of sticklac

At maturity the sticklac was harvested on 6th November' 2012 in case *Rangeeni* and 18th December' 2012 in case *Kusmi* for estimation of lac yield.

Observation were recorded from

2.5sq cm. of lac insect settlement on branches

5 randomly selected lac insect settled branches per plant the observations recorded following schedule mentioned in the Table 3.

RESULTS AND DISCUSSION

Mean number of parasitoid infested lac cell at 90 days after BLI

Two applications of pesticides significantly reduced the infestation of parasitoid infected lac cell on both *Kusmi* and *Rangeeni* lac on *Ber* over the control T_2 and T_4 at 90 days after BLI (Table-4).

At 90 days after BLI, the incidence of parasitoids was significantly higher in *Rangeeni* over *Kusmi*. There was significantly less incidence of parasitoids (0.68/2.5sq cm) in case of treatment (T_1) over T_2 (0.92) i.e. lac growers practice. In case of *Rangeeni* lac there was significantly less incidence parasitoids (1.16/2.5sq cm) in case of treatment (T_3) over T_4 (1.58) i.e. lac growers practice.

Among the pesticides treatment, in case of *Rangeeni* lac (T_3) there were 41.37 percent more parasitoid infested cell over *Kusmil* lac (T_1). Among the growers practices also the percent of parasitoid infest cell were more 41.77per cent in case of *Rangeeni* lac (T_4) over *Kusmi* lac (T_2) . This indicates that *Rangeeni* lac is more susceptible to parasitoid infestation.

Parasitization during rainy season crop, fecundity and resin production capability of strains i.e. *Kusmi* and *Rangeeni* strain of *K. lacca* were adversely affected (Sharma and Ramani, 2001, Kumari *et al.*, 2012).The extent of parasitization varied between 15.5 per cent in summer season (*Baisakhi*) crop to 18.6 per cent in rainy season (*Katki*) crop of *Rangeeni* strain. While for *Kusmi* strain it was 19.04 per cent in winter season (*Aghani*) crop and 22.8 per cent in summer season (*Jethwi*) crop. Thus as the number of parasites in each cell increases, a correspondence decrease in fecundity count was noticed (Kumari *et al.*, 2012)

Mean number of predator and parasitoids infected lac cell at harvest per 30 cm sticklac

Pesticide applications significantly reduced the mean number predators and parasitoids infested lac cells at harvest. It was in (44.00) in case of T_4 followed by T_3 (29.50), T_2 (22.50) and T_1 (20.50) at harvest. The mean number of predators and parasitoids infested lac cell was significantly higher in *Rangeeni* over *Kusmi*.

Table 1: Details of the Experiment

Host trees	*Ber* (*Z. mauritiana*)
Design	R.B.D.
Number of Lac growers	10
Number of treatments	4
Number of *Z mauritiana* trees per treatment	1
Total number of *Z mauritiana* trees/grower	4
Treatment details	
T_1	*Kusmi* lac - with two sprays of Cartap hydrochloride + Dithane M-45 (at 30 and 65 day after BLI)
T_2	*Kusmi* lac - control (Lac growers practices i.e., no use of pesticides)
T_3	*Rangeeni* lac - with two sprays of Cartap hydrochloride + Dithane M-45 (at 30 and 65 day after BLI)
T_4	*Rangeeni* lac - control (Lac growers practices i.e., no use of pesticides)

*BLI-Brood lac inoculation

Table 2: Details of major operations

S. No.	Operations	Period
i.	Broodlac inoculation	19th to 20th July'2012
ii.	Date of *phunki* removal	8th to 10th August'2012
iii.	Date of 1st Spraying of pesticides	19th to 20th August'2012
iv.	Date of 2st Spraying of pesticides	29th to 30th September'2012
v.	Harvesting of sticklac	6th November'2012 (R),18th December '2012 (K)

R = *Rangeeni* lac, K = *Kusmi* lac

Table 3: Details of observations and its schedule

S.no.	Observation	Scale	Period
A. Pre-harvest			
a.	Predator/parasitoids count	2.5 sq. cm succulent branch *	Before harvest
B. Post-harvest			
a.	Predator/parasitoids count	2.5 sq. cm succulent branch *	Oct to Dec 2012
b.	Predators/parasitoids infected cell count	30 cm of stickLac	Nov-Dec 2012
c.	Predators/parasitoids infected cell	Weight(g) of infected cell /30 cm of stickLac	Nov-Dec 201
d.	Predators/parasitoids count	30 cm of stickLac	Nov-Dec2012
e.	Cost of pesticide application	Per tree	

* 5 branches/plant; Data recorded on various aspects were tabulated and subjected to statistical analysis by using the techniques of analysis of variance (Panse and Sukhatme., 1967).

Table 4: Mean number of parasitoids infested lac cell 90 days after BLI

Lac growers (Replication)	Mean no. of parasitoids per 2.5sq cm			
	Kusmi lac		*Rangeeni* lac	
	T_1	T_2	T_3	T_4
R_1	0.6	0.8	0.8	1.2
R_2	0.6	0.8	1.0	1.6
R_3	0.6	1.0	1.0	1.8
R_4	0.6	0.8	1.2	1.6
R_5	0.8	1.0	1.4	1.8
R_6	0.8	0.8	1.2	1.4
R_7	0.6	1.0	1.4	1.6
R_8	0.8	1.0	1	1.4
R_9	0.6	1.0	1.2	1.6
R_{10}	0.8	1.0	1.4	1.8
Mean	0.68	0.92	1.16	1.58
CD 5%	0.12			
SEm ±	0.04			

In *Kusmi* lac there was no significant difference in the mean number of predators and parasitoids infected lac cells among T_1 and T_2. In case of *Rangeeni* lac there was significantly less mean number predators and parasitoids infested lac cell (22.50) in case of treatment (T_3) over T_4 (44.00) i.e. lac growers practice.

Pesticide applications significantly reduced the mean number predators and parasitoids infested lac cells per 30 cm at harvest. In case of treatment 5.66 per cent more infested cell T_3 over T_1 and 28.00 per cent more in case of untreated T_4 over T_2.

Janghel *et al.,* 2014b reported that pesticide application in *Raneeni* lac of *Katki* crop significantly reduced the mean number of predators and parasitoid infected lac cell per 30 cm of stick lac at harvest it was highest (26.20) in control, comparatively low 14.47 in case of Emamectin benzoate + Mancozeb and (13.17) Cartap hydrochloride + Dithane M-45.

Bhattacharya *et al.,* 2004 reported that the larval stages of two Lepidopteran predators, *E. amabilis* and *P. pulverea* predate on different stages of the lac insect and are responsible for a cumulative average crop damage of 30 to 40 per cent and 35.31 per cent in MP (Khobragade *et al.,* 2012b). Bhattacharya (2011) reported that *E. amabilis* feeds on the lac larvae and spins a loose web. A single predator is capable of destroying 45 to 50 mature lac cells. In another study Mehra (1965) reported the ability of *C. madestes* to destroy the whole *Kusmi* lac crop as its first, second and third instar larvae can destroy up to 20, 24 and 74 mature females of lac insect per day.

Mean weight (g) of predators per parasitoids infected cell at harvest

There was no significant difference in the mean weight (g) of predators and parasitoids infected cell at harvest per 30 cm of sticklac in T_1 and T_2 case of *Kusmi* lac but in case of *Rangeeni* lac it was significant. The mean weight (g) of predators and parasitoids infected cell was highest in case of T_4 (1) followed by T_2 (0.72), T_1 (0.53) and T_3 (0.53).

Weight (g) of predators and parasitoids infected cell at harvest per 30 cm of sticklac in case of treatment 8.88 per cent more T_3 over T_1 and 32.95 per cent more in case of untreated T_4 over T_2.

Table 5: Mean number of predators and parasitoids infected lac cell at harvest

Lac growers (Replication)	Mean no. of predators/parasitoids infected lac cell			
	Kusmi lac	*Rangeeni* lac		
	T_1	T_2	T_3	T_4
R_1	15.0	25.0	25.0	30.0
R_2	30.0	30.0	30.0	60.0
R_3	25.0	35.0	10.0	30.0
R_4	25.0	25.0	20.0	20.0
R_5	15.0	30.0	20.0	75.0
R_6	20.0	25.0	25.0	50.0
R_7	20.0	30.0	25.0	30.0
R_8	15.0	35.0	20.0	25.0
R_9	20.0	40.0	20.0	60.0
R_{10}	20.0	20.0	30.0	60.0
Mean	20.50	29.50	22.50	44.00
CD 5%	9.72			
SEm ±	3.35			

Management of predator of lac

Application of pesticides significantly reduced the incidence of predators *E. amabilis* and *P. pulverea* in both the strain (*Kusmi* and *Rangeeni*) of lac over the lac growers practice.

Mean number of predators count per at 30 cm of sticklac at harvest

Mean number of *E. amabilis* per 30 cm of sticklac during scraping more infestation in *Kusmi* over *Rangeeni*(Table- 7). There was significantly more infestation of *E. amabilis* (4.0) in case of T_2 over T_1 (1.45) i.e. *Kusmi lac* with two sprays of Cartap hydrochloride + Dithane M-45 (at 30 and 65 day after BLI). In case of *Rangeeni* lac there was significantly more infestation *E. amabilis* (1.45) in case of Rangeeni lac with two spray of Cartap hydrochloride + Dithane M-45 (at 30 and 65 day after BLI).

Table 6: Mean weight (g) of predators/parasitoids infected cell at harvest

Lac growers (Replication)	Mean weight of predators/parasitoids infected lac cell			
	Kusmi lac		*Rangeeni* lac	
	T_1	T_2	T_3	T_4
R_1	0.38	0.52	0.81	0.8
R_2	0.82	0.58	0.52	1.39
R_3	0.68	0.72	0.17	0.74
R_4	0.59	0.85	0.46	0.4
R_5	0.34	0.67	0.79	1.22
R_6	0.47	0.77	0.36	1.3
R_7	0.69	0.68	0.56	0.95
R_8	0.48	0.87	0.49	0.77
R_9	0.53	0.98	0.38	1.13
R_{10}	0.34	0.58	0.5	1.3
Mean	0.53	0.72	0.50	1.00
CD 5%	0.21			
SEm ±	0.07			

Table 7: Mean number of *E. amabilis* per 30 cm of sticklac during scraping

Lac growers (Replication)	Mean number of *E. amabilis* per 30 cm of sticklac			
	Kusmi lac		*Rangeeni* lac	
	T_1	T_2	T_3	T_4
R_1	1(1.22)	2(1.58)	1(1.22)	2(1.58)
R_2	0(0.71)	3(1.87)	2(1.58)	1(1.22)
R_3	0(0.71)	2(1.58)	0(0.71)	1(1.22)
R_4	0(0.71)	2(1.58)	0(0.71)	1(1.22)
R_5	1(1.22)	1(1.22)	0(0.71)	2(1.58)
R_6	2(1.58)	2(1.58)	1(1.22)	0(0.71)
R_7	0(0.71)	3(1.87)	1(1.22)	0(0.71)
R_8	1(1.22)	3(1.87)	0(0.71)	1(1.22)
R_9	2(1.58)	2(1.58)	0(0.71)	0(0.71)
R_{10}	1(1.22)	2(1.58)	1(1.22)	0(0.71)
Mean	1.45(1.98)	4.00(2.97)	1.09(1.82)	1.45(1.98)
CD 5%	0.49			
SEm ±	0.16			

*Figures in parenthesis are square root ("x + 0.5) transform values

Table 8: Mean number of *P. pulverea* per 30 cm of sticklac during scraping

Lac growers (Replication)	Mean number of *P. pulverea* per 30 cm of sticklac			
	Kusmi lac		*Rangeeni* lac	
	T_1	T_2	T_3	T_4
R_1	0(0.710)	0(0.71)	0(0.71)	1(1.22)
R_2	1(1.22)	2(1.58)	0(0.71)	2(1.58)
R_3	0(0.71)	1(1.22)	0(0.71)	0(0.71)
R_4	1(1.22)	1(1.22)	1(1.22)	2(1.58)
R_5	1(1.22)	2(1.58)	2(1.58)	1(1.22)
R_6	0(0.71)	3(1.87)	0(0.71)	3(1.87)
R_7	1(1.22)	1(1.22)	0(0.71)	1(1.22)
R_8	2(1.58)	3(1.87)	1(1.22)	1(1.22)
R_9	0(0.71)	1(1.22)	0(0.71)	3(1.87)
R_{10}	1(1.22)	2(1.58)	1(1.22)	2(1.58)
Mean	1.27(1.92)	2.90(2.56)	0.90(1.73)	2.90(2.56)
CD 5%	0.42			
SEm ±	0.14			

*Figures in parenthesis are square root ("x + 0.5) transform values

Mean number of*P. pulverea* per 30 cm of sticklac during scraping was significantly highest (2.90) in case of T_2 and T_4. It was comparatively low (0.90) in case of T_3 and (1.27) in case of T_1. (Table 8).

Application of pesticides significantly reduced the incidence of predator *E. amabilis* and *P. pulverea* in both the strain of lac over the lac growers practice. Incidence of predator *E. amabilis* per 30 cm of lac sticklac in case of treatment 24.82 per cent more T_3 over T_1 and in case of untreated tree 63.75 per cent more T_4 over T_2. Incidence of predator *P. pulverea* per 30 cm of lac sticklac in cases of treatment 9.89 per cent more T_3 over T_1.

Pesticides application significantly reduced the incidence of *E. amabilis* and *P. pulverea* on lac crop has been reported by Janghel *et al.,* 2014b and Khobragade *et al.,* 2012b. Similarly incidence of *Chrysopa spp* on *K lacca* has been reported by Bhattacharya *et al.,* 2008.

Cartap hydrochloride as an effective insecticide against predator and safe for *K. lacca* has been reported by Jaiswal *et al.,* 2006.

Jaiswal *et al.* (2004) recommended Endosulfan, Dichlorvos, Cartap hydrochloride and Ethofenprox for the management of lepidopterian *E. amabilis* and *P. pulverea* and *Chrysopa* spp predators of *K. lacca*. Jaiswal and Singh (2010) control for predators of lac insect spraying of ethofenprox 0.02 per cent or Endosulfan 0.05 per cent + carbendanzim 0.01 per cent solution is to done one month after inoculation.

REFERENCES

Bhattacharya, A. Jaiswal, A. K. and Singh, J. P. 2008. Management of lac insect predators through IPM based bioregional approaches. *Emerging trends of researches in insect pest management and environmental safety*. **1(2):** 221-226.

Bhattacharya, A. Jaiswal, A. K. Mishra, Y. D. and Chakrabarty, P. K. 2004. Efficacy of *Trichogramma brasiliense* Ashmead in the management of Lepidoptera predators of lac insect, *Kerria lacca* (Kerr.) Lac production divition, Indian Lac Research Institute, Namkum, Ranchi Jharkhand.

Ghosal, S. 2013. Soil fertility management of established *Ber* (*Zizyphus mauritiana*) plantation under lac cultivation. *The Bioscan*. **8(3):** 787-790.

Ghosh, J. lohot, V. D. Singhal, V. Ghosal, S. Sharma, K. K. and Ramani, R. 2014. Plant-insect-environnent interaction for Kusmi lac resin production on Ber (*Zizyphus mauritiana)* varieties. *The Ecoscan*. **6:** 407-401.

Jaiswal, A. K. and Singh, J. P. 2010. How to culture lac insect on *Zizyphus mauritiana* - Indian Plum tree. *Indian Institute of Natural Resin and Gums* Namkum Ranchi, *Bulletin*. **(1):** 1-22.

Jaiswal, A. K. Bhattacharya, A. Kumar, M. and Kumar, S. 2006. Effect of ethofenprox, cartap hydrochloride and endosulfan on the incidence of two major parasitoids *Aprostocetus purpureus* Cameron (Hymenoptera: Eulophidae) and *Tachardiaephagus tachardiae* Howard (Hymenoptera: Encyrtidae) on lac crop. *J. Ento. Res*. **30(1):** 71-73.

Jaiswal, A. K. Bhattacharya, A. Kumar, K. K. and Kumar, S. 2004. Evaluation of ethofenprox (Nukil 10 EC) on lac insect culture for management of *Eublemma amabilis* Moore-A lepidopteran predator. *New Horizon of animal sciences. Zoological society of India Magadh University, Bodh Gaya. Bihar,* India. pp. 47-50.

Jaiswal, A. K. Bhattacharya, A. Kumar, S. and Singh, J. P. 2008. Evaluation of *Baccillus thuringiensis* Berliner subsp. *kurstaki* for management of lepidopteran pests of lac insect, *Entomon*. **33:** 1-5.

Janghel, S. K. Thomas, M. Thakur, A. S. and Sharma, H. L. 2014a. Impact of newer insecticides in the *Butea monosperma* on survivility of *Kerria lacca* (Kerr) and the yield of Rainy season *Rangeeni* Lac crop. Interface on "Management of Economically Important Insects in India" August 16, 2014. *JNKVV* Jabalpur MP pp. 36-37.

Janghel, S. K. Thomas, M. Thakur, A. S. and Sharma, H. L. 2014b. Study on Bio Efficacy of Insecticides in the Predator Management of *Katki* Lac Crop. *Bioengineering and Bioscience*. **2(2):** 15-22, 2014

Kapoor, V. P. and Pushpangadan, P. 2002. Natural dye-based: Herbal Gulal. *Natural Prod. Radiance*. **1(2):** 8-14.

Khobragade, D. Thomas, M. Pachori, R. Sharma, H.L. and Shrivastava, A. 2012a. Farmer participatory trial onthe predator management of Lac insect *K. laacc* (Kerr.) in Anuppur District, Madhya Pradesh. *J. Trop. For*. **28(1/2):** 38-45.

Khobragade, D. Thomas, M. Pachori, R. Sharma, H. L. and Shrivastava A. 2012b. Seasonal incidence of *Eublemma amabilis* on *Baisakhi* crop of *Rangeeni* lac in Madhya Pradesh. *J. Trop. For*. **28(IV):** 31-37

Kumari, K. Gupta, K. K. and Sharma, K. K. 2012. A comparative report on the extent of parasitisation on fecundity of two strains of lac insect, *Kerria lacca* Kerr (Homoptera: Tachardiidae) P.G. Department of Zoology, Vinoba Bhave University, Hazaribag, Jharkhand India.

Lac Production Division, Indian Institute of Natural Resin and Gums, Namkum, Ranchi. **10:** 146-152.

Meena, S. C. Sharma, K. K. Mohanasundaram, Verma, S. and Monobrullah, Md. 2014. Insect-pest complex of *Flemingia semialata* Roxb. -a bushy host for lac cultivation.The Bioscan **9**(4):1375-1381

Mehra, B.P. 1965. Biology of *Chrysopa madestes* Banks (Nuropteran), Chrysopidae. *Indian Ento. Sci.* **27(4):** 398-407.

Panse, V. G. and Sukhatme, P. V. 1967. Statistical methods for agricultural workers. New Delhi , Indian Council of Agricultural Research, **xvi:** 381, 25.

Ramani, R. Monobrullah, M. and Baboo, B. 2010. Lac hosts and gum-yielding trees for agro-forestry inJharkhand Indian Institute of Natural Resin and Gums, Namkum, Ranchi. *W. J. Agri. Sci.* **6(3):** 268-273.

Ramesh, B. K. 2013. Predator surveillance and its management on *Rangeeni* lac crop. M.Sc. (Ag.) Thesis submitted in *JNKVV, Jabalpur*.

Sharma, K. K. and Jaiswal, A. K. 2011. Recent Advances in Lac Culture. Lac cultivation operation. Basis concepts Indian Institute of Natural Resin and GumsNamkum, Ranchi. pp.138-141.

Sharma, K. K. and Ramani, R. 2001. Parasites effected reduction in fecundity and resin yield of two strains of indian lac insect, *Kerria lacca*. *Indian J. Ent.* **63(4):** 456-459.

Singh, J. P. Jaiswal, A. K. Monobrullah, M. and Bhattacharya, A. 2009. Response of some selected insecticides on neuropteran predator (*Chrysopa lacciperda*) of lac insect (*Kerria lacca*). *Indian J. Agri. Sci.* **79(9):** 727-731.

Tewari, D. N. 1994. Tropical Forest Produce. *International Book Distributers*, Dehradun. pp. 83-85.

Thomas, M. 2010b. Madhya Pradesh: Current status of lac production, issues, remedial measures and support system for development. Foundation day Conference of Stakeholders on Current issues related to Lac Production, at IINRG, Ranchi on 20-21 Sep2011. pp. 25-27.

Thomas, M., Engla, Y., Rathore, V., Devendra, K., Bhale Rao, K. and Shrivastava, A. 2012. Stress management in lac production – A review article. *JNKVV Res. J.* **46(3):** 277-285.

Thomas, M., Khare, V., Shukla, R. P. K., Srivastava R. and Dave R. 2011. Impact of promostion of Lac cultivation in rural livelihoods and forest conservation in M.P. International conference on Non-wood forest produce for sustainable livelihood held on 17th- 19th Dec 2011. *MP forest department*. pp. 45-47.

Thomas, M., Shrivastava, R. and Khare, V. R. 2010a. Nationalization of lac in Madhya Pradesh. lessons Learnt. Foundation day Conference of Stakeholders on Current issues related to lac production Indian Institute of Natural Resin and Gums, Namkum, Ranchi on 20-21 Sep201. pp. 25-27.