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Record of lac insect occurrence in Maharashtra

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Abstract

In the present study, intensive surveys were conducted in 36 districts of Maharashtra state from 2015 to 2020 under the ICAR funded "Network Project on Conservation of Lac Insect Genetic Resources" to record the district level occurrence of lac insects on different host plants for *in-situ* and *ex-situ* conservation. During the survey, information was taken from the concerned Forest department, traders and farmers at the block level in each surveyed district. Randomly different lac host plants were also observed for identifying lac insect species on other host plants. The live lac insect population was traced through observations and through binoculars or visually. In the survey, lac insect occurrence was observed in 115 sites in 26 districts of Maharashtra on 10 different host plant species. The survey revealed maximum lac insect occurrence on *Ficus religiosa* in 46 sites (39.70%) followed by *Butea monosperma* in 34 sites (29.30%), *Albizia saman* in 19 sites (16.4%), *Ficus racemosa* in 5 sites (4.31%), *Ficus bengalensis* and *Ficus amphissimma* in 3 sites (2.59%), *Pithocobium dulce*, *Ziziphus mauritiana* in 2 sites (1.72) whereas minimum occurrence sites were reported on *Albizia lebbek* and *Ficus citrifolia* in only one site (0.86%). Maximum lac insect occurrence sites were reported from Gondia in 26 sites (22.6%) followed by Washim in 10 sites (8.62%), Parbhani, Hingoli in both 8 sites (6.90%), Gadchiroli in 07 sites (6.03%), Nanded in 6 site (5.17%), Buladana, Jalna, Latur, Ahmednagar in each 5 sites (4.31%), Solapur in 4 sites (3.45%), Nashik, Bhandara, Aurangabad in each 3 sites (2.61), Beed, Osmanabnad, Satara, Sangli, Dhule and Nandurbar in each 2 sites (2.59). Minimum occurrence sites of lac insect were reported from Akola, Jalgaon, Mumbai, Chandrapur, Yavatmal and Pune in only one site (0.86%). During the present study, colour variation of lac, insects was also observed from 116 lac insect occurrence sites in Maharashtra. There is only 2 colour found, these are crimson and yellow. Crimson lac insect was reported from 70 sites in 17 districts and Yellow lac insect reported from 37 sites in 13 districts, while mixed lac insect populations (Crimson and yellow) were reported from 8 sites of 3 districts of Maharashtra.

Keywords: Rangeeni strain, lac insect occurrence, *Butea monosperma*, *Ficus religiosa*, *Albizia saman*

Introduction

Lac is a natural, biodegradable, resinous compound of animal origin, secreted by a tiny insect known as lac-insect, as a protective covering. Lac insects are plant sap feeders (Sharma *et al.*, 2006; Singh *et al.*, 2009) ^[1, 2] therefore thrive well only on certain plant species known as lac hosts. Lac insect secretes true lac (Sharma and Ramani, 1999) ^[3], a resinous compound of great economic importance (Roonwal *et al.* 1958, Ramani *et al.*, 2007) ^[4, 5]. Lac consists of resin, wax and dye, thus has a wide range of applications in food, pharmaceuticals, cosmetics, perfumes, varnishes, paints, polishes, adhesives, jewelry and textile dyes.

Lac insect depends on plants as host for survival. More than 400 lac hosts have been observed throughout the world (Kapur, 1962; Varshney and Teotia, 1968; Varshney, 1968; Sharma *et al.*, 1997) ^[6, 7, 8, 9], while in India there are 113 species (Roonwal *et al.*, 1958) ^[4]. Varshney and Teotia (1967) ^[7] listed 217 plant species of lac host plants in India in alphabetical order with references. Varshney and Ganguli (1968) ^[10] reported 10 new species of host plants of lac insects. Palas (*Butea monosperma*), Ber (*Ziziphus mauritiana*) and Kusum (*Schleichera oleosa*) are the most common hosts for commercial lac production in India (Roonwal, 1962; Pal, 2009; Mohanta *et al.*, 2012) ^[11, 12, 13].

Lac is mainly produced in India, Thailand, Indonesia, parts of China, Vietnam, Cambodia etc. (Pal *et al.*, 2009; Pal *et al.*, 2011; Yogi *et al.*, 2014) ^[12, 14, 15]. India is the largest producer of lac globally, which contributes about 50-60 percent of the world's production (Sharma *et al.*, 2006).

Lac production in India is a major economic activity among forest-dependent farmers in central and eastern India. Major Indian states engaged in lac production are Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal and Maharashtra contributing around 95 percent of National lac production (Pal *et al.*, 2011; Yogi *et al.*, 2014; Sharma *et al.*, 2006) ^[14, 15, 16].

Fast depletion of forests is a serious threat to the biodiversity of lac insects. Many lac insects and associated fauna have become endangered where lac cultivation has been abandoned or its habitat destroyed. Promoting and encouraging lac culture will not only check environmental degradation, but also conserve associated fauna and flora for posterity (Sharma *et al.*, 2006). With this in view a Network Project on Conservation of Lac insect genetic resources was undertaken to survey the lac insect occurrence and conserve the rich diversity in lac insect.

Maharashtra lies in the western parts of India with a long coast along the Arabian sea and has an area of 307,713 km² which accounts for 9.36% of the country's geographical area. Physiographically, the state can be divided into three distinct regions, namely, Deccan Plateau, Western Ghats and Coastal plains. The state has a tropical monsoon climate, the mean annual temperature ranges from 25 °C to 27.5 °C and the average annual rainfall ranges between 1600 to 2000 mm. The recorded forest area of the state is 61,939 km² of the geographical area.

Maharashtra state is the 4th largest lac producer in our country producing about 1465 tons lac annually and its share is 8% of the total lac production in the country (Yogi *et al.*, 2018) ^[17]. In Maharashtra, lac is mainly known to be produced in Gondia, Bhandara and Gadchiroli districts. Farmers of this region have been growing lac traditionally. There is no information available on whether there is lac insect occurrence in other districts or sites.

Therefore the present study was planned to check occurrence of lac insect on different host plants at block level so as to identify districts and also to record the new sites of lac insect in Maharashtra. Insect recorded in this region will help to promote lac culture in other areas as well as biodiversity of lac insect species will also remain conserved and maintained. Keeping the above in view, the present study was planned.

Materials and Methods

The present investigation was carried out at block level in 36 districts of Maharashtra during 2015 to 2020. The Lac insect cooperating centre established at State Forest Research Institute, Jabalpur, conducted the study. Prior to undertaking the survey work contact was made with the concerned Forest department in each surveyed district. The districts have information about lac insect/host plant occurrence and cultivation status at the block level. Information was also taken from traders and farmer at blocks level. With this pre-information and cultivation status, surveys were undertaken at blocks level for the occurrence of lac insect. Randomly different lac host plants were also observed for

identifying lac species. The live lac insect population was traced through observations and through visual binoculars.

In the field survey if lac insect samples were found, then the branches having the lac insect were collected by using secateurs and tree pruner, kept in the 60 mesh net and labelled. The observations of different parameters of host plants, their intensity and location were recorded under the study. The lac insect and host plants were observed for the presence of lac insects, their strain, growth, stage, intensity and colour variation documented in the prescribed passport datasheet and photographs of lac insect encrustation. The altitude, latitude and longitude of the location were marked using GPS (Montana Garmin). Relative abundance was calculated through formula given below.

$$\text{Relative abundance (RD\%)} = \frac{\text{No. of host plant of one species}}{\text{Total no. host plant of all species}} \times 100$$

Result and Discussion

During the survey 115 lac insect occurrence sites were identified with lac encrustation on different host plants. Visual survey was done in the fringe areas of forests, farmers' fields, revenue lands, roads side and city areas. During the study lac encrustation was found on Palas (*Butea monosperma*), Pipal (*Ficus religiosa*), Rain tree (*Albizia saman*), Bargad (*Ficus benghalensis*), Ber (*Ziziphus mauritiana*), Jangli Jalebi (*Ficus citrifolia*) Gular (*Ficus racemosa*), Indian bat tree (*Ficus amphissimma*), Kala Siris (*Albizia lebbek*), Jangli Jalebi (*Pithecolobium dulce*). It was also observed that at almost all locations only Rangeeni strain was found growing well on these natural hosts.

Occurrence of live lac insect in different districts of Maharashtra

Lac insect cultivation in different districts

During the survey, maximum cultivated sites of lac insect were reported from the Gondia district (25 sites) on *Butea monosperma* and *Ziziphus mauritiana* tree, which produce 1100 quintals of stick lac annually (Yogi *et al.*, 2018) ^[17] and contributed 75% total lac production of the Maharashtra state. Lac cultivation continues only on farmers' fields in Salekasa, Amgaon, Deori, Goregaon, Gondia, Tirrora blocks in the Gondia district. Cultivated insects were also observed in Gadchiroli district in 6 sites, Bhandara district in 03 sites and Chandrapur district in 1 sites on *Butea monosperma* tree produces 25% lac of the Maharashtra state. *Butea monosperma* is the major host of lac insect, which is abundantly found in the Vidharbh zone of Maharashtra. This activity needs to be promoted in other areas as well as forest areas through training and demonstration. All the 35 cultivated sites reported for lac insect population. The occurrence of lac insect during the years 2015 to 2020 is given in Table 1.

Table 1: lac insect occurrence in different districts of Maharashtra

S. No.	District	Block	Village/ Site	GPS detail		Host plant observed	Period of survey	Status	Colour variation
1	Gondia	Gondia	Murdara	E 080° 00' 58.5"	N 21° 00' 58.5"	<i>Butea monosperma</i>	18/11/2015	Cultivated	Crimson
2	Gondia	Gondia	Bhagwatola	E 080° 09' 35.4"	N 22° 28' 8.08"	<i>Butea monosperma</i>	18/11/2015	Cultivated	Crimson
3	Gondia	Gondia	Dhapewara	E 080° 04' 38.4"	N 21° 32' 45.4"	<i>Butea monosperma</i>	18/11/2015	Cultivated	Crimson
4	Gondia	Tirora	Bhuratola	E 079° 56' 30.7"	N 21° 26' 7.68"	<i>Butea monosperma</i>	18/11/2015	Cultivated	Crimson
5	Gondia	Gondia	Satona	E 080° 14' 6.45"	N 21° 36' 7.76"	<i>Butea monosperma</i>	20/11/2015	Cultivated	Crimson
6	Gondia	Goregawn	Tumsar	E 080° 17' 9.82"	N 21° 15' 9.85"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
7	Gondia	Goregawn	Mohari	E 080° 15' 57.4"	N 21° 17' 05.8"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
8	Gondia	Goregawn	Gidari	E 080° 17' 01.3"	N 21° 17' 50.9"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
9	Gondia	Goregawn	Nonegawn	E 080° 16' 8.72"	N 21° 20' 53.6"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
10	Gondia	Salekesa	Gandhitola	E 080° 26' 54.6"	N 21° 15' 9.3"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
11	Gondia	Salekesa	Sitepala	E 080° 29' 8.01"	N 21° 16' 48.2"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
12	Gondia	Salekesa	Pandarwani	E 080° 28' 6.56"	N 21° 11' 16.0"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
13	Gondia	Salekesa	Sakritola	E 080° 25' 01.6"	N 21° 15' 7.62"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
14	Gondia	Amgawn	Kopitola	E 080° 19' 7.37"	N 21° 17' 7.37"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
15	Gondia	Amgawn	Surkudi	E 080° 17' 8.06"	N 21° 20' 05.2"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
16	Gondia	Amgawn	Surkudi	E 080° 17' 8.06"	N 21° 20' 05.2"	<i>Ficus amphissimma</i>	19/11/2015	Natural	Crimson
17	Gondia	Amgawn	Sangvi	E 080° 24' 8.25"	N 21° 21' 28.7"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
18	Gondia	Amgaon	Dhobitola	E 080° 17' 4.69"	N 21° 18' 58.5"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
19	Gondia	Deori	Fukimeta	E 080° 25' 23.2"	N 21° 07' 14.3"	<i>Butea monosperma</i>	28/12/2019	Cultivated	Crimson
20	Gondia	Amgaon	Amgaon	E 080° 22' 8.57"	N 21° 22' 12.1"	<i>Butea monosperma</i>	29/12/2020	Cultivated	Crimson
21	Gondia	Gondia	Chulod	E 080° 15' 3.6"	N 21° 27' 15.5"	<i>Butea monosperma</i>	30/12/2020	Cultivated	Crimson
22	Gondia	Gondia	Chulod	E 080° 15' 3.6"	N 21° 27' 15.5"	<i>Ziziphus mauritiana</i>	30/12/2020	Cultivated	Crimson
23	Gondia	Devri	Halvitola	E 080° 23' 38.2"	N 21° 13' 02.1"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
24	Gondia	Devri	Halvitola	E 080° 23' 38.2"	N 21° 13' 02.1"	<i>Ziziphus mauritiana</i>	19/11/2015	Cultivated	Crimson
25	Gondia	Devri	Badegawn	E 080° 22' 9.22"	N 21° 08' 9.34"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
26	Gondia	Devri	Mulla	E 080° 02' 06.7"	N 21° 09' 725"	<i>Butea monosperma</i>	19/11/2015	Cultivated	Crimson
27	Bhandara	Tumsar	Sukudi	E 079° 53' 8.31"	N 21° 29' 09.0"	<i>Butea monosperma</i>	18/11/2015	Cultivated	Crimson
28	Bhandara	Tumsar	Bamantola	E 079° 52' 858"	N 21° 30' 50.1"	<i>Butea monosperma</i>	18/11/2015	Cultivated	Crimson
29	Bhandara	Bhandara	Kandarmore	E 079° 45' 58.5"	N 21° 05' 52.8"	<i>Butea monosperma</i>	18/11/2015	Cultivated	Crimson
30	Chandrapur	Barora	Rampur	E 079° 00' 45.4"	N 20° 24' 6.14"	<i>Butea monosperma</i>	02/04/2016	Cultivated	Crimson
31	Gadchiroli	Dhanaura	Murmgaon	E 080° 27' 27.7"	N 20° 19' 37.6"	<i>Butea monosperma</i>	30/03/2016	Cultivated	Crimson
32	Gadchiroli	Dhanaura	Muramgaon	E 080° 27' 46.1"	N 20° 19' 6.26"	<i>Butea monosperma</i>	31/03/2016	Cultivated	Crimson
33	Gadchiroli	Dhanaura	Kulbhatti	E 080° 31' 57.5"	N 20° 20' 33.9"	<i>Butea monosperma</i>	05/06/2016	Cultivated	Crimson
34	Gadchiroli	Dhanaura	Erabdondari	E 080° 22' 254"	N 22° 25' 2.0"	<i>Butea monosperma</i>	05/06/2016	Cultivated	Crimson
35	Gadchiroli	Dhanaura	Erabdondari	E 080° 22' 254"	N 22° 25' 2.0"	<i>Ficus citrifolia citrifolia</i>	05/06/2016	Natural	Crimson
36	Gadchiroli	Potegaon	Saoli	E 080° 07' 51.5"	N 22° 02' 54.4"	<i>Butea monosperma</i>	03/06/2016	Cultivated	Crimson
37	Gadchiroli	Chamorsi	Somnapur			<i>Butea monosperma</i>	03/06/2016	Cultivated	Crimson
38	Parbhani	Parbhani	Gangakheda	E 076° 44' 50.9"	N 18° 58' 0.3"	<i>Ficus religiosa</i>	08/12/2016	Natural	Crimson
39	Parbhani	Patri	Patri	E 076° 26' 06.9"	N 19° 14' 4.8"	<i>Ficus religiosa</i>	08/12/2016	Natural	Yellow
40	Parbhani	Parbhani	Parbhani	E 076° 45' 49.3"	N 19° 15' 29.4"	<i>Ficus religiosa</i>	08/12/2016	Natural	Yellow
41	Parbhani	Selu	Selu	E 076° 26' 01.5"	N 19° 27' 3.5"	<i>Ficus religiosa</i>	08/12/2016	Natural	Yellow
42	Parbhani	Parbhani	Phhadni	E 076° 43' 37.2"	N 19° 07' 04.0"	<i>Ficus religiosa</i>	08/12/2016	Natural	Yellow
43	Parbhani	Parbhani	Phhadni	E 076° 43' 37.2"	N 19° 07' 04.0"	<i>Ficus amphissimma</i>	08/12/2016	Natural	Yellow
44	Parbhani	Selu	Selu	E 076° 26' 01.5"	N 19° 27' 03.5"	<i>Ficus religiosa</i>	08/12/2016	Natural	Yellow
45	Parbhani	Selu	Selu	E 076° 54' 49.3"	N 19° 15' 29.4"	<i>Ficus religiosa</i>	08/12/2016	Natural	Yellow
46	Jalna	Ambad	Jalna	E 075° 54' 22.8"	N 19° 22' 02.4"	<i>Ficus religiosa</i>	08/12/2016	Natural	Yellow
47	Jalna	Jalna	Jalna	E 075° 54' 22.8"	N 19° 50' 38.2"	<i>Ficus religiosa</i>	08/12/2016	Natural	Yellow
48	Jalna	Jalna	Jalna	E 075° 54' 22.8"	N 19° 50' 38.2"	<i>Ficus amphissimma</i>	08/12/2016	Natural	Yellow
49	Jalna	Partur	Partur	E 076° 12' 34.5"	N 19° 34' 51.8"	<i>Ficus religiosa</i>	08/12/2016	Natural	Yellow
50	Jalna	Partur	Burpal	E 076° 15' 45.6"	N 19° 34' 14.4"	<i>Albizia lebbek</i>	08/12/2016	Natural	Crimson
51	Nanded	Ardhanpur	Patrur	E 077° 31' 07.4"	N 19° 16' 12.3"	<i>Ficus religiosa</i>	09/12/2016	Natural	Yellow
52	Nanded	Ardhanpur	Malegaon	E 077° 16' 22.4"	N 19° 18' 1.2"	<i>Albizia saman</i>	09/12/2016	Natural	Crimson
53	Nanded	Modkhed	Modkhed	E 077° 30' 09.0"	N 19° 08' 52.9"	<i>Albizia saman</i>	09/12/2016	Natural	Crimson
54	Nanded	Bhokar	Bhokar	E 077° 39' 34.1"	N 19° 13' 23.9"	<i>Ficus benghalensis</i>	09/12/2016	Natural	Crimson
55	Nanded	Hadgaon	Hadgaon	E 077° 39' 17.2"	N 19° 29' 45.3"	<i>Albizia saman</i>	09/12/2016	Natural	Crimson
56	Nanded	Nanded	Nanded	E 077° 21' 33.6"	N 19° 08' 28.0"	<i>Ficus recemosa</i>	09/12/2016	Natural	Crimson
57	Washim	Malegaon	Malegaon	E 077° 00' 0.23"	N 20° 14' 13.1"	<i>Albizia saman</i>	10/12/2016	Natural	Crimson
58	Washim	Malegaon	Malegaon	E 077° 00' 0.23"	N 20° 14' 13.1"	<i>Ficus religiosa</i>	10/12/2016	Natural	Crimson
59	Washim	Mangurpeer	Jogadari	E 077° 24' 42.6"	N 20° 15' 52.8"	<i>Ficus religiosa</i>	10/12/2016	Natural	Crimson
60	Washim	Washim	Washim	E 077° 08' 29.1"	N 20° 06' 28.2"	<i>Albizia saman</i>	10/12/2016	Natural	Crimson
61	Washim	Washim	Washim	E 077° 08' 29.1"	N 20° 06' 28.2"	<i>Ficus religiosa</i>	10/12/2016	Natural	Crimson
62	Washim	Washim	Near bus stand	E 077° 08' 51.9"	N 20° 06' 40.1"	<i>Pithocobium dulce</i>	10/12/2016	Natural	Crimson
63	Washim	Washim	Washim	E 077° 08' 29.1"	N 20° 06' 28.2"	<i>Ficus recemosa</i>	10/12/2016	Natural	Crimson

64	Washim	Washim	Washim	E 077° 08' 31.0"	N 20° 06' 06.1"	<i>Ficus religiosa</i>	10/12/2016	Natural	Crimson
65	Washim	Washim	Manora	E 077 33' 24.1"	N 20° 13' 19.7"	<i>Ficus religiosa</i>	10/12/2016	Natural	Crimson
66	Washim	Manglorpur	Manglorpur	E 077° 20' 44.3"	N 20° 18' 42.3"	<i>Ficus religiosa</i>	10/12/2016	Natural	Crimson
67	Akola	Akola	Akola	E 076° 59' 12.2"	N 20° 42' 02.2"	<i>Ficus religiosa</i>	10/12/2016	Natural	Crimson
68	Buldana	Khamgaon	Khamgaon	E 076° 33' 39.1"	N 20° 42' 47.9"	<i>Ficus religiosa</i>	06/12/2016	Natural	Yellow
69	Buldana	Deolgaon	Deolgaon	E 076° 02' 13.5"	N 20° 00' 59.6"	<i>Ficus benghalensis</i>	06/12/2016	Natural	Yellow
70	Buldana	Buldhana	Buldhana	E 076° 10' 49.2"	N 20° 32' 11.6"	<i>Ficus religiosa</i>	06/12/2016	Natural	Yellow
71	Buldana	Sindkhed Raja	Sindkhed Raja	E 076° 06' 10.3"	N 19° 56' 43.3"	<i>Ficus religiosa</i>	25/11/2019	Natural	Yellow
72	Buldana	Mehkar	Dongaon	E 076° 43' 30.6"	N 20° 10' 9.75"	<i>Ficus religiosa</i>	25/11/2019	Natural	Yellow
73	Hingoli	Hingloi	Kanhergon	E 077° 0.8' 55.9"	N 19° 57' 25.1"	<i>Ficus religiosa</i>	10/12/2016	Natural	Yellow
74	Hingoli	Malhibra	Malhivra	E 077° 11' 13.5"	N 19° 49' 36.5"	<i>Ficus religiosa</i>	10/12/2016	Natural	Crimson
75	Hingoli	Malhibra	Malhivra	E 077° 11' 13.5"	N 19° 49' 36.5"	<i>Pithocobium dulce</i>	10/12/2016	Natural	Crimson
76	Hingoli	Aurah	Aurah	E 077° 0.3' 25.1"	N 19° 33' 26.7"	<i>Albizia saman</i>	09/12/2016	Natural	Crimson
77	Hingoli	Bisamat	Bismat	E 077° 10' 06.1"	N 19° 19' 18.8"	<i>Albizia saman</i>	09/12/2016	Natural	Crimson
78	Hingoli	Kalamnuri	Kalamnuri	E 077° 18' 21.6"	N 19° 40' 36.0"	<i>Albizia saman</i>	10/12/2016	Natural	Mixed
79	Hingoli	Hingoli	Hingoli	E 077° 0.8' 48.1"	N 19° 43' 04.2"	<i>Albizia saman</i>	10/12/2016	Natural	Mixed
80	Hingoli	Kalamnuri	Umra	E 077° 15' 26.4"	N 19° 41' 32.5"	<i>Albizia saman</i>	10/12/2016	Natural	Mixed
81	Yawatmal	Arni	Sakalgaon	E 078° 01' 19.7"	N 20° 09' 20.8"	<i>Butea monosperma</i>	10/12/2016	Natural	Crimson
82	Latur	Latur	Meghrajnagar	E 076° 35' 32.0"	N 18° 24' 05.2"	<i>Ficus religiosa</i>	12/07/2017	Natural	Yellow
82	Latur	Latur	Amleshwarnagar	E 076 32' 17.4"	N 18° 24' 29.1"	<i>Ficus religiosa</i>	22/11/2018	Natural	Yellow
84	Latur	Shirur	Shirur	E 076° 58' 07.3"	N 18° 36' 48.4"	<i>Ficus religiosa</i>	12/07/2017	Natural	Yellow
85	Latur	Shirur	Shirur	E 076° 58' 07.3"	N 18° 36' 48.4"	<i>Ficus recemosa</i>	12/07/2017	Natural	Crimson
86	Latur	Ahemedpur	Ahemedpur	E 076° 56' 16.3"	N 18° 42' 23.7"	<i>Ficus religiosa</i>	12/07/2017	Natural	Yellow
87	Sangli	Sangli	Sangli	E 077° 33' 51.0"	N 16° 50' 26.0"	<i>Albizia saman</i>	13/07/2017	Natural	Crimson
88	Sangli	Kavathe Mahankal	Kavathe Mahankal	E 074° 51' 28.0"	N 17° 00' 54.7"	<i>Ficus recemosa</i>	13/07/2017	Natural	Crimson
89	Osmanbad	Osmanabad	Osmanabad	E 076° 02' 31.3"	N 18° 11' 14.8"	<i>Ficus religiosa</i>	13/07/2017	Natural	Crimson
90	Osmanbad	Osmanabad	Osmanabad	E 076° 02' 31.3"	N 18° 11' 14.8"	<i>Ficus recemosa</i>	13/07/2017	Natural	Crimson
91	Satara	Pachwad	Pachwad	E 73° 57' 13.5"	N 17° 51' 50.05"	<i>Albizia saman</i>	14/07/2017	Natural	Crimson
92	Satara	Karad	Malkapur	E 074° 10' 6.75"	N 17° 15' 25.6"	<i>Albizia saman</i>	21/11/2018	Natural	Crimson
93	Pune	Shirur	Shikrapur	E 074° 09' 23.0"	N 18° 42' 16.1"	<i>Albizia saman</i>	14/07/2017	Natural	Crimson
94	Ahemdnagar	Ahemdnagar	Ghodegaon	E 077° 52' 44.2"	N 19° 20' 48.8"	<i>Albizia saman</i>	15/07/2017	Natural	Crimson
95	Ahmednagar	Kopargaon	Bhojdi	E 074° 33' 8.49"	N 19° 52' 08.2"	<i>Ficus religiosa</i>	26/11/2019	Natural	Yellow
96	Aurangabad	Aurangabad	Aurangabad	E 075° 18' 59.1"	N 19° 52' 26.8"	<i>Ficus religiosa</i>	15/07/2017	Natural	Yellow
97	Aurangabad	Aurangabad	Shekta	E 075° 37' 40.1"	N 19° 52' 23.2"	<i>Ficus religiosa</i>	25/11/2019	Natural	Yellow
98	Aurangabad	Ganganagar	Kaygaon	E 075° 01' 9.98"	N 19° 38' 13.7"	<i>Albizia saman</i>	29/11/2018	Natural	Mixed
99	Dhule	Sindhkhede	Dondaich	E 074° 33' 19.5"	N 21° 19' 47.5"	<i>Ficus benghalensis</i>	26/07/2017	Natural	Yellow
100	Dhule	Sindhkhede	Dondaich	E 074° 33' 19.5"	N 21° 19' 47.5"	<i>Ficus religiosa</i>	26/07/2017	Natural	Yellow
101	Nandurbar	Nandurbar	Road side of Nandurbar	E 074° 15' 0.6"	N 21° 21' 45.4"	<i>Albizia saman</i>	26/07/2017	Natural	Crimson
102	Nandurbar	Shahada	Shahada	E 074° 28' 21.2"	N 21 32' 7.68"	<i>Ficus religisa</i>	26/07/2017	Natural	Yellow
103	Nashik	Malegaon	Jhogde	E 074° 40' 23.5"	N 20° 39' 31.9"	<i>Ficus religiosa</i>	27/07/2017	Natural	Yellow
104	Nashik	Nashik	Nashik	E 073° 51' 41.5"	N 19° 56' 02.7"	<i>Ficus religiosa</i>	28/07/2017	Natural	Yellow
105	Ahmednagar	Kopalgaoon	Yesgaon	E 074° 28' 56.1"	N 19° 53' 25.9"	<i>Albizia saman</i>	28/07/2017	Natural	Yellow
106	Ahmednagar	Sangamner	Palshkhed	E 077° 09' 46.2"	N 19° 42' 34.7"	<i>Ficus religiosa</i>	28/07/2017	Natural	Yellow
107	Ahmednagar	Rahori	Kumhre	E 074° 44' 06.7"	N 19° 22' 20.1"	<i>Ficus religiosa</i>	26/11/2019	Natural	Yellow
108	Nashik	Yeola	Yeola	E 074° 29' 24.1"	N 20° 02' 18.2"	<i>Ficus religiosa</i>	28/07/2017	Natural	Yellow
109	Jalgaon	Chalisgaon	Chalisgaon	E 075° 00' 28.3"	N 20° 27' 46.1"	<i>Ficus religiosa</i>	29/07/2017	Natural	Yellow
110	Solapur	Solapur North	Tinhe	E 075° 46' 30.3"	N 17° 39' 33.4"	<i>Ficus religiosa</i>	21/11/2018	Natural	Mixed
111	Solapur	Solapur North	Deogaon	E 075° 51' 4.95"	N 17° 40' 06.1"	<i>Albizia saman</i>	22/11/2018	Natural	Mixed
112	Solapur	Solapur North	Deogaon	E 075° 51' 29.7"	N 17° 14' 03.7"	<i>Ficus religiosa</i>	22/11/2018	Natural	Mixed
113	Solapur	Solapur	Solapur	E 075° 55' 18.9"	N 17° 40' 24.6"	<i>Ficus religiosa</i>	13/07/2017	Natural	Mixed
114	Beed	Beed	Beed	E 075° 45' 38.7"	N 18° 59' 22.5"	<i>Ficus religiosa</i>	30/11/2018	Natural	Yellow
115	Beed	Patoda	Patoda	E 076° 15' 25.5"	N 18° 03' 7.74"	<i>Ficus religiosa</i>	30/11/2018	Natural	Yellow
116	Mumbai	Fort Mumbai	Near Crawford Market	E 073° 56' 8.80"	N 15° 16' 9.06"	<i>Ficus religiosa</i>	24/11/2018	Natural	Crimson

District wise analyzed data of occurrence of lac insect in Maharashtra

On the basis of survey 116 sites were observed in different districts of Maharashtra state. The findings of the present investigation are in conformity with the earlier work which recorded *Acacia auriculiformis* and *Peltophorum ferrugineum* from Ranchi and Jamshedpur, respectively (Kapur 1954).

During the survey, maximum lac insect occurrence sites were reported from Gondia on *Butea monosperma*, *Ziziphus mauritiana* and *Ficus citrifolia* in 26 sites (22.4%) followed by Washim on *Albizia saman*, *Ficus racemosa* and *Ficus religiosa* in 10 sites (8.62%), Parbhani on *Ficus religiosa* and *Ficus ampiciana*, Hingoli on *Ficus religiosa*, *Albizia saman* and *Ficus citrifolia* in each 8 sites (6.90%), Gadchiroli on

Butea monosperma and *Ficus citrifolia* in 07 sites (6.03%), Nanded on *Ficus benghalensis*, *Ficus religiosa*, *Ficus racemosa* and *Albizia saman* in 6 site (5.17%), Buldhana on *Ficus religiosa* and *Ficus benghalensis*, Jalna on *Ficus religiosa*, *Albizia lebbek*, and *Ficus amphiciana*, Latur on *Ficus religiosa* and *Ficus racemosa*, Ahmednagar on *Ficus religiosa*, and *Albizia saman* in each 5 sites (4.31%), Solapur on *Ficus religiosa* and *Albizia saman* in 4 sites (3.45%), Nashik on *Ficus religiosa*, Bhandara on *Butea monosperma*, Aurangabad on *Albizia saman* and *Ficus religiosa* in each 3

sites (2.59%), Beed on *Ficus religiosa*, Osmanabnad on *Ficus religiosa* and *Ficus racemosa*, Satara on *Albizia saman*, Sangli on *Albizia saman* and *Ficus racemosa*, Dhule on *Ficus religiosa* and *Ficus benghalensis*, Nandurbar on *Ficus religisa* and *Albizia saman* in each 2 sites (1.72%). Minimum occurrence of lac insect was reported from Akola, Jalgaon, Mumbai on *Ficus religiosa*, Chandrapur and Yavatmal on *Butea monosperma*, Pune on *Albizia saman*, each one site (0.86%).

Table 2: District wise occurrence of lac insect on different host plants in Maharashtra

District	lac encrustation found with host plants	No. of lac insect occurrence sites	Relative abundance of lac insect on different host plants	District wise lac occurrence sites	District wise abundance frequency %
Gondia	<i>Butea monosperma</i>	23	19.8	26	22.4
	<i>Ziziphus mauritiana</i>	02	1.72		
	<i>Ficus amphissimma</i>	01	0.86		
Bhandara	<i>Butea monosperma</i>	03	2.59	03	2.59
Gadchiroli	<i>Butea monosperma</i>	06	5.17	07	6.03
	<i>Ficus citrifolia</i>	01	0.86		
Chandrapur	<i>Butea monosperma</i>	01	0.86	1	0.86
Akola	<i>Ficus religiosa</i>	01	0.86	1	0.86
Buldana	<i>Ficus religiosa</i>	04	3.45	05	4.31
	<i>Ficus benghalensis</i>	01	0.86		
Washim	<i>Albizia saman</i>	02	1.72	10	8.62
	<i>Ficus racemosa</i>	01	0.86		
	<i>Ficus religiosa</i>	06	5.17		
	<i>Pithocobium dulce</i>	01	0.86		
Yavatmal	<i>Butea monosperma</i>	01	0.86	01	0.86
Aurangabad	<i>Albizia saman</i>	01	0.86	03	2.59
	<i>Ficus religiosa</i>	02	1.72		
Jalna	<i>Ficus religiosa</i>	03	2.59	05	4.31
	<i>Albizia lebbek</i>	01	0.86		
	<i>Ficus amphiciana</i>	01	0.86		
Parbhani	<i>Ficus religiosa</i>	07	6.03	08	6.9
	<i>Ficus amphiciana</i>	01	0.86		
Hingoli	<i>Ficus religiosa</i>	02	1.72	08	6.9
	<i>Albizia saman</i>	05	4.31		
	<i>Pithocobium dulce</i>	01	0.86		
Nanded	<i>Ficus racemosa</i>	01	0.86	06	5.17
	<i>Ficus religiosa</i>	01	0.86		
	<i>Ficus benghalensis</i>	01	0.86		
	<i>Albizia saman</i>	03	2.59		
Beed	<i>Ficus religiosa</i>	02	1.72	02	1.72
Latur	<i>Ficus religiosa</i>	04	3.45	05	4.31
	<i>Ficus racemosa</i>	01	0.86		
Osmanabad	<i>Ficus religiosa</i>	01	0.86	02	1.72
	<i>Ficus racemosa</i>	01	0.86		
Pune	<i>Albizia saman</i>	01	0.86	01	0.86
Satara	<i>Albizia saman</i>	02	1.72	02	1.72
Solapur	<i>Ficus religiosa</i>	03	2.59	04	3.45
	<i>Albizia saman</i>	01	0.86		
Sangli	<i>Albizia saman</i>	01	0.86	02	1.72
	<i>Ficus racemosa</i>	01	0.86		
Nandurbar	<i>Albizia saman</i>	01	0.86	02	1.72
	<i>Ficus religiosa</i>	01	0.86		
Dhule	<i>Ficus religiosa</i>	01	0.86	02	1.72
	<i>Ficus benghalensis</i>	01	0.86		
Nashik	<i>Ficus religiosa</i>	03	2.59	03	2.59
Jalgaon	<i>Ficus religiosa</i>	01	0.86	01	0.86
Ahmednagar	<i>Ficus religiosa</i>	03	2.59	05	4.31
	<i>Albizia saman</i>	02	1.72		
Mumbai city	<i>Ficus religiosa</i>	01	0.86	01	0.86
	Total	116	100	116	100

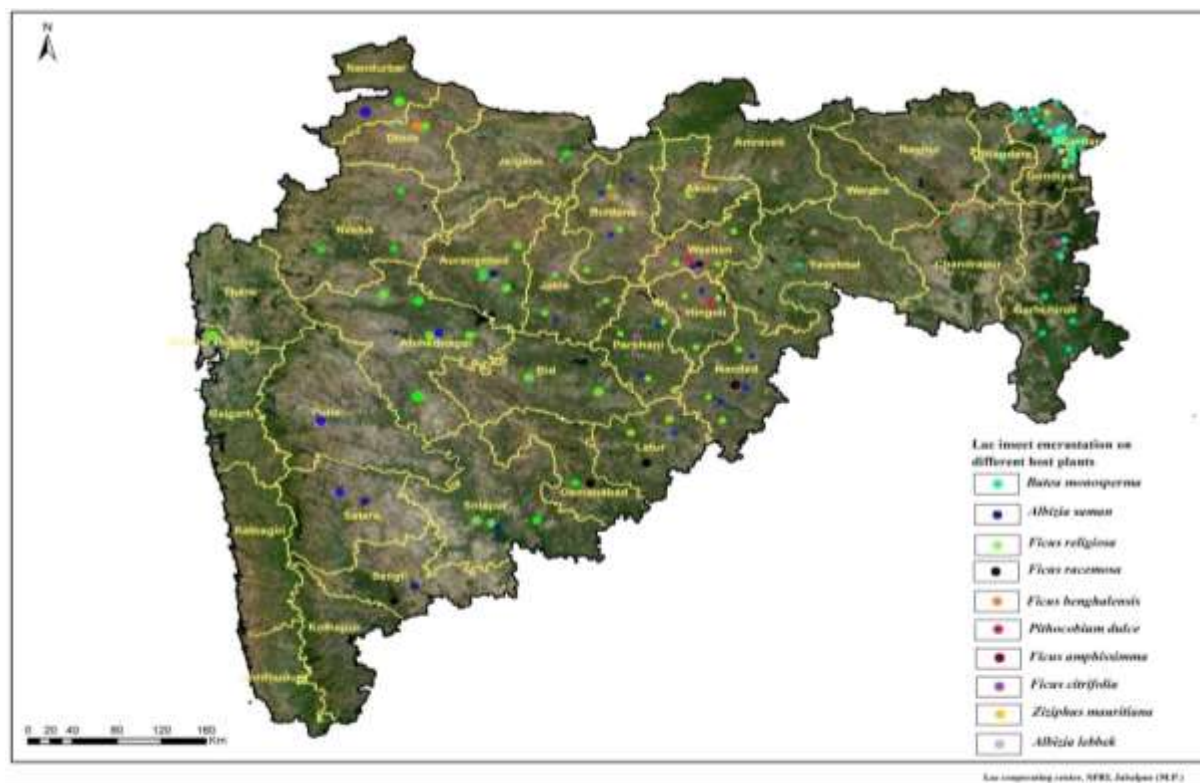


Fig 1: Map showing lac insect occurrence on different host plants in Maharashtra

Colour variations of lac insect in Maharashtra

Qualitative variations with regard to body colour of lac dye have been reported in lac insects showing crimson, yellow, cream and albin (White) body colours (Sharma *et al.*, 2006) [16]. The body is crimson in colour due to presence of complex water soluble colouring pigments collectively called as lac dye. Ordinary lac insects are crimson or red coloured, on account of a red dye present in their body fluid, but sometimes yellow colonies of lac insects also come across. Chauhan (1967) [18] has reported yellow insects as mutants.

During the present study colour variation of lac insects were observed in 116 lac insect occurrence sites of Maharashtra. It was observed during the study that there are two type coloured found and these are crimson and yellow. Crimson lac insect has been reported from 71 sites of Gondia, Bhandara, Gadchiroli, Chandrapur, Parbhani, Nanded, Jalna, Washim, Akola, Hingoli, Yavatmal, Sangli, Osmanabad, Satara, Pune, Ahmednagar Nandurbar districts on *Butea monosperma*, *Zizyphus mauritiana*, *Ficus benghalensis*, *Albizia lebbek*, *Ficus racemosa*, *Pithocobium dulce*, *Ficus amphidissima*, *Ficus citrifolia* and *Albizia saman* whereas yellow lac insect was found in 37 sites of Parbhani, Jalna, Nanded, Hingoli, Latur, Ahmednagar, Buldana, Aurangabad, Dhule, Nashik, Jalgaon and Beed, Nandurbar districts on *Ficus religiosa*, *Albizia saman*, *Ficus benghalensis* and *Ficus amphidissima* plants while mixed (Crimson and Yellow both) was reported from 8 sites of Solapur, Hingoli and Aurangabad districts on *Albizia saman* and *Ficus religiosa* host plants. Meena *et al.*, (2020) [19] have also reported crimson and yellow colour mutants of lac insect on *Ficus religiosa* in western plains of India. Details of colour variations of lac insect is given in table 1.

Lac insect occurrence on different host plants

Survey revealed maximum lac insect occurrence on *Ficus*

religiosa plants in 46 sites (39.7%) followed by *Butea monosperma* (Palas) in 34 sites ((29.30%), *Albizia saman* (Rain tree) in 19 sites (16.4%), *Ficus racemosa* (Gular) in 5 sites (4.31%), *Ficus benghalensis* (Bargad) and *Ficus amphidissima* (India bat tree) in 3 sites (2.59%), *Pithocobium dulce* (Jangli Jalebi), *Zizyphus mauritiana* (Ber) in 2 sites (1.72) whereas minimum occurrence sites were reported on *Albizia lebbek* and *Ficus citrifolia* in only one site (0.86%). *Ficus religiosa*, *Butea monosperma*, *Albizia saman* and *Ficus racemosa* are the major host plants of lac insect found in about 90% lac insect occurrence sites of Maharashtra. Host plant wise occurrence of lac insect is given in figure 1, and table 3.

Major lac insect host plants species

Study revealed that major host plants are *Butea monosperma*, *Ficus religiosa*, *Albizia saman* and *Ficus racemosa* observed in 90 per cent of the lac insect occurrence sites in the state. Occurrence of lac insect on *Butea monosperma* was only found in cultivated condition in Vidharbh region. *Ficus religiosa* has been found to be a good host for natural conservation lac insect in the central region of the state. Similarly observation was made by Meena *et al.*, 2020 [19] on *Ficus religiosa* in many sites of western plains covering the state of Rajasthan, Gujrat and Haryan. Another good host plants for natural conservation of lac insect is *Albizia saman* reported from Deccan plateau of Maharashtra. Sharma *et al.*, 2006 [16] have also reported *Albizia saman* as major host species in Andhra Pradesh and West Bengal. Mohansundaram *et al.*, 2018 [20] have also reported it to have natural population of lac insect in Tamilnadu. Natural occurrence of lac insect on *Ficus racemosa* also have been reported from some adjoining districts of Telangana border of Maharashtra. District wise occurrence sites of lac insect on different host plants in Maharashtra are given in Table 2 and Fig.1.

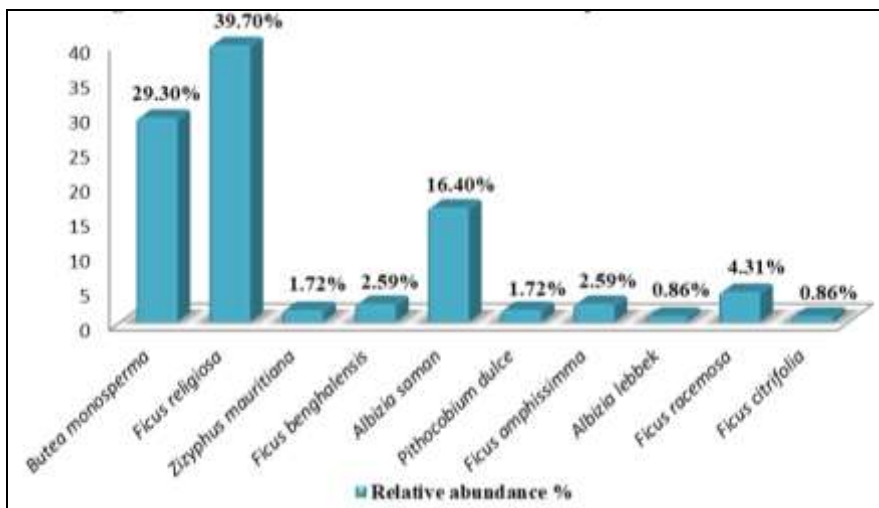


Fig 2: Lac insect occurrence on different host plants in Maharashtra

Table 3: Host plant wise occurrence of lac insect in Maharashtra

Common name	Botanical name	Family	Lac insect occurrence sites	Relative abundance %
Palas	<i>Butea monosperma</i>	Fabaceae	34	29.3
Pipal	<i>Ficus religiosa</i>	Moraceae	46	39.7
Ber	<i>Zizyphus mauritiana</i>	Rhamnaceae	2	1.72
Bargad	<i>Ficus benghalensis</i>	Moraceae	3	2.59
Rain tree	<i>Albizia saman</i>	Mimosaceae	19	16.4
Jangli Jalebi	<i>Pithocobium dulce</i>	Fabaceae	2	1.72
Indian bat tree	<i>Ficus amphissimma</i>	Moraceae	3	2.59
Kala siris	<i>Albizia lebbek</i>	Fabaceae	1	0.86
Gular	<i>Ficus racemosa</i>	Moraceae	5	4.31
Jangli Bargad	<i>Ficus citrifolia</i>	Moraceae	1	0.86
Total	10 Host plants	4 Family	116	100



Lac insect encrustation on different host plants in Maharashtra (a) Lac on *Butea monosperma* in Sakritola (Gondia), (b) Lac on *Ziziphus mauritiana* in Halvitola (Gondia), (c) Lac on *Ficus religiosa* in Rahori (Ahmednagar), (d) Lac on *Ficus racemosa* in Osmanabad, (e) Lac on *Ficus benghalensis* in Deolgaon (Buldana), (f) Lac on *Pithocobium dulce* in Malhivra (Hingoli), (g) Lac on *Ficus citrifolia* in Erabdondari (Gadchiroli), (h) Lac on *Ficus amphissimma* in Surkudi (Gondia), (i) Lac on *Albizia saman* in Pathri (Parbhani) (j) Lac on *Albizia lebbek* in Partur (Jalna), (k) Lac on *Ficus religiosa* in Sindhkhe (Buldana), (l) Lac on *Albizia saman* in Kopargaon (Ahmednagar).

Conclusion

In the study lac insect encrustation was observed on 10 different host plants in Maharashtra. Survey revealed that *Ficus religiosa*, *Butea monosperma*, *Albizia saman* and *Ficus racemosa* are the major host plants of lac insect in about 90% lac insect occurrence sites of Maharashtra. In cultivated condition about 75% lac is produced from only from Gondia district. It is also an important processing and marketing center for lac. Interstate trade is also done with Madhya Pradesh and Chhatisgarh. Vidharbh area of Maharashtra have good potential for producing lac crop. Gondia, Bhandara, Gadchiroli, Amravati and Yavatmal districts are suitable for Rangeeni strain on *Butea monosperma* whereas Bhandara and Gadchiroli district forest areas are suitable for Kusmi lac cultivation on *Schleichera oleosa* plants. Lac cultivation requires special focus as it can provide sustainable employment and economic returns to local inhabitants. This activity needs to be promoted in forest areas and farmers field through training and demonstration. It will not only result in extra income of *van samiti* members and Self Help Groups but will also help in protection of forests and conservation of lac insect. Efforts need to be made district wise for conserving valuable lac associated faunal and floral diversity of Maharashtra. Effort may also be made for the conservation of local hosts and strains of lac insect availability and popularizing the lac cultivation in non lac growing areas of Maharashtra.

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