



# Extent and Pattern of Natural Occurrence of Lac Insect and their Host Plants in different Agro-Climatic Zones of Bihar

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## ABSTRACT

Surveys were conducted in 28 districts of Bihar for occurrence of natural population of lac insect; *Kerria lacca* Kerr (Hemiptera, Tachardiidae), and abundance of its host plant. Naturally occurring lac insect was observed in 18 districts in varied proportion mostly on *Ficus religiosa*, *Ficus benghalensis* and rarely on *Ziziphus mauritiana* and *Butea monosperma*. Majority of insects were found dead but at a few places good live population was noticed. Natural occurrence of lac insect was found highly vulnerable to human interventions, high temperature, parasitoids and predators. Out of 17 districts of south Bihar, falling under zone III, 10 districts were found rich in naturally surviving lac insects. Lac insects in scattered manner were also observed in many other districts of Northern Bihar, but occurrence and population densities were very low. Survey revealed the abundance of lac hosts and natural population of lac insects in various districts (59%) of zone III of Bihar. These findings could open a new window for introduction of lac cultivation in these areas for livelihood support to resource poor farmers, especially during off-agricultural season.

## KEYWORDS

Agro-climatic zone, Bihar, *Ficus religiosa*, host, Lac insect

## INTRODUCTION

Lac is the resinous secretion produced by the lac insect, *Kerria lacca* (Kerr. (Hemiptera: Tachardiidae) which is formed as a protective nest, or hard shell, around the insect's soft body throughout most of its life-cycle, and is the only natural resin of animal origin. Due to its non-toxicity, strength and excellent bonding properties it finds numerous applications in industrial sectors like food, pharmaceuticals, cosmetics, perfumes, polishes, varnishes, paints, adhesives, jewelry and in textile dye (Srivastava and Jeet, 2020).

Lac insects require specific plant species as host for their survival. More than 400 host plants had been documented but only few are of commercial importance (Sharma *et al.*, 1997). India is the home of the *Kerria* species, as 20 out of the 27 known species of this genus are from India (Sharma *et al.*, 2006). However, natural populations of other species of *Kerria* are distributed throughout India. *Kerria communis* had been reported from south India *viz.*, Andhra Pradesh, Goa, Karnataka, Kerala and Tamil Nadu whereas; *Kerria lacca mysorensis* had been reported from Karnataka. The Indian lac insect, *Kerria lacca* (Kerr) can further be distinguished into two infra subspecific forms (strains), the *rangeeni* and *kusmi* on the basis of differences in lifecycle, host plant preference and the quality of lac produced. *Rangeeni* is characterized by unequal duration of bivoltine life cycle (4 and 8 months) and preference of *palas*, *Butea monosperma* as host, whereas *kusmi* by and large has equi-durational life cycle (6 months each) prefer *kusum*, *Schleichera oleosa* as host. The major host plants of *K. lacca* include *B. monosperma*, *S. oleosa*, *Ziziphus mauritiana*, *Ficus* spp., *Cajanus cajan* and *Flemingia semialata* (Sharma and Ramani, 2010; Monobrullah *et al.*, 2016).

India is the global leader in lac production and contributes about 85 percent of world lac production. Lac occurs in most parts of India but mainly cultivated in Jharkhand, Chhattisgarh, Madhya Pradesh, Maharashtra, Odisha, West Bengal and parts of some other states. Jharkhand and Chhattisgarh are among the most productive states, accounting about 70 per cent of the country total production (Yogi *et al.*, 2018). Total lac production of the country was 18,746 tons, of which 7668.42 tons were exported fetching Rs. 247.55 crores (Yogi *et al.*, 2018).

Lac cultivation is an important source of income for livelihood of forest and sub forest dwellers in different parts of the country. It generates employment for resource constrained farmers, particularly during off-agricultural seasons. Lac insect genetic resources exist in the form of a vast array of populations which have evolved and adapted over time to the range of environmental conditions. The lac insect genetic resources available in the country are under threat due to the disappearance of a substantial number of local populations as many lac insects and associated fauna have been abandoned or its habitat destroyed (Mohanta *et al.*, 2014). Therefore, the future improvement and development of lac insect will depend on the availability of the genetic variation, which is principal resource. Promoting and encouraging lac culture will not only check environmental degradation, but also conserve the associated fauna and flora for posterity. Conservation is of particular concern in regions of rapid agricultural change, where indigenous stocks and farming methods are being replaced. Areas where climatic extremes or particular parasitic conditions have resulted in genetically modified and unique local stocks which are able to survive under extreme conditions should be a high priority. Such conservation efforts are particularly important in the light of predicted global climate change, and the ability of microbial and insect parasites to

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evolve and adapt to modern chemical control methods. Not long ago, undivided Bihar was the number one lac producing state of the country which contributed significantly to national lac production, but after division of state its share is almost negligible as major lac producing districts fall under Jharkhand. There is no documented literature available about abundance and lac cultivation in Bihar after division of state. However, a natural occurrence of lac insect in Bihar is well established particularly on *Ficus* spp. It is pertinent to mention that naturally surviving lac insect population are available in certain part of Bihar, and people used to collect and sell it commercially. Interestingly, this State is bestowed with ample of lac host plants particularly adjoining area of Jharkhand. Keeping these in mind, the present study was planned to assess the availability of naturally occurring lac insect for future promotion of lac cultivation in the region.

### MATERIALS AND METHODS

Extensive surveys were undertaken during January, 2019 to May, 2020 in all three agro-climatic zones of Bihar. Keeping in view the potentiality of lac insect we restricted our surveys to only 28 districts of Bihar. To explore the naturally occurring lac insect population and abundance of its host trees block level survey was carried out. List of districts are as under (Table 1) for the all three zones.

**Table 1:** Survey for availability of Natural occurrence of Lac insect and their host trees in different Agro- Climatic Zones of Bihar

| Zone I<br>(North-West) | Zone II<br>(North-East) | Zone III a<br>(South-East) | Zone III b<br>(South-West) |
|------------------------|-------------------------|----------------------------|----------------------------|
| Begusarai              | Kishanganj              | Bhagalpur                  | Patna                      |
| Darbhangha             | Khagaria                | Banka                      | Bhojpur                    |
| East Champaran         |                         | Sheikhpura                 | Kaimur                     |
| Gopalganj              |                         | Munger                     | Arwal                      |
| Muzaffarpur            |                         | Lakhisarai                 | Buxar                      |
| Samastipur             |                         | Jamui                      | Jehanabad                  |
| Saran                  |                         |                            | Rohtas                     |
| Siwan                  |                         |                            | Aurangabad                 |
| Vaishali               |                         |                            | Gaya                       |
|                        |                         |                            | Nalanda                    |
|                        |                         |                            | Nawada                     |

The lac insect populations were located through visual observations and through binoculars, especially on reported lac host species. If lac insects were noticed, then the branches and twigs having the lac insect colonies were tagged and marked for subsequent collection. Matured female cells were collected and brought to ICAR-Research Complex for Eastern Region, Patna by cutting lac insect bearing branches with

**Table 2:** Natural occurrence of Lac insect and their host trees in Agro- Climatic Zone-I (North-West) of Bihar

| District       | Surveyed areas (Block)   | Host plants observed   | Availability of Lac insect | Lac insect available on host                   |
|----------------|--|--|----------------------------|--|
| Begusarai      | Begusarai, Bhagwanpur, Matihani, Barauni, Naokothi, Teghra, Garhpura, Chhorahi, Balia  | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i> , <i>F. benghalensis</i> | Available                  | <i>F. religiosa</i> and <i>F. benghalensis</i> |
| Darbhangha     | Darbhangha, Baheri, Biraul, Singhwara, Jale, Bahadurpur, Benipur, Manigachhi, Hanumannagar, Alinagar, Ghanshyampur, Tardih, Kiratpur | <i>F. religiosa</i> , <i>Z. mauritiana</i>   | Available                  | <i>F. religiosa</i>                            |
| East Champaran | Motihari, Chakiya, Mehsi, Kotwa, Harsidhi  | <i>F. religiosa</i> , <i>Z. mauritiana</i>   | Not available              | Not available                                  |
| Gopalganj      | Gopalganj, Thawe, Phulwaria, Manjha, Barauli   | <i>F. religiosa</i> , <i>Z. mauritiana</i>   | Available                  | <i>F. religiosa</i>                            |
| Muzaffarpur    | Paroo, Katra, Minapur  | <i>F. religiosa</i> , <i>Z. mauritiana</i>   | Available                  | <i>F. religiosa</i>                            |
| Samastipur     | Samastipur Pusa, Kalayanpur, Tajpur, Morwa, Patori, Warisnagar, Ujarpur, Khanpur   | <i>F. religiosa</i> , <i>Z. mauritiana</i>   | Available                  | <i>F. religiosa</i>                            |
| Saran          | Chapra, Maker, Masharkh, Nagra, Dariypur, Sonapur, Dighwara, Amnour, Taraiya, Panapur, Parsa   | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i>                          | Available                  | <i>F. religiosa</i>                            |
| Siwan          | Nautan, Siwan, Barharia, Hasanpura, Siswan, Raghunathpur, Darauli, Mahrajganj, Ziradei   | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i>                          | Available                  | <i>F. religiosa</i>                            |
| Vaishali       | Hajipur, Vaishali  | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i>                          | Not Available              | Not Available                                  |

secateurs and covered with moistened cotton plugs at both the ends to avoid desiccation. This was kept in the 60 mesh synthetic net with proper label for recording data on emergence of predators and parasitoids, if any. To record the fecundity of lac insect, the mature female cells were

collected and brought to the laboratory and placed individually into glass vials plugged with cotton for about a month and the total number of emerged larvae per female were counted and taken as fecundity of the female lac insect.



Fig. 1a: Natural occurrence of lac on *F. benghalensis*



Fig. 1b: Natural occurrence of lac on *F. religiosa*

**RESULTS AND DISCUSSION**

Based upon extensive survey done at block level in twenty-eight districts of Bihar, covering all three agro-climatic zones, results were summarized as zone wise to depict the extent and pattern of natural occurrence of lac insects and their host plants.

**Extent and pattern of natural occurrence of lac insect in zone I**

Out of thirteen districts of zone I of Bihar, the survey was conducted only in nine districts reveals the presence of lac insect in seven districts (Table 2). The occurrences of surviving populations were very low in majority of surveyed places. In all places lac insects were found only on *F. religiosa* except Begusarai where lac insect was also found on few *F. benghalensis* trees in surviving (Fig. 1a & b).

**Extent and pattern of natural occurrence of lac insect in zone II**

Out of eight districts of zone II of Bihar, the survey was conducted only in Kishanganj and Khagaria districts reveals the presence of lac insect in Kishanganj district. The occurrence of surviving populations were low to moderate in most the surveyed blocks and insect was found only on *F. religiosa* (Table 3).

**Extent and pattern of natural occurrence of lac insect in zone IIIa**

All six districts of southern districts of Bihar under zone IIIa was surveyed, in which lac insects were found abundantly in five districts mostly on *F. religiosa*. However, in Banka and Lakhisarai it was also observed on *B. monosperma* and *F. benghalensis*, respectively (Table 4).

**Extent and pattern of natural occurrence of lac insect in zone IIIb**

All eleven districts of southern districts of Bihar under zone IIIb was surveyed, in which lac insects were found moderately in five districts mostly on *F. religiosa*, except Nawada and Patna where it was also observed on *B. monosperma* and *Z. mauritianl*, respectively in scattered manner (Table 5).

Table 3: Natural occurrence of Lac insect and their host trees in Agro- Climatic Zone II (North-East) of Bihar

| District   | Surveyed areas (Block)   | Host plants observed  | Availability of Lac insect | Lac insect available on host |
|------------|--|---|----------------------------|------------------------------|
| Kishanganj | Kochadhamin, Thakurganj, Pothia, Bahadurganj, Kishanganj, Dighalbank, Terhagachh | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i> | Available                  | <i>F. religiosa</i>          |
| Khagaria   | Khagaria, Gogri, Alauli, Beldaur, Parbatta, Chautham, Mansi                      | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i> | Not available              | Not available                |

**Table 4:** Natural occurrence of Lac insect and their host trees in Agro- Climatic Zone IIIa (Southern East) of Bihar

| District   | Surveyed areas (Block)  | Host plants observed  | Availability of Lac insect | Lac insect available on host                   |
|------------|---|---|----------------------------|--|
| Bhagalpur  | Sabour, Bhagalpur, Kahalgaon  | <i>F. religiosa</i> , <i>Z. mauritiana</i>                          | Available                  | <i>F. religiosa</i>                            |
| Banka      | Banka, Barahat, Dhoraiya, Katoria                                     | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i>   | Available                  | <i>F. religiosa</i> , <i>B. monosperma</i>     |
| Sheikhpura | Sheikhpura, Ariari, Chewara, Ghat kusumbha, Shekhopur sarai           | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i>   | Available                  | <i>F. religiosa</i>                            |
| Munger     | Munger Sadar, Dharahara, Bariyarpur, Jamalpur, Tetiya bamber, Tarapur | <i>F. religiosa</i> , <i>Z. mauritiana</i>                          | Available                  | <i>F. religiosa</i>                            |
| Lakhisarai | Lakhisarai, Barahiya, Pipariya, Surajgarha, Ramgarh Chowk             | <i>F. religiosa</i> , <i>Z. mauritiana</i> , <i>F. benghalensis</i> | Available                  | <i>F. religiosa</i> and <i>F. benghalensis</i> |
| Jamui      | Jhajha, Jamui, Barahat, Chakai, Gidhaur, Sono                         | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i>   | Not available              | Not available                                  |

**Table 5:** Natural occurrence of Lac insect and their host trees in Agro- Climatic Zone IIIb (Southern West) of Bihar

| District   | Surveyed areas (Block)   | Host plants observed  | Availability of Lac insect | Lac insect available on host                 |
|------------|--|---|----------------------------|--|
| Patna      | Patna sadar, Masaurhi, Dhanarua, Punpun, Bikram, Pali, Danapur, Phulwari   | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i> | Available                  | <i>F. religiosa</i> , <i>Z. mauritiana</i>   |
| Bhojpur    | Arrah, Jagdishpur, Piro, Barhara, Shahpur, Koilwar, Tarrai, Behea, Agaion  | <i>B. monosperma</i> , <i>F. religiosa</i>                        | Available                  | <i>F. religiosa</i>                          |
| Kaimur     | Bhabhua, Bhagwanpur, Mohania, Chand, Adhaura, Ramgarh, Rampur  | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i> | Available                  | <i>F. religiosa</i> , <i>Z. mauritiana</i>   |
| Arwal      | Kaler, Karp, Kurtha, Sonvadra Bansi, Arwal   | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i> | Available                  | <i>F. religiosa</i>                          |
| Buxar      | Kesath, Chaugain, Buxar, Nawanagar, Barhampur, Dumraon   | <i>F. religiosa</i> , <i>Z. mauritiana</i>                        | Not Available              | Not Available                                |
| Jehanabad  | Kako, Ghoshi, Jehanabad, Makhdumpur  | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i> | Not Available              | Not Available                                |
| Rohtas     | Akorhigola, Bikramganj, Chenari, Dawath, Dehri, Dinara, Karakat, Kochas, Nasirganj, Nauhata, Rajpur, Rohtas, Sasaram | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i> | Not Available              | Not Available                                |
| Aurangabad | Nabinagar, Aurangabad, Deo, Kutumba, Obra, Daudnagar   | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i> | Not Available              | Not Available                                |
| Gaya       | Manpur, Banke Bazar, Sherghati, Imamganj, Dobhi, Parayia, Tekari   | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i> | Not available              | Not available                                |
| Nalanda    | Ekgarsarai, Parbalpur, Noorsarai   | <i>F. religiosa</i> , <i>Z. mauritiana</i>                        | Not available              | Not available                                |
| Nawada     | Akbarpur, Gobindpur, Pakribarawan, Ben, Nawada   | <i>B. monosperma</i> , <i>F. religiosa</i> , <i>Z. mauritiana</i> | Available                  | <i>F. religiosa</i> and <i>B. monosperma</i> |

During the survey in twenty-eight districts of Bihar, the natural occurrence of lac insect and its host plants was recorded in eighteen districts mostly on *F. religiosa* and *F. benghalensis* where as, on *B. monosperma* it was recorded only in Banka and Nawada districts. Similarly, on *Z. Mauritiana* it was recorded only in Patna and Kaimur districts. The prevalence of lac insect was more on both species of *Ficus* in majority of region particularly on the protected trees grown in the vicinity of religious places like temples. The abundance of surviving lac insect was more in Southern part of Bihar namely Bhagalpur, Banka, Sheikhpura, Munger, Lakhisarai, Arwal, Nawada and Patna. However, scattered population was also observed in some districts in Northern part of Bihar (Fig. 2). During the survey only crimson coloured *rangeeni* strains on these hosts with varying

densities were observed. Through interaction with local resident during visit it was ascertained that the lac insect was highly prone to summer heat mortality and its natural occurrence is highly threatened through human interventions, coupled with the occurrence of parasitoids and predators. Local resident bordering with Jharkhand informed that lac was abundant and was collected by tribal people about 15-20 years back. However, majority of the local people were unaware about this insect. Not long ago, collection of lac was carried out practically throughout the country including Bihar which contributed significantly to national lac production, but now its share is almost negligible after division of Bihar. However, a natural occurrence of lac insect is well established particularly on *Ficus* spp. as evident during survey period.

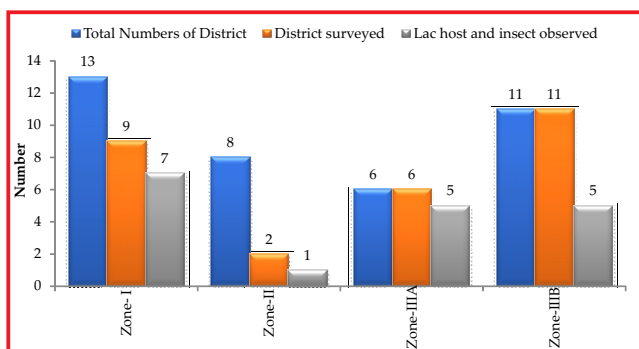


Fig. 2: Natural occurrence of lac insect in different agro-climatic zones of Bihar

### Parasitoids and predators

During the investigation 2 species of predators viz., *Eublemma amabilis*, *Pseudohyapatopa pulverea*, and two species of primary parasitoids namely *Tachardiaephagus tachardiae* and *Aprostocetus purpureus* were recorded with lac insect whereas other reported predators and parasitoids of lac insects were in meagre number. Among the parasitoids, *A. purpureus* was found more in number (42 per 10 cm lac encrustation) as compared to *T. tachardiae* (14 per 10 cm lac encrustation). This observation is in accordance of earlier findings of Monobrullah *et al.* (2015) wherein they reported *A. purpureus*, as the most dreaded endoparasitoid of lac insect and established direct correlation between decline in lac production and parasitisation. Sharma *et al.* (2010) also reported upto 57.6 percent parasitisation of lac insects with *A. purpureus* whereas only 20 per cent parasitisation was reported about two decades back. Simultaneously, predators are also serious and may cause damage to the lac crop up to 35-45% annually. About 20 predators have been reported from different parts of the country, among which *Eublemma amabilis*

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and *Pseudohyapatopa pulverea* were the most destructive (Sharma *et al.*, 2008; Monobrullah *et al.*, 2015).

### Fecundity

Data on fecundity (Number of young ones produced by the female insect) of lac insect revealed the maximum mean fecundity of 392 crawlers from single female cell from the Banka collection as against minimum mean fecundity of 217 from the collection of Saran, which corroborate the earlier findings of (Mohanta *et al.*, 2012) who evaluated the productivity of *K. lacca* on *Flemingia semialata* and *F. macrophylla* in terms of fecundity and found that the fecundity varied from 253-565 and 297-477 larvae per female cell, respectively on the two hosts.

### CONCLUSIONS

Based on above findings, it has been realized that the vast area of Bihar region particularly the agro-climatic zone IIIa and IIIb, i.e., southern region are bestowed with ample population of lac insect and its host plants viz., *Ber*, *Palas* and *Ficus*. These plants could be exploited for cultivation of lac on commercial scale through large scale demonstration and extensive training programmes for the rural people of the area as well as extension workers at frequent intervals. The survey conducted indicates that there is need to explore possibility of sustaining livelihood through lac cultivation, particularly in off-agricultural season for resource constrained farmers.

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