
Chapter 4

Resistance of Lac Host Plant against Insect Pest

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ABSTRACT:- Lac cultivation is an important agro-forestry activity in India, particularly in Jharkhand, where it contributes significantly to rural livelihoods and biodiversity conservation. Lac is a natural resin secreted by the insect *Kerria lacca*, which depends on specific host plants such as *Butea monosperma* (Palas), *Schleichera oleosa* (Kusum), and *Ziziphus mauritiana* (Ber) for nourishment. The productivity of lac largely depends on the health and resistance of these host plants against insect pests. This study highlights the interaction between lac insects and their host plants, focusing on cultivation practices, pest challenges, and inherent resistance mechanisms. Major pests such as bark borers, defoliators, and sap-sucking insects negatively affect host plant vitality and lac yield. However, host plants exhibit morphological and biochemical resistance traits, including thick bark, tough leaves, tannins, phenolic compounds, and regenerative capacity, which help mitigate pest damage. Proper management practices such as pruning, scientific inoculation, and timely plant protection measures further enhance productivity. Understanding host plant resistance is crucial for sustainable lac cultivation and improving economic returns for farmers.

Keywords- *Kerria lacca*, *Butea monosperma*, *Schleichera oleosa*, *Ziziphus mauritiana*, Lac cultivation

INTRODUCTION

Lac is a natural resin secreted by an insect, *Kerria lacca*, which thrives on tender twigs of specific host trees namely Kusum (*Schleichera oleosa*), Palas (*Butea monosperma*) and Ber (*Zizyphus mauritiana*).¹ India is leading lac producing country in the world with Thailand being a close competitor. Jharkhand is the major lac growing state. Lac is a natural resinous material with significant economic importance. It has a diverse application and used as a protective and decorative coating in the form of thin films, adhesive and plastics. Lac production is advantageous in a variety of ways, guaranteed production even in drought condition, easy marketability, high return with low investment, low risk, non-perishable cash crop, facilitate biodiversity conservation, little interference with agriculture and horticulture crops.² The prosperity of the lac market has encouraged farmers to enhance lac production, and farmers are increasingly transitioning from traditional lac gathering to scientific lac farming on a plantation basis.³



Fig. 1: Lac stick



Fig. 2: Phunki broodlac

LAC INSECT:

Laccifera lacca (lac) insect is the only organism which produces natural resins.⁴ The insect belongs to group Coccoidea of order Homoptera. There are nine genera 87 species of lac found worldwide. Lac is beneficial for commercial purposes as it secretes a resinous material. Millions of the sessile lac insects live on specific host plants, secreting resin as their body covering, which is eventually harvested in the form of resin, dye, and wax of commercial importance. It is the only animal derived resin, making it suitable for a wide range of application such as protective and

ornamental coating in the thin films, adhesive, and plastics. It contributes tiny but considerable contribution to the country's foreign exchange earnings, but the most essential role that lac play in the economy. *K. lacca* and *K. chinesis* found in tropical regions while *K. sharda* found in coastal regions. *K. lacca* and *K. chinesis* are bivoltine corps which produces two corps in a year, while *K. sharda* is a trivoltine crops which is largest producer of lac among worldwide. In India, Jharkhand is largest lac producing state.

Lac Crop Cycle Lac is a natural resin secreted by small insects, specifically *K. lacca*. The insects are cultivated on delicate shoots of different plants called hosts. It gets its nutrients by sucking sap from the host plants. Lac insect strains are usually associated with insect life cycle. There are two strains of the lac bug viz, rangeeni and kusmi. Each strain completes its life cycle twice a year, yielding two crops per year. However, in the coastal regions of West Bengal and Odisha, a tri-voltine insect called *Kerria sharda* is present, which produces three crops every year. However, in each case, the duration of the life cycle and the seasons of maturation vary.

Kerria lacca is most common and commercially important. It has two strains-

1. Rangeeni
2. Kusmi

1. Rangeeni strain: Rangeeni strain of *K. lacca* have two crops –

- (a) **Katki** – It is also known as rainy crop which inoculate in June–July and harvested in the month of October–November. It is four months crops.
- (b) **Baisakhi** – It is also known as summer crop which inoculate in October–November and harvested in June–July. It is eight months crops.

2. Kusmi strain: Kusmi strain of *K. lacca* has two crops

- (a) **Aghani** – It is also known as winter crop which inoculate in the month of June–July and harvested in the month of January–February. It is six-month crop.
- (b) **Jethwi** – It is known as summer crop which is inoculate in the month of January–February and harvested in the month of June–July. It is months crop.

LAC HOST

Lac host plants play a crucial role in the cultivation of lac insects, serving as their primary biotic associates. Lac insects depend on these plants for nourishment, feeding on tender, succulent branches and extracting sap through their proboscis. Therefore, the success of lac cultivation is highly dependent on the proper management of both host plants and lac insects. However, deforestation and the indiscriminate cutting of host plants due to expanding social, industrial, and mining activities have led to a steady decline in the area available for lac cultivation. This reduction poses a significant challenge to sustainable lac production. To enhance lac yield and ensure long-term sustainability, there is a need to promote intensive cultivation of lac on a plantation basis. Lac host plants are broadly classified into five categories based on the degree of preference (predilection) shown by lac insects.

Common / major lac hosts:

1. *Schleichera oleosa* (kusum)
2. *Butea monosperma* (palas)
3. *Ziziphus mauritiana* (ber)
4. *Flemingia semialata*

Regional lac hosts:

1. *Acacia Arabica*
2. *Grewia* spp.
3. *Leea* spp.
4. *Shorea talura*
5. *Cajanus cajan*

Quick growing lac hosts:

1. *Acacia auriculiformis*
2. *Albizzia lucida*
3. *Flemingia macrophylla*
4. *Albizzia saman*

Occasional lac hosts:

1. *Acacia farnesiana*
2. *Shorea robusta*

MAJOR HOST PLANTS: CULTIVATION OF LAC ON PALAS TREE

Palas Tree: Nomenclature and Importance in Lac Cultivation

The Palas tree (*Butea monosperma*), popularly known as “*Chaak ke teen pat,*” is widely recognized across India. It is also known by various

regional names such as Palas, Parsa, Dhak, and Tesu. In English, it is referred to as *Bastard Teak* or *Bengal Kino*. In different Indian languages, it is called Patlas or Parsa (Bengali), Murka (Odia), Moduga (Telugu), Murukka Maram (Malayalam), and Muruv (Mundari and Santhali). Palas is an important host plant for lac cultivation, and notably, lac insect rearing does not cause any significant harm to the tree. The Rangeeni strain of lac insect produces two crops annually on Palas:

(a) **Baisakhi (summer crop)**

(b) **Katki (rainy season crop)**

For the Baisakhi crop, brood lac (beehan lac) is inoculated onto the host trees.

GENERAL PRACTICES FOR LAC INSECT REARING ON PALAS

1. Pruning of Trees: Pruning is essential before inoculation, as lac insects thrive on soft, tender, and succulent branches. Ideally, pruning should be carried out about 6 months prior to insect release. Thus, for the Baisakhi crop (inoculated in October–November), pruning should be done in April. If the tree is not already inoculated with lac, pruning should be done when pods begin to develop (around March).

Pruning guidelines:

- Avoid cutting branches thicker than 2.5 cm (thumb thickness)
- Branches of 1.25–2.5 cm diameter should be cut at a height of about 1–1.5 feet
- Thinner branches (<1.25 cm) should be cut from their point of origin
- Remove dry, diseased, broken, or damaged branches completely
- Use a sharp saw and make clean, slanting cuts in a single stroke
- During the first pruning, slightly thicker branches may be removed to give proper shape to the tree

2. Inoculation (Insect Transmission)

Insect transmission is carried out by tying beehan lac sticks onto branches. It can be done by three methods:

- 1. Traditional (Farmer's method):** Twigs (1–3 feet long) bearing mature lac encrustation along with insects are directly tied to new host branches
- 2. Scientific method:** Beehan lac sticks are cut, bundled, and tied at selected locations using twine

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3. **Net method (Protected inoculation):** Beehan lac is placed in 60-mesh nylon bags to protect from predators

Procedure:

- Fill approximately 100 g of beehan lac in a nylon mesh bag (approx. 27×12 cm)
- Tie both ends with plastic twine
- Attach the bag to branches, keeping the twine slightly long for easy tying
- If nylon net is unavailable, tie 100 g bundles directly onto branches
- Once insects emerge and nearby branches are colonized, shift the bundle to uninfested branches

3. Plant Protection (Spraying)

To protect lac insects from predators and fungal infections, timely spraying is essential.

Recommended solution:

- Fipronil 5% SC at 0.007% concentration
- Carbendazim fungicide (10 g per 15 litres of water)
- Mix approximately 22–25 ml Fipronil in 15 litres of water along with Carbendazim

Spray schedule:

- First spray: 30 days after inoculation or insect emergence
- Second spray: 60 days after inoculation

These measures help in minimizing pest attack and protecting the crop from fungal damage, especially during foggy conditions.

Segment system:

Palas trees (*Butea monosperma*) can be efficiently managed for lac cultivation by dividing them into three sections. Out of these, two sections are maintained for the production of brood lac (beehan lac), while the third section is utilized for the production of the Baisakhi Ari (raw lac) crop. The brood lac obtained from the first beehan section is used for inoculating the trees in both the second beehan section and the Ari section. This rotational system ensures a continuous and sustainable supply of brood lac. As a result, beehan lac is obtained from the first section in even-numbered years (2, 4, 6, 8, etc.) during the month of October, while

the second section produces beehan lac in odd-numbered years (3, 5, 7, 9, etc.).

The Ari section, on the other hand, consistently contributes to brood lac availability and supports raw lac production. Through this systematic division and rotation, raw lac can be harvested annually, typically in the month of April, ensuring regular production and efficient utilization of host trees.



Fig. 3: Palas tree host of lac



Fig. 4: lac on Palas tree



Fig. 5: broodlac on palas tree

RESISTANCE OF PALAS TREE (HOST) OF LAC INSECT AGAINST INSECT PEST

The Palas tree (*Butea monosperma*) is widely used for large-scale lac production; therefore, maintaining a healthy host plant is essential. However, several insect pests adversely affect its productivity. One of the major pests is the bark borer (*Indarbela* spp.), commonly known as the bark-eating caterpillar. The larvae bore into the bark of the Palas tree and create irregular tunnels within the stem and branches. By feeding on internal tissues, they disrupt nutrient flow, leading to drying and dieback of branches. Another important pest is the leaf-eating caterpillar *Arthroschista hilaralis*, commonly known as the Palas leaf webber. The larvae feed on green leaves and, in severe infestations, can consume almost the entire leaf lamina, leaving only the veins. Such defoliation weakens the host tree and significantly reduces lac production. Despite these pest pressures, the Palas tree possesses several adaptive resistance mechanisms. Morphologically, it has a thick, irregular, and robust bark that makes larval penetration difficult. Biochemically, the bark contains high levels of tannins and phenolic compounds, which act as feeding deterrents and growth inhibitors for insect pests. These secondary metabolites reduce pest survival and feeding efficiency. Additionally, Palas exhibits strong wound-healing capacity, allowing rapid recovery

of damaged tissues. Its well-developed branching system helps limit localized damage and prevents total loss of the plant. Overall, the Palas tree demonstrates considerable tolerance and resilience against insect pests, making it a highly suitable host for sustained lac cultivation.

CULTIVATION OF LAC ON KUSUM TREE

Kusum (*Schleichera oleosa*), a member of the Sapindaceae family, is commonly referred to as the “lac tree.” It is widely found in forests and rural landscapes, where it often resembles the Mahua tree in both appearance and structure. During the autumn months of February–March, the tree produces striking new foliage that is characteristically reddish in color. The oil extracted from its seeds is used for lighting and various other purposes. Notably, the Rangini strain of lac insect cannot be cultivated on Kusum, making it a useful species for distinguishing between Rangini and Kusmi lac insects. Moreover, Kusum supports the rearing of lac insects in both summer and winter seasons.

The Kusum tree

The *Aghani* (winter) and *Jethvi* (summer) crops of Kusmi lac are cultivated from June–July to January–February and from January–February to June–July, respectively. Under normal conditions, Kusmi lac insects reared on Kusum trees can yield 7–8 times the quantity of the initial brood lac (beehan lac) within a six-month cropping period; that is, 1 kg of beehan lac can produce approximately 7–8 kg of harvested lac. Kusum trees are generally large in size, and typically 4–6 kg of beehan lac is inoculated per tree. This can result in a yield of about 30–45 kg of lac after six months, making beehan lac production relatively efficient and economically viable.

Pruning of Trees

Under normal conditions, pruning should be carried out about 18 months in advance to obtain soft branches of adequate length and suitability. However, for the first pruning, it can be done after 12 months, during which thicker branches may also need to be removed. The most appropriate time for pruning Kusum (safflower) trees is during January–February or June–July, coinciding with the maturity period of lac insects.

Inoculation (Insect Transmission)

The process of transferring lac insect larvae onto soft branches is known as inoculation or insect transmission. For this purpose, beehan lac twigs are cut into pieces of about 6 inches in length. While cutting,

portions without encrustation are removed. A roll-cut secateur (single-sided blade) is used for clean cutting. Approximately 100 grams of beehan lac is bundled and tied with plastic twine at both ends. The bundle is then securely attached to a suitable branch in such a way that the emerging larvae can easily crawl onto fresh shoots.

Removal and Sale

After the complete emergence of lac larvae from the brood lac, the remaining lac-encrusted twig is known as *phunki lac*. Once emergence is complete, these twigs should be promptly removed from the trees. The lac is then scraped, collected, and made ready for sale.

Plant Protection Measures

To control pests such as *Chrysopa*, the following measures should be adopted:

- First spray (25–30 days after inoculation): Ethofenprox 0.02% (Bombard 10 EC) combined with Carbendazim 0.05%
- Second spray (38–40 days): Apply the same mixture or use Indoxacarb or Fipronil when eggs or larvae of *Chrysopa* appear
- Third spray (62–65 days): If infestation persists, apply any one of the above insecticides mixed with Carbendazim fungicide

These timely interventions help in protecting lac insects and ensuring better yield.

RESISTANCE OF KUSUM TREE (HOST) OF LAC AGAINST INSECT PEST

The major insect pests affecting lac cultivation on Kusum (*Schleichera oleosa*) include bark borers, mealybugs, and various predators. Among them, *Euproctis fraterna*, commonly known as the hairy caterpillar moth, is a significant defoliator. This species belongs to the family Erebidae and is widely distributed across India and other native regions. The larvae of *E. fraterna* are characterized by a dense covering of hairs, which can cause irritation and itching upon contact with human skin. These larvae feed voraciously on the green foliage of the Kusum tree and complete their entire life cycle on the host plant.⁵ Continuous feeding leads to severe defoliation, weakening of the tree, and a substantial reduction in plant growth and lac yield. Despite these challenges, the Kusum tree possesses several adaptive features that support its survival and sustained lac production. It exhibits both biochemical and morphological resistance against insect pests. The tree has strong, woody

branches that prevent extensive damage, while its thick and dense leaves are relatively less suitable for larval feeding. Additionally, the branching pattern of Kusum helps localize damage, thereby preventing complete destruction of the tree.



Fig. 6: Kusum tree segment for lac production

CULTIVATION OF LAC ON BER (*Ziziphus mauritiana*)

Role of Plum Trees in Lac Cultivation

Plum trees are not only valued for their fruits but also serve as an important host for lac cultivation.⁶ A key advantage of plum is that it supports the rearing of all types of lac insects, including both two-crop and three-crop strains found in regions such as Odisha and West Bengal. Unlike Kusum (which supports only Kusmi lac) and Palas (which supports only Rangeeni lac), plum trees can support both Rangeeni and Kusmi types of lac insects.

Two-Crop Rangeeni Lac Cultivation

Rangeeni lac is typically cultivated in two crop cycles annually: Baisakhi (summer crop) and Katki (rainy season crop)

For the Baisakhi crop, inoculation is carried out during October–November, while for the Katki crop, it is done in June–July. The crops mature approximately after 8 months (Baisakhi) and 4 months (Katki), becoming ready for harvest in July and October–November, respectively.

Baisakhi Ari (Raw) Crop Production

This method is commonly practiced in hot climatic regions, where plum is cultivated in combination with Palas. During peak summer (May–June), high temperatures and reduced foliage on plum trees lead to increased mortality of lac insects. Therefore, only raw lac is harvested from plum during this period, while brood lac (seed lac) for the next cycle is generally obtained from Palas or other host trees such as Podho, Putkal, and Peepal.

Plant Protection Measures

- To control insect pests and fungal infections, a spray solution is prepared by mixing:
- 22–25 ml of Fipronil in 15 litres of water
- 15 g of Carbendazim fungicide

Spraying schedule:

- First spray: One month after inoculation
- Second spray: Late January or early February, before the emergence of adult males
- In infested crops: A single spray should be applied one month after insect emergence
- Spraying should be restricted to lac-encrusted branches only

Productivity:

- An average-sized plum tree yields about 2 kg of lac, which can increase to 6–8 kg under normal management conditions annually.

Advantages of Plum Trees in Kusmi Lac Cultivation:

- Higher productivity compared to Rangeeni lac on other hosts
- Good compatibility with Kusum-based lac cultivation systems
- Helps overcome the shortage of brood lac caused by low winter yield on Kusum
- Harvesting of Kusmi lac coincides with pruning, eliminating the need for separate pruning operations
- Requires only about 6 months for re-inoculation, compared to 1.5 years in Kusum
- Avoids premature shedding of lac encrustations, a common issue in Kusum during winter
- Can be used for brood lac (beehan) production in Kusmi cultivation, while in Rangeeni it is mainly used for raw lac
- Enables efficient mixed farming systems, especially beneficial for farmers with limited Kusum trees, reducing the need for multiple host plant sections

Productivity: About 2-3 kg on an average sized tree. After 6 months of sowing under normal circumstances, the yield is 15 to 20 kg. Behan lac can be produced.

RESISTANCE OF BER TREE (HOST) OF LAC AGAINST INSECT PEST

The Ber tree (*Ziziphus mauritiana*) is affected by several insect pests, among which the leaf-eating caterpillar *Pericyma cruegeri* is a major

defoliator.⁷ The larvae feed extensively on the leaves, causing severe defoliation under heavy infestation. Such damage weakens the tree and adversely affects its growth and productivity. Another important pest of Ber is the mealybug *Ferrisia virgata*, commonly known as the striped mealybug, belonging to the family Pseudococcidae. This sap-sucking insect feeds on plant sap, leading to symptoms such as leaf curling, yellowing, and overall weakening of the plant. Continuous feeding by this pest significantly reduces plant vigour. Despite these challenges, the Ber tree exhibits several defense mechanisms that confer resistance against insect pests. It possesses both morphological and biochemical resistance traits. The tree has a tough bark that restricts penetration and damage by pests like *Pericyma cruegeri*. Its strong and well-developed branching system prevents extensive damage to the plant structure. Additionally, the leaves of the Ber tree have a thick cuticle, which makes them less palatable and reduces feeding by insect pests. This cuticular layer also provides protection against other pest species. The presence of modified spines at the nodes further acts as a defensive adaptation, limiting feeding and grazing by insects and other herbivores. The strong bark also limits the bark borer to enter the plant tissue. The bark borers do not completely damage the host plant. The structure of leaves of Ber host tree also help in the limitation of harmfulness of insect pest.

The Ber tree have small and shiny leaves which are less suitable for insect to feed on them. The cuticle leaves reduce the attack of defoliators. The Ber tree also have biochemical resistance against insect pest. The presence of biochemical factors such as tannin, phenolic compound and chemical, which act as a toxic substance for the insect pest. The presence of tannin and phenolic compound limits the feeding capacity of insect pest by playing the role of feeding deterrents. The biochemical factors do not allow the multiplication or survival of insect pest.



Fig. 8: lac on ber host tree



Fig. 9: Planting segment of Ber host plant

CONCLUSION

Lac cultivation is a sustainable and economically viable practice that relies heavily on the health and resilience of host plants. Palas, Kusum, and Ber not only serve as primary hosts for lac insects but also demonstrate significant resistance against a variety of insect pests through both structural and biochemical defenses. These natural resistance mechanisms reduce pest impact and support stable lac production even under adverse conditions. However, increasing pest pressure and declining host plant availability due to environmental degradation pose serious challenges. Therefore, adopting scientific cultivation practices, conserving host plant diversity, and promoting integrated pest management strategies are essential for enhancing productivity and ensuring long-term sustainability. Strengthening research and farmer awareness on host plant resistance can further improve lac yield and contribute to rural economic development and ecological balance.

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