

all temperatures at NAP. However, low-pressure fumigation resulted in significant decrease in germination. Fumigations at 23°C exhibited slight enhancement and those at 33°C caused little deterioration in germination in specific cases but in general, orange oil fumigation was found superior to others. These results are supported by previous reports that seed quality and viability were not affected by the citrus peel treatments (Don-Pedro, 1985). Crushed orange peel treatment has also been reported to improve the quality of seed during storage as compared to untreated lot. Deleterious effects on seed viability and vigour in the event of repeated fumigations or fumigation at higher concentration, temperatures or seed moisture contents and longer exposure periods have also been reported (Scudamore and Goodship, 1992; Gupta and Kashyap, 1995; Ren *et al.* 1996).

The studies revealed that citrus peel oils if used judiciously, would not affect seed viability which may be rather enhanced on account of prevention of damage caused by insects. Hence, citrus peel oil fumigation treatments at NAP can be safely recommended for quarantine disinfestation of cowpea seeds harbouring hidden infestation caused by *C. maculatus*. Further studies are required for use of these oils in low-pressure fumigation.

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## Collection and Conservation of Lac Insects and their Host-Plants: Importance and Strategies

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**Key Words:** Lac insect, *Kerria* species, Host plants

Lac is regarded as an important natural heritage of our country as its utility has been known since time immemorial. The financial value of lac insects and their host-plants is of major importance in the economics of tribal lac growers. Cultivation of lac not only provides livelihood to millions of them but also has helped in conserving the vast stretches of forests. Forests are store-house of lac insect diversity. Over exploitation of these directly affects the survival of lac insects. Habitat destruction has been the major cause of shrinkage in

area of lac cultivation. With destruction of forests disappear the lac insect also. Human impact on environment particularly on forests has put many species of lac insects and lac host-plants in the 'waiting list' of extinction. Hence, preservation of habitat is the most important criterion for conservation of lac insects.

India is privileged in being the largest producer of lac in the world. Lac insects are the crowning glory of India's rich insect fauna. Of the nine genera and 87 species of lac insects reported from the world (Sharma

and Ramani, 1999), two genera and 19 species are found in our country representing 21.8% of the known lac insects species diversity (Table 1).

Lac insect ecosystem is a complex multi-trophic web of flora and fauna. Eight species of lac predators, 19 species of primary parasites and 35 species of secondary parasites (Das, 1990) besides, several fungal pathogens (Shaoji, 1993) represent a rich biodiversity of this ecosystem. Some of the insect fauna associated with the lac insects are species specific and hence, loss of even one species of lac insect will pose a danger of losing many other related insect species.

Lac insects are our highly valued but least appreciated resources. With the increase in human population inaccessible areas are being encroached upon which has

affected adversely lac insects and their host-plants. Some of the important and real threats which, merit immediate attention are:

- For commercial production of lac mainly *Kerria lacca* (Kerr) has been exploited. Potential of other species remains to be tested and exploited. In the absence of any human intervention the un-exploited lac species remain neglected and may be lost. Wild lac insects are principally distributed in the forest and sub-forest region thus, the future of lac insects is intricately linked to the fate of forests. Fast depleting forest cover of the country is a serious threat to the biodiversity of lac insects as well as their host plants.

Following are the threats to lac insects and their host plants:

**Table 1. Different species of lac insects reported from India (modified after Sharma *et al.* 1999) and their vulnerability status.**

S. No.	Lac insects species	Host plants	State/Locality from which reported
<b>A. <i>Kerria</i> spp. reported from major lac growing areas</b>			
1	<i>K. albizziae</i>	<i>Landolphia</i> sp.	Bihar*, Uttar Pradesh and West Bengal
2	<i>K. brancheata</i>	<i>Schleichera oleosa</i>	Bihar
3	<i>K. chinensis chinensis</i>	<i>Cajanus cajan</i>	North-East India
4	<i>K. kydia</i>	<i>Kydia calycina</i>	Assam (Silcher)
5	<i>K. fici fici</i>	<i>Ficus religiosa</i>	Bihar (Monghyr), Delhi, Jammu and Kashmir, Rajasthan, Uttar Pradesh and West Bengal
6	<i>K. lacca lacca</i>	<i>Ficus religiosa</i>	All India
7	<i>K. mysorensis</i>	<i>Shorea talura</i>	Karnataka (Mysore)
8	<i>K. nagoliensis</i>	<i>Schleichera oleosa</i>	Madhya Pradesh**
9	<i>K. sharda</i>	<i>Schleichera oleosa</i>	Orissa (Mayurbhanj)
10	<i>K.c. rangoonesis</i>	<i>Quisqualis</i> sp.	Assam
<b>B. <i>Kerria</i> spp. reported either from minor lac growing or non-lac growing regions and are considered endangered</b>			
1	<i>K. chamberlini</i>	<i>Ficus infectoria</i>	Rajasthan (Jodhpur)
2	<i>K. communis</i>	<i>Ficus mysorensis</i>	Andhra Pradesh, Goa, Karnataka, Kerala Maharashtra and Tamil Nadu
3	<i>K. ebracheata</i>	<i>Ficus elastica</i>	Bihar (Manbhum District), Karnataka
4	<i>K. fici jhansiensis</i>	<i>Ziziphus mauritiana</i>	Uttar Pradesh (Jhansi)
5	<i>K. indicola</i>	<i>Ziziphus mauritiana</i>	Bihar, Uttar Pradesh (Jamunia)
6	<i>K. ambigua</i>	<i>Jheolia</i> ?	Uttar Pradesh (Guna near Jhansi)
7	<i>K. nepalensis</i>	<i>Litchi chinensis</i>	Bihar (Champaran)
8	<i>K. pusana</i>	<i>Ziziphus mauritiana</i>	Bihar, Pusa
<b>C. <i>Paratachardina</i> spp. which do not produce true lac and are treated as pests, bearing the burnt of control measures, thus making these the most vulnerable</b>			
1	<i>P. lobata</i>	<i>Pongamia pinnata</i>	Andhra Pradesh, Karnataka and Tamil Nadu
2	<i>P. lobata</i> var. <i>schmidtii</i>		
3	<i>P. lobata</i> var. <i>walezuchae</i>		
4	<i>P. mithilae</i>	<i>Photinia notoniana</i>	Meghalaya (Shillong)
5	<i>P. silvestrii</i>	<i>Ixora parviflora</i>	Karnataka (Mysore)
6	<i>P. ternata</i>	<i>Acacia chundra</i>	Kerala (Travancore)
7	<i>P. theae</i>	<i>Thea chinensis</i>	Sikkim and West Bengal

\* Bihar includes Jharkhand also

\*\* Madhya Pradesh includes Chhattisgarh also

? Botanical name not traceable

- Many of the lac host plants like lichi (*Litchi chinensis*), ber (*Ziziphus mauritiana*), mango (*Mangifera indica*) and sandal (*Santalum album*) are economically important. Therefore, lac insect populations infesting such plant species are deliberately destroyed paving the way to erosion of the biodiversity of lac insects.
- Fluctuating prices of lac and over dependence on foreign buyers leading to shrinking economic returns from lac cultivation has eroded the lac cultivation area. Orissa, Gujarat, Assam, Punjab and Uttar Pradesh earlier contributed significantly in lac production but now their share is almost negligible as cultivation of lac has been abandoned. Many species of lac insects reported from these places have thus, become endangered.
- Unlike conservation of plant species, conservation of lac insects is more demanding and requires continuous monitoring as they can only be maintained under living state on host-plants. The mechanism and manpower available for this purpose is inadequate.
- Some of the species/varieties of lac insects e.g. *kusmi* strain of *K. lacca* which produces superior quality of lac are exclusive to our country and need to be protected in this era of free trade and open market.
- Species of *Paratachardina* do not produce true lac and hence, are not cultivated. These insects are direct target of pest control measures and this makes them the most vulnerable.
- Out of more than 400 reported lac-hosts not more than two dozens are utilized for commercial production of lac. Danger looms large on other host-plants whose economic importance remains to be realized.
- Collection and survey of lac insects and their host-plants unlike in other crops is very demanding and poses certain peculiar difficulties. In non-lac growing regions people do not have any knowledge about lac insects and are unable to provide any information regarding its habits and habitats.

*Strategies for conservation:* Fate of lac insects and their host-plants is linked with the fate of forests. Urgent and immediate steps are required to have these resources conserved. Strategies which are expected to yield results, are listed as follows:

- There is strong need to undertake extensive surveys of our country and abroad to know the present status of the lac insects and their plant-hosts biodiversity.

The reported species of lac insect do not give any idea, hitherto, of unreported species and more importantly the infraspecific genetic diversity of those species of economic value. There is a great need for properly identifying, documenting and conserving (*in situ* and *ex situ*) the diversity of lac insects.

- Action needs to be initiated to build a strong infrastructure to develop field germplasm bank to conserve at one suitable place, all the recorded lac insects and host-plants. Protected lac insect and host habitats on the pattern of sanctuaries and wild life parks in different agro-climatic zones are needed to conserve the precious wealth of our country.
- To offset the shrinking forests there is an urgent need to integrate lac culture with agriculture. This will not only augment the earnings/unit area but also help in conserving the lac insect and host plants. A system has to be evolved where lac insects can remain as one component of the agri-horticultural ecosystem without adversely affecting the economic returns from these crops.
- Afforestation programmes should include planting of lac host tree species according to the preference of the lac insects.
- Scientific research on lac insects' fauna should be encouraged in different research institutions and universities regarding lac-culture as an important component of different cropping systems. An All India Coordinated Research Project on lac insects could be the first step in this direction.
- Lac insects of *Paratachardina* species have been reported to be very potential biocontrol agents for managing weeds (Campbell *et al.* 1994) and need to be nurtured as such.
- Under suitable local initiative there is considerable scope utilizing lac hosts in India which are either poorly exploited or not exploited at all. Such species might prove to be suitable if experimented with. Awareness regarding usefulness and conservation of lac insects and host-plants should be emphasized to the people residing close to the lac habitats.

In the ultimate analysis it is only the love for nature that will set us on the path of conservation. Lac belongs to us and conservation of lac insects and their host-plants is our responsibility. Let us protect these for the posterity.

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## Bioresource Potential of North-Western Himalayas

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Hills and mountains occupy one fifth of earth's landscape and are home to one tenth of the world's population. An additional two billion people live downstream from the mountains and directly depend on them for their water, hydroelectricity, grasslands, timber, medicines and mineral resources. Patterns and processes influencing natural as well as human systems in the mountains influence not only the hill people of India, China, Nepal, Pakistan, Laos, Vietnam, Malaysia and many other countries but also those living in the adjacent lowland areas. Development prospects of the 90% of the world's population living in the 75% of the earth's plains are ultimately bound to what happens or doesn't happen in the hills which occupy only 25% of the earth's surface and where only 10% of the world's population lives.

However, in the recent years, the mountain specificities like fragility, marginality, diversity and vulnerability have been seriously tempered with by the developments like relentless population pressures, market integration from local to national and international levels, migration to the cities, revolution in the technology and social mobility, which have weakened and disrupted the traditional structures. Extreme internal variability and complexity of hills, with a multiplicity of highly localized micro-ecosystems providing the habitats for many unique crop varieties and animals species have been disturbed or are being disturbed. Environmental developmental issues concerned with a fragile and vulnerable hill landscape

like the Himalayas have, thus, to be on the forefront of sustainable development.

For sustainable agricultural development, plant genetic diversity is a key ingredient. The use of plant diversity—a gene, genotype, genepool and ecosystem levels increases the capacity of crops and agro-ecosystems to adjust the unpredictable weather conditions and unexpected pests and diseases. Diversity also provides capacity to adapt the changing crop needs and also to contribute to essential ecological processes. However, the tropical and sub-tropical regions which harbour the major portion of biological diversity are being over-exploited and abused. Both natural disasters and human activities are progressively eroding the earth's capacity to support life and at the same time the population explosion combined with increasing level of energy consumption are resulting in the destruction of the buffer that has always existed to protect against harmful environmental changes. Therefore, the international community has an increased responsibility to ensure that conservation, development and utilization of the biological/genetic diversity is sustainable, economic and equitable especially in the developing nations.

According to FAO, management and conservation of natural resource base and orientation of technological and institutional changes which conserve land, water, plant and animal genetic resources define the sustainable development of hills that is environmentally non-degrading,