(ISSN 2395 - 468X)
Year - 2022 Vol. 9, No. 11 Issue: November 2022

Van Sangyan

A monthly open access e-magazine

Impact Factor
SJIF: 2020-6.61

Indexed in:
COSMOS Foundation (Germany)
International Inst. of Org. Res. (Australia)
IIJIF

Tropical Forest Research Institute
(Indian Council of Forestry Research and Education)
Ministry of Environment, Forests and Climate Change (MoEFCC)
PO RFRC, Mandla Road, Jabalpur – 482021, India

Van Sangyan

Note to Authors:

We welcome the readers of Van Sangyan to write to us about their views and issues in forestry. Those who wish to share their knowledge and experiences can send them:

by e-mail to vansangyan_tfri@icfre.org

or, through post to The Editor, Van Sangyan,
Tropical Forest Research Institute,
PO-RFRC, Mandla Road,
Jabalpur (M.P.) - 482021.

The articles can be in English, Hindi, Marathi, Chhattisgarhi and Oriya, and should contain the writers name, designation and full postal address, including e-mail id and contact number. TFRI, Jabalpur houses experts from all fields of forestry who would be happy to answer reader's queries on various scientific issues. Your queries may be sent to The Editor, and the expert's reply to the same will be published in the next issue of Van Sangyan.

Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve
Photo credit: Dr. N. Roychoudhury and Dr. Rajesh Kumar Mishra, TFRI, Jabalpur (M.P.)

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From the Editor's desk

Eucalyptus has proven to be particularly successful in tropical and subtropical regions. Several species are also successful in some temperate regions, but problems with sudden and severe frosts pose limitations. Current plantations around the world are dominated by the "big nine" species (E. camaldulensis, E. grandis, E. tereticornis, E. globulus, E. nitens, E. urophylla, E. saligna, E. dunnii, and E. pellita) and their hybrids, which together account for more than 90% of Eucalyptus planted forests. Much of current tree improvement efforts focus on the use of hybrids and clones, and development of genetically modified Eucalyptus is already underway.

Water use of Eucalyptus is a controversial issue, and many studies have been directed toward water use at the individual tree and stand levels with fewer studies at the landscape (catchment or watershed) level. Actual water use by Eucalyptus in a watershed depends on many factors including the areal extent, size, spatial distribution, productivity, and age-class distribution of planted stands. Much has been made of the effect of converting other land uses to Eucalyptus plantations. Eucalyptus has potentially higher water use and water use efficiency compared to pasture, pine plantations, and native forests.. Studies in other countries suggest that effects of Eucalyptus plantations on stream flow may be most apparent in drier regions where precipitation is approximately equal to evapotranspiration. Environmental implications of Eucalyptus culture should be considered in the context of those associated with alternatives for fiber and energy production.

In line with the above this issue of Van Sangyan contains six articles on varied subject ranging from alternative narrative for Eucalyptus, Parkia timoriana, an endemic and underutilized multipurpose tree from northeast India, Celtis australis, a versatile tree of the north-western Himalayas, opportunies for Sandalwood farming in Himalchal Pradesh, Environmental impact of communication towers and larval parasitoids of sal defoliator.

I hope that readers would find maximum information in this issue relevant and valuable to the sustainable management of forests and agroforestry. Van Sangyan welcomes articles, views and queries on various such issues in the field of forest science.

Looking forward to meet you all through forthcoming issues

Dr. Naseer Mohammad

Chief Editor

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Alternative narrative for the most controversial tree – Eucalyptus- Book review

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Writing about a tree is a usual routine part of our life. As professional foresters and passionate ones, we are here to narrate a story about a tree species. For the millennials and most of XGen folks, forests and trees are introduced via digital media platforms say it maybe social media or the mainstream media in the form of TV channels or movies. And we would confidently proponent that the perception of the common people can be influenced highly by these mediums. We can point out a few examples here but that is not the objective here. We would like to introduce you all to the most productive and controversial tree in India.

Some of you folks while travelling along the highways or trains must have noticed a tall straight white tree with a long narrow leaf reaching up to a heightof 15mon average – it is the Eucalyptus. This tree is an introduced species to our country owing to unique traits - adaptable, fast-growing, highly suitable for composite wood making, and need minimum care. Even though, this tree was brought to our country in the 1790s, only in the 1980's it gained popularity. Many of our grandparents might easily recognize this tree. It is one of the most plantedtrees in social forestry programmes dotting the sides of roads and water canals mostly. This tree is regarded as a water guzzler and often vilified as an invasive and exotic tree. Here is a book that provides an alternative and holistic narrative on this tree. The current book is more than a monograph which it has been aptly titled "Farmer and Planet Friendly - Newgen Eucalyptus". This book comprises 15 chapters with the usual style of foreword and executive summary. The exhaustive list of references and annexure indicates the meticulous nature of the authors of this book.

As a normative, the book begins with an introduction to the history, distribution, and botany of eucalyptus across the world in chapter 1. It would be appropriate to mention here that Eucalyptus is the common name representing 800 different species of *Eucalyptus* including *E. tereticornis, E. camaldulensis, E. globulus, E. grandis, E. citridora* which are the common species in India. There is a crisp narrative on Eucalyptus in India as an exclusive chapter (Chap. 2). In this juncture, it would be more prompt for the readers to remove the prejudice on Eucalyptus and comprehend why such a controversial tree is also one of the most researched tree species for growth and yield which is detailed in chapter 3 and 4. For the sake of beginners, chapter 3 lists the number of hybrids developed by different forest research institutes apart from Australia (the origin place of the eucalyptus). It is also indicative that this

tree is the most preferred choice of commonly cultivated/grown trees as plantation/farm forests in the whole world. The answer to the question – why this tree is the most preferred choice? is detailed by authors in chapters 8 and 9. Whilst Chapters 5, 6 and 7 provide details on how to grow this tree. A unique perspective of cultivation narrated in this book would the eucalyptus in agroforestry. There is wide opinion that agroforestry has allelopathy effect and no other plant can grow under it. The book breaks this opinion by providing real time examples of eucalyptus cultivated in farmer's field along with crops. Chapters 10 and 11 attempt to portray a positive picture of the Eucalyptus plantation by providing data and statistics on certified eucalyptus plantations across the globe. Also, there is an attempt to highlight the carbon sequestration benefit of this tree.

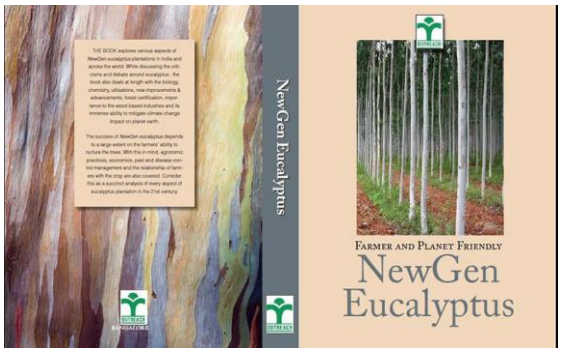
Overall, the book encompasses all the latest topics from cultivation, propagation, supply chain management, and modelling techniques with details on the latest development in Eucalyptus froma plantation perspective along with case studies (Chap. 15). The contents are carefully chosen by editors to address the major issuepertaining to policy and legal issues and its intricacies – the ban on Eucalyptus plantation. This book provides a centralized albeit explanation and legal debate on this tree (Chap 12 and 13). The fact that ban on eucalyptus cultivation has been implemented as well as revoked by the judicial system in India and yet the debate on its ban still continues. We believe this tree has gathered so much attention from the judicial system compared to any other tree species in India.

Chapter 14 is the crux of this book titled – *Debate on land for eucalyptus plantation* and all other chapters are intended as a prelude for the readers to understand this tree. Far from being anecdotal, the numbers that are quoted regarding the water usage of eucalyptus are always problematic. There is ample literature which supports as well as negatesthe water use efficiency of this tree. The scientific evidence listed in this book can provide a glaring insight into the veracity of the debate happening on this tree.

We are neither for nor against growing eucalyptus as this tree is important for meeting the country'swood demand -pulp and fibre. It would be also pertinent to point out that India is a net importer of wood, especially paper and pulp. As reviewers of this book, we would like to state one fact: Typically, the water usage estimates for any plant/crop/tree depend on tree size, age, and many other factors. Therefore, data from long-term experimental studies either measured per tree or in experimental catchments are important. Having stated this, we urge the readers to read this detailed and scrupulous compilation before having a verdict on this tree.

In all goodwill, we would also like to point out that the phrase – NewGen Eucalyptus sounds more like a notification that has not been fully explained in the book and also the lack of data and statistics about the total eucalyptus area in India is a major draw back for any policymakers. This book with more data and statistics will be a ready reference for forestry students and

environmentalists who are interested in this tree – EUCALYPTUS!



Title of book: Farmer and Planet Friendly - Newgen Eucalyptus
Publication Date: July 2019
Total Pages: 338 pages
Publisher: Outreach Bangalore

Parkia timoriana (DC.) Merr.: An endemic and underutilized multipurpose tree from northeast India

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Bangalore

A multipurpose agroforestry tree species termed *Parkia timoriana* (Tree bean) can be found in home gardens and jhum (local term for "shifting agriculture") sites in the Eastern Himalayan foothills. It is a member of the family Leguminosae and subfamily Mimosoiodeae and is referred to as a "tree bean" because it produces clusters of pods or beans in groups of 10-15 that are 25-40 cm long and 2-4 cm wide. The most extensively dispersed species in the Indo-Pacific region, tree beans are native to Thailand, Malaysia, Myanmar, Indonesia, and the northeast of India. Different vernacular names for the plant have been given to it around the world.

Table 1. Vernacular names of *Parkia timoriana* in Northeast India

Language	Local Name
Assamese	Khorial
Garo	Aoelgap
Kachari	Bire-phang
Mikir	Themuk-arang
Mizo	Zawngtrah
Naga	Unkamn-pinching
Hindi	Supota, Kharial

(Angami et al., 2017)

Morphology

Its morphometric traits differ across cultivated trees as well as in accordance with its geographic range. Generally, it grows to a height of 10 to 12 metres and has many branches. 30-80 cm long, equally bipinnate leaves are seen. 40–60 pinnae, each measuring 8–20 cm in length, are present. The leaflets are close-set, linear-oblong, 6–12 mm long, shiny above, and pointed at the tip. There are 60–140 of them. The flowerheads are dense, oblong or oval, up to 6 cm long, and hang from leaf axils on long, cable-like stalks like vintage electric bulbs. The flowers are roughly 1 cm long and are white and yellow. When ripe, the pods are about 3.5 cm broad, around 25-30 cm long, thick, pendulous, and black and shiny. They hold about 15-20 seeds.

Growth requirements

It thrives well in soil that is sandy, loamy, podzolic, and located close to riverbanks. The ideal temperature for its propagation is 24°C.It typically grows in semi-wild environments or in the backyard gardens of residences.

Fig. 1. Mature tree

Fig. 2. Pods

Fig. 3. Inflorescence

(https://sites.google.com/site/efloraofindia)

***Parkia timoriana*as a tree component in agroforestry systems**

One of the best species for recovering the fertility and biodiversity of degraded Jhum (shifting agriculture) soil is *Parkia timoriana*, a fast-growing legume tree with extremely valuable economic fruits. This tree requires little maintenance as it is a legume and fixes nitrogen in the soil. Additionally, the associated microorganisms in the tree rhizosphere may promote the development and growth of the plant as well as help the damaged Jhum fallow replenish its depleted nutrients.

In Jhum fields, where rice, maize, and other vegetables like colocasia, tomato, brinjal, and chillies, etc. are interplanted, tree beans can be found prospering. In coffee plants and nurseries, tea gardens, and pineapple-based agroforestry systems in the North-eastern states, they are grown to provide shade and companion trees.

It encourages soil stabilisation, which is crucial for managing land use sustainably by lowering runoff and erosion.It encourages soil stabilisation, which is crucial for managing land use sustainably by lowering runoff and erosion. One of the advantages of the plant's morphological traits for agroforestry techniques is that the bipinnate leaves of the plant aid in the uniform dispersion of raindrops and prevent them from splashing on the soil (Ovung et al., 2021)

Utilization

Numerous wild plants were discovered to be domesticated by tribal people in NEI for their palatable and therapeutic qualities. It is significant to the local economy and diet. Every phase of *P. timoriana*, from flowering to pod maturity, is edible and has a distinct flavour. Among the other delicacies given at different rites and events, their traditional cuisines created from the pod and seeds of this species hold a significant place. Anti-diabetic, antioxidant, pulpwood, and firewood are some of the additional uses for this plant.It is an excellent multipurpose tree with numerous application possibilities, such as;

Timber tree bean

Wood, a light hardwood with a density of 0.39 g/cm^3, is used to create decorative items like boxes and furniture. The wood can be used to make paper pulp as well. Branches make excellent fuel wood and are occasionally used to build domestic cattle shelters (Singh et al., 2019).

Delectable tree bean

Its long, delicate pods are frequently recognized as the most gorgeous vegetables in the Northeast. The pods can be used in a variety of ways, including fresh, cooked, or sun-dried for use off-season, and they can be consumed at different stages of maturity. Their golden-yellow pulp has a sweet-tart flavour and a scent resembling violet. Because the roasted seeds are used to make an infusion resembling coffee in some regions of Africa, they are known as Soudan coffee.

Nourishing tree bean

It is recognised as one of the finest sources of amino acids and proteins since the kernels (28.8%), mature pods (18.8%), and tender pods (12.1%) have the maximum protein content. It also offers a rich quantity of lipids, carbs, vitamins, and minerals when compared to other legumes.

Therapeutic tree bean

Tree beans are quite beneficial from an ethnobotanical standpoint in terms of

medicine. In the past, fresh or dried seeds and pods have been used to treat a range of illnesses, including piles, diarrhoea, constipation, and stomach or intestinal diseases. Locals and Indigenous people in northeast India use the fruit and seeds for several therapeutic purposes.

Insecticidal tree bean

A variety of destructive insects can be managed with the use of seed oil extract, which possesses insecticidal properties. To scare off pests and insects, the leaves are also pounded, dispersed around plants, or burned to create smoke.

Economic importance of tree bean

When the tree was first planted, it was merely done so to increase its aesthetic value; now, as its economic significance has become clear, plantations for commercial usage have started (Ovung et al., 2021). During favourable seasons, a mature tree can produce up to 500–1500 pods annually, or 90–260 kg per tree. Because the price of the pods at the market is approximately Rs. 150–180 for an unripe pod and Rs. 400–500 for a completely ripe one, a single plant might cost the producer between Rs. 8,000 and 10,000 each year (Rocky et al., 2004). Due to its extensive ethnobotanical uses, it is regarded as the most expensive vegetable in north-east India, earning a market value of Rs. 70–120 per kg (Firake et al. 2013; Elangbam and Singh 2020). Thus, a single plant has a maximum annual yield of about Rs. 30,000.

Conclusion

It is a versatile tree that could be of commercial and ecological importance. It is widely cultivated for food, medicine, wood, and decorative purposes. It is one of the most abundant sources of regional crops that are underutilised, and it is grown in the northeast of India. The agro-climatic conditions are ideal for growing *P. timoriana* in the states of Nagaland, Manipur, Meghalaya, and Mizoram, and it is frequently grown in house-yards and home gardens with little maintenance. Therefore, it is time to take the necessary steps to ensure the better utilization of the species and develop more agroforestry systems and practises to ensure sustainable tree-based systems in north-east India.

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हिमाचल प्रदेश मे चंदन की खेती की संभावनाएं

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परिचय एवं वितरण

चंदन जिसे अंग्रेजी में *Santalum* के नाम से जाना जाता है, सबसे मूल्यवान लकड़ी की प्रजातियों मे से एक प्रजाति है जिसका संसार में सर्वोच्च स्थान एवं आर्थिक महत्त्व है। । चंदन की उत्पत्ति का स्थान भारत है इसके अलावा यह ऑस्ट्रेलिया, मलेशिया व इंडोनेशिया आदि देशों मे भी पाया जाता है। भारत मे यह वृक्ष कर्नाटक के दक्षिणी भाग और उत्तरी भाग वाले क्षेत्र तथा तमिलनाडु मे प्राकृतिक रूप मे पाया जाता है। इसके अतिरिक्त गुजरात , मध्य प्रदेश, राजस्थान, हिमाचल प्रदेश आदि राज्यों मे भी चंदन पाया जाता है। भारत में मुख्यतः चंदन की दो किस्म की प्रजातिया क्रमश: सफेद (*Santalum album*) व लाल (*Pterocarpus santalinus*) पाई जाती है । उतरी भारत मे सफेद चंदन की प्रजाति पाई जाती है जो हिमाचल, उत्तराखंड, पंजाब, हरियाणा तथा उत्तर प्रदेश में वितरित है।

वानस्पतिक विवरण

चंदन मध्यम आकार का सदाबहार वृक्ष है जिसकी परिधि 1-2.4 मीटर और ऊंचाई 12-15 मीटर तक होती है । यह प्रजाति साल में दो बार मार्च से अप्रैल और सितंबर से दिसम्बर के दौरान कुसुमित एवं फल देती है। सितंबर से दिसंबर के मौसम में बीज का उत्पादन अच्छा होता है।कुछ पेड़ साल में केवल एक बार ही खिलते हैं जबकि कुछ नियमित रूप से नहीं खिलते। यह पेड़ 2 से 3 साल की छोटी उम्र में ही फलने लगता है। फूल

चित्र 1: चंदन का वृक्ष

अलग होता है। अधिक ऊंचाई पर उगने वाले पेड़ों की तुलना में कम ऊंचाई पर उगने वाले पेड़ों में फूल आना लगभग एक महीने पहले शुरू हो जाता है। परिपक्वता के समय, फल का रंग हरे से बैंगनी काले रंग में बदल जाता है। कम आयु वाले चंदन के वृक्ष की छाल गहरे भूरे या लगभग काले रंग की होती है। जैसे-जैसे वृक्ष की आयु बढ़ती है

चित्र 2 : चंदन के फूल

छाल गहरी खड़ी दरारों के साथ खुरदुरी होती जाती है।

उपयुक्त जलवायु परिस्थितियाँ, मृदा एवं प्राथमिक होस्ट

यह वृक्ष 0-38 °C तापमान , मध्यम वर्षा 600 से 1600 मिमी, ठंडी जलवायु एवं लंबे समय तक शुष्क मौसम मे अच्छा विकास करता है। यह आम तौर पर रेतीली या अच्छी तरह से जल निकासी वाली पथरीली लाल मिट्टी में उगता है तथा पथरीली या बजरी वाली मिट्टी पर उगने वाले चंदन के पौधों मे अधिक सुगंधित लकड़ी पाई जाती है। चंदन एक आंशिक जड़ परजीवी है क्योंकि इसे होस्ट प्रजातियों के साथ उगाया जाता है जो पेड़ों के विकास के लिए आवश्यक है। प्राथमिक होस्ट के बिना, चंदन की वृद्धि कम होती है क्योंकि इस पौधे की जड़ें हॉस्टोरिया के सहारे दूसरे पेड़ों की जड़ों से जुड़कर भोजन, पानी और खनिज की जरूरतों को पूरा करती है।

चन्दन की खेती

बीज संग्रह, प्रसंस्करण

चंदन के फल रसीले ड्रूप, गोलाकार/ अंडाकार, व्यास मे 6.32 - 7.00 mm एवं परिपक्व होने

चित्र : चंदन के फल

पर गहरे बैगनी रंग के होते है। हरे रंग के फलों को तब तक परिपक्व नहीं माना नहीं जाता है जब तक वे गहरे बेंगनी रंग के नहीं हो जाते है। चंदन के फल अप्रैल-मई और सितंबर- दिसम्बर के दौरान एकत्र किए जाते हैं। फलों के संग्रह के लिए पेड़ों के आस पास की जगह को साफ किया जाता है ताकि फलों को एकत्रित किया जा सके। बीजों को फलों से अलग करने के लिए फलों को पानी मे भिगोया जाता है एवं गूदे को खुरदुरी सतह पर रगड़ा जाता है ताकि बीज प्राप्त हो सके। गुदा कवकीय संक्रमण के लिए अति संवेदनशील होता है, इसलिए बीजों को जितनी जल्दी हो सके उतना जल्दी गूदे से अलग किया जाता है।

नर्सरी तकनीक

चंदन की नर्सरी में रोपण स्टॉक उत्पादन के दौरान कम बीज अंकुरन जैसी प्रमुख समस्या का समाधान किया जा सकता है। चंदन के पौधे का प्रवर्धन सामान्यतःबीजों द्वारा होता है जिनका साल में एक या दो बार ही उत्पादन होता है। चन्दन के बीजों मे अंतर्निहित मॉर्फोफिजियोलॉजिकल निष्क्रियता (Morphophysiological dormancy) पाई जाती है जिसकी वजह से चंदन के बीजों से

चित्र 3: चंदन के फल

अंकुरित होने मे बाधाए आती है। चंदन के बीज पानी और ऑक्सीजन के प्रतिरोधी होते हैं, जो बीज को अंकुरित होने से रोकते हैं। बुवाई से पूर्व विभिन्न बीज उपचारों के माध्यम से बीज निष्क्रियता को तोड़ा जा सकता है। बीजों की अंकुरित क्षमता बड़ाने के लिए बीजों को रात भर 0.05% जिबरेलिक अमल (Gibberellic acid) से उपचारित किया जाता है। चंदन के जिन बीजों का जिबरेलिक अमल (Gibberellic acid) के साथ उपचार किया जाता है उनकी अंकुरण क्षमता बढ़ जाती है । चंदन की नर्सरी उगाने के लिए 10 x1 मीटर आकार की क्यारिया बनाई जाती हैं जिसमे रेत: मिट्टी: FYM का अनुपात 2:1:1 रखा जाता है । सूत्रकृमिनाशक : यूकेलक्स

चित्र 4 चंदन की नर्सरी (एक वर्ष)

(Exalux) या थायमेट (Thimet) के रूप में 500 ग्राम प्रति क्यारी पर मिट्टी में मिलाया जाता है। फिर बीज को 2 सें.मी. बालू से ढकी क्यारी पर समान रूप से फैलाया जाता है और पानी से सिंचाई की जाती है। कवकीय संक्रमण को रोकने के लिए क्यारियों पर 15 दिनों में एक बार 0.25% डाइथेन का छिड़काव करना अनिवार्य है । जिन पौधों मे 4-6 पत्ती आ जाती है उस समय उन्हे पॉलीबैग (आकार 30 x14 सेमी) में प्रत्यारोपित किया जाता है जिसमे रेत , मिट्टी और गोबर के मिश्रण (2:1:1 अनुपात) के साथ लाल चना (*Cajanus cajan*), अकेशिया कटेचू (*Acacia catechu*) के एक दो बीज लगाए जाते है जो की प्राथमिक होस्ट के रूप मे काम करते है। होस्ट पौधों की समय-समय पर छंटाई की जाती है ताकि वे चंदन के पौधे के विकास में बाधा नहीं डालें।

वृक्षारोपण प्रौद्योगिकी

मानसून की शुरुआत में 3 x 3 मीटर के अंतराल के साथ स्वस्थ चन्दन के पौधे जिनकी ऊँचाई 30 सें.मी. तक होती है, उन्हें 50 सैं.मी. आकार के गड्ढों में लगाया जाता है। विभिन्न वानिकी माध्यमिक होस्ट प्रजातियों को या तो एक ही गड्ढे में या अलग-अलग गड्ढों में लगाया जाता है ताकि पौधे का विकास अच्छे से हो सके। कैसुरिना इक्विसेटिफोलिया *(Casuarina equisetifolia)*, अकेशिया कटेचू (*Acacia catechu*), अकेशिया निलोटिका (*Acacia nilotica*), पोंगामिया पिन्नाटा (*Pongamia pinnata*), अल्बिजिया लेबेक (*Albizia lebbeck*), डलबर्गिया सिसू (*Dalbergia sisso*) चंदन के अच्छे होस्ट साबित हुए हैं।

चन्दन की खेती मे खरपतवार, कीट एवं रोग नियंत्रण

चंदन की खेती करते समय पहली साल सबसे अधिक देखभाल की जरूरत होती है इसी समय पौधे के इर्द-गिर्द खरपतवार पनपने की संभावना अधिक होती है । किसी भी तरह का खरपतवार या जंगली छोटा कोमल पौधा जो पेड़ों के विकास मे बाधा उत्पन्न कर रहा हो तो उसे भी हटा देना चाहिए । सैडल स्पाइक नामक विनाशकारी बीमारी से चंदन को बहुत नुकसान पहुंचता है क्युकी फाइटोप्लाज्मा से होने वाला यह रोग चंदन का प्रमुख रोग है । स्पाइक रोग के प्रमुख लक्षण पत्ती के आकार में कमी, छोटे इंटरनोड्स और पत्तियों की टहनियों पर झाड़ीनुमा जैसी रचना बन जाती है। रोगी पौधों मे आमतौर पर फल ओर फूल नहीं लगते है और

वे 1 से 2 वर्षों के भीतर ही मर जाते हैं। स्पाइक रोग के कारण भारत मे चंदन का उत्पादन लगभग 20 प्रतिशत की वार्षिक दर से घट रहा है। चंदन के पेड़ से 5-7 फुट दूर नीम का पौधा लगाया जा सकता है जिससे इसे संक्रमण से बचाया जा सकता है।

चंदन की खेती के किसानों को लाभ

चन्दन सूखा और ठंड प्रतिरोधी प्रजाति है इसलिए हिमाचल प्रदेश के कुछ जिलों बिलासपुर, हमीरपुर एवं कांगड़ा में खेती की संभावनाएं जताई गई है जिससे यहाँ के किसान लाभ कमा सकते है । चन्दन से मिलने वाली लकड़ी व तेल दोनों ही विभिन्न प्रकार की औषधिया बनाने के काम आते है। चंदन में कुछ खास प्रकार के एंटी-इंफ्लेमेटरी गुण पाए जाते हैं जो चेहरे की सूजन, लालिमा व जलन जैसी समस्याओं को कम करने में मदद करती हैं। चंदन का उपयोग सामान्य सर्दी, खांसी, ब्रोंकाइटिस, बुखार और मुंह और गले में खराश के इलाज के लिए किया जाता है। इसका उपयोग मूत्र पथ के संक्रमण (यूटीआई), यकृत रोग, पित्ताशय की समस्याओं, हीटस्ट्रोक, गोनोरिया, सिरदर्द और हृदय और रक्त वाहिकाओं (हृदय रोग) की स्थितियों के इलाज के लिए भी किया जाता है। चंदन की लकड़ी बहुत सी अंगराग, साबुन, अगरबत्ती व गंध-द्रव्य कंपनिओ मे भी उपयोग होता है। चंदन का उपयोग वेदों व पुराणों के समय से मंदिरों मे तिलक लगाने व पूजा करने मे होता आया है। चंदन की लकड़ी से बहुत से शोपीस भी बनाए जाते है। चंदन की लकड़ी बहुमूल्य होने के कारण चंदन की खेती दुनिया भर मे प्रसिद्धि पा रही है। चंदन की लकड़ी के दाम मे दिन प्रति दिन बड़ रहे है जिसकी वजह से सरकार भी अब किसानों को इसकी खेती करने के लिए प्रोत्साहित कर रही है। चन्दन के पौधों को जैविक और पारंपरिक तरीके से उगाया जा सकता है। जैविक तरीके से पौधे को उगाने मे 15 से 20 साल लगते है एवं पारंपरिक तरीके से इसे उगाने मे 20 से 25 साल लग जाते है। चंदन का पेड़ सबसे ज्यादा मुनाफा देने वाला पेड़ माना जाता है जिसकी खेती से किसान आसानी से लाखों कमा सकते है । एक चंदन के पेड़ से लगभग 10 से 20 किलो लकड़ी मिल जाती है। चन्दन की लकड़ी की कीमत बाजार मे लगभग 5-7 हजार किलो होती है लेकिन इसकी बदती मांग को लेकर किसान इसे 10000 रुपए किलो भी बेच सकते है। चंदन की नर्सरी लगाने से किसान एक पौधा लगभग 100 से 150 रूपये मे बेच सकते है। किसान चाहें तो एक हेक्टेयर भूमि पर 600 से 700 पौधे लगा सकते हैं. ये ही पौधे अगले 12 साल में पेड़ बनकर 30 करोड़ रुपये तक का लाभ दे सकते हैं। चंदन के एक पेड़ से ही लगभग 6 लाख रुपये तक की कमाई हो जाती है। चन्दन की लकड़ी को साबुन, तेल, गंध द्रव्य व अगरबत्ती आदि कंपनिओ द्वारा भी किसानों से खरीद जा सकता है। चन्दन के साथ लगे प्राथमिक होस्ट पौधों से भी अलग मुनाफा कमाया जा सकता है।

चन्दन की खेती के लिए शासकीय प्रावधान

वर्ष 2017 से पहले चन्दन की खेती पर सरकार द्वारा प्रतिबंध लगाया गया था लेकिन अब ये प्रतिबंध हटा दिया गया है जिससे किसान अपनी खाली पड़ी जमीनो मे चंदन की खेती करके मुनाफा कमा रहे है। चन्दन की खेती बिना सरकार की रोकटोक से की जा सकती है हालांकि इसकी कटाई के लिए सरकार से नो अब्जेक्शन प्रणामपत्र लेना जरूरी होता है एवं इसका निर्यात सिर्फ सरकार द्वारा किया जाता है।

निष्कर्ष

भारतीय चंदन को दुनिया की मूल्यवान वाणिज्यिक लकड़ी के रूप में माना जाता है और

वर्तमान में यह इसकी हार्टवुड और तेल के लिए विश्व स्तर पर प्रसिद्ध है। इसी कारण की वजह से चंदन की खेती किसानों को प्रोत्साहित कर रही है क्योंकि इसकी खेती से किसान मुनाफा कमा सकते है । हिमाचल जैसे छोटे राज्यों मे जहा जलवायु प्रभाव एक महत्वपूर्ण भूमिका निभाता है वहाँ भी निचले भू वाले क्षेत्रों मे इसकी खेती की संभावनाएं जताई गई है जिसकी खेती से किसान मुनाफा कमा सकते है।

Celtis australis (Khirak): a versatile tree of the north-western Himalayas

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Introduction

Celtis austral is L. is a multi-purpose tree species belonging to the family Cannabaceae. *Celtis australis*, also known as hackberry, nettle tree, khidak, or Roku, is a medium to large, long-living deciduous perennial tree that grows up to the height of 30 m and 60 cm diameter at breast height. The crown is irregular, spherical and spreading in shape while the stem is straight, cylindrical, smooth and has bluish-grey bark. It bears fruit in the autumn, consisting of spherical drupes with a diameter of 9 to 12 mm, each enclosing a single seed and accounting for approximately around 38 per cent of the fruit's dry mass. The kernel is careen, robust, sweet and fleshy, with a thin mesocarp covering it and for this reason, is called the tree of chocolate.

Figure 1. Typical *C. australis* tree in North-western Himalayas.

Phenology

Normally, bud sprouting occurs in February, followed by floral bud production. Young shoots emerge from March to April (Table 1). Fruit matures in August-September and has a long lifespan on the trees. The drupes remain green until September-October and afterwards turn yellow. Every year, at the age of 10-15 years, the trees bear fruit. Trees remained in leafy conditions from March till the end of October. The tree starts shedding leaves from November through January.

Table 1. Phenology of *C. australis* tree species (Panda et al., 2021)

	Spring	Summer	Autumn	Winter
Bud sprouting	✓			
Flowering	✓			
Fruiting		✓		
Leaf flush	✓	✓	✓	
Fruit		✓	✓	
Leaf drop		✓	✓	✓

Distribution

C. australis is an indigenous tree of a vast area, extending from France to India and Pakistan with Mediterranean Europe as its main origin. In India, it is found in Jammu Kashmir, Himachal Pradesh, Uttarakhand and in North-East hill regions ascending to the elevation of 500-2500 m above mean sea level in temperate to tropical zones where the rainfall falls between 500-2500 mm. In the western Himalayas, it grows in association with horse chestnut, maple, bird cherry and oak in moist areas of blue pine and deodar forests. However, the tree is usually found in mixed deciduous forests and is tolerant to a wide range of soil preferring deep loamy silt and clay. Sometimes it also found in damp areas near naulas or springs, hedges, banks, rivers and sandy areas. Thus, *C. australis* can be one of the suitable species for degraded lands, rainfed agricultural lands and wastelands.

Propagation

By Seed

Seed is one of the easiest methods for the reproduction of this species. Seeds are sown in a cold frame as soon as they are mature, then in a greenhouse in February/March. Seed parameters, such as length, width, and weight, differ considerably on the seed source or geographical area. The seed can be kept for up to five years. Seeds treated with hot water, cold-stratified seed, and excised embryos germinate earlier than untreated seeds. Furthermore, seed germination is extremely dependent on temperature (25 °C), despite of the seed source; thus, germination of khirak in nurseries occurs only when the temperature rises, which normally occurs in February-March.

By vegetative method

Vegetative propagation is done through stem cuttings that are 5-15 cm long and 1.5-2.0 cm thick. The hormone (IBA) treatment of cuttings improves rooting percentage and volume of roots per cutting; also, sprouting percentage and root length may increase. However, the

most successful asexual propagation techniques were root cuttings (5 cm long) from juvenile phase (2-year-old) trees shallowly planted into a peat-sand medium and side grafts using parafilm wraps and a graft tent. *Celtis australis* is also capable of propagation through grafting and budding. Due to high biotic pressure, the tree's natural regeneration is quite less therefore; artificial regeneration is preferred over natural regeneration.

Pest and diseases

Defoliators are the most harmful pests for this particular species. The Coleoptera *Diorhabda lusca* maulik is a serious pest of foliage that causes extreme defoliation/skeletonization of young leaves and affects the nutritional value of the leaves as well as the phenological behaviour of the tree (Figure 2). Leaf spot diseases and powdery mildew are also observed on the leaves of *C. australis*

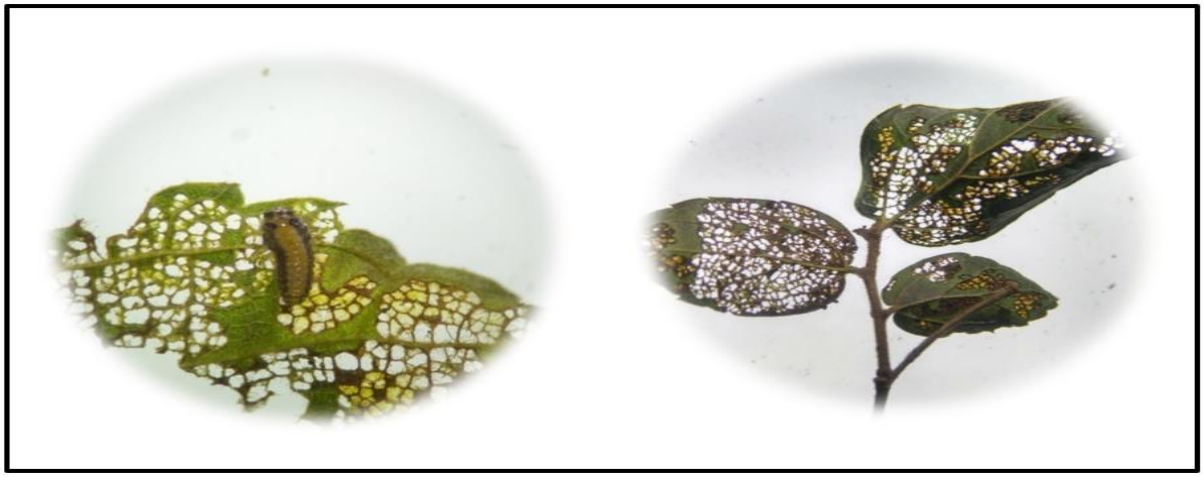

Figure 2. Attack of *Diorhabda lusca* maulik

Uses

Celtis australis is a multipurpose tree grown for fodder, fuel, timber and various other uses in or around agricultural fields in rainfed agriculture and it plays a crucial role in the socioeconomic structure of hill people by providing highly palatable and nutritious fodder. It could be harvested twice a year. The leaves of *C. australis* are generally high in crude protein content 91.7-169.7 mg/g, crude fibre 139.3- 198.0 mg/g, phosphorus 0.77 1.63 mg/g, sugar 11.12- 18.29 mg/g, potassium 2.84-7.57 mg/g and starch 47.90- 65.26 mg/g (Yadav et al., 2015) and tannin-free green fodder to livestock species (Table 2), especially during summers when the green fodder is unavailable. The average leaf dry biomass is 5.18 kg DM tree^{-1} yr^{-1} (Navale et al., 2022). The wood is rigid, strong, and elastic contains grey hardwood and yellow sapwood and can be carved to make musical instruments, oars, sporting goods and paddles.

Table 2. Nutritional value of *C. australis* tree leaves (Navale et al., 2022).

Nutrients (%)	
Parameters	Value
Dry matter	48.05
Crude protein	15.56
carbohydrates	61.45
Ether extract	3.40
Total ash content	19.59
Nitrogen free extract	39.68
Organic matter content	80.41
Minerals (%)	
Phosphorus	0.22
Potassium	1.29
calcium	10.53
Micronutrients (ppm)	
Copper	17.50
Iron	665.53
Manganese	38.60
Zinc	19.26

The wood of *C. australis* is also an excellent fuel wood which contains 16.81Kj/g calorific value, 3.4% ash, 0.54g/cc density, and 0.40% moisture (Singh et al., 2022). The juvenile shoots are wiry and narrow, making them good whips and rods (Table 3). The fruits are eaten by monkeys, birds, rodents and rats. The tree's extract is used to treat edema, headaches and boils. It is a heliophilous species and hence, can be used for afforestation. Owing to the versatility of *C. australis*, it is mainly grown in agrisilviculture and silvopastoral agroforestry systems throughout the hills. *C. australis* sequesters atmospheric carbon in biomass and soils while improving annual tolerance to shifting climatic circumstances in different agroforestry systems. The species also enhances the local microclimate and alters regional climatic conditions, helping to mitigate and adapt to climate change in the Himalayas (Kumar et al., 2018). Additionally, khidak is tolerant to stressors like drought and air pollution therefore; it can be a suitable choice for landscape planning and cultivation. However, in recent years, the C. australis has seen a significant drop in growth as a result of climate change, particularly rising temperatures (Panda et al., 2022).

Table 3. Multiple uses of *C. australis* tree species.

Plant part	Uses	Sources
Bark	Yellow dye	Badoni and Semwal (2011)
Fruit and leaves	Astringent, lenitive and stomachic, amenorrhea and other health benefits.	Durak and Karaguzel (2022)
Fruit	Biodiesel	Samani et al. (2019)
Leaves	Fodder	Navale et al. (2022)
Wood	Fuel wood, walking sticks, timber	Singh et al. (2022)

Conclusions

Celtis australis is a broad-leaved fodder tree species that grows around agricultural fields and villages and provides highly palatable and nutritious fodder. It is lopped during the summers when there is no green fodder available. It is a multipurpose tree that is planted for fodder, firewood, timber etc and plays a significant role in the socioeconomic structure of hill people. The tree is attacked by different foliage pests, resulting in the complete skeletonization of the leaves and altering the behaviour of the appearing leaves. This tree provides nutritive fodder and mitigates the problem of insufficient palatable nutritive tree fodder during peak periods, thus improving the diet and health of the cattle population.

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Environmental impact of communication towers

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Rapid urbanization brings in the issue of installation of mobile towers in the vicinity of residential areas, schools and hospitals. Regardless of a huge number of complaints, the telecom companies haven't deterred so far in installing mobile towers near residential complexes and schools. Companies have usually been able to provide sources to prove that the installation of such towers doesn't harm humans. However, the research for determining whether these towers have a harmful effect on the ecosystem in which they are installed seems inadequate.

As per a 2016 news report cell phone towers were found exceeding radiation limits in the three years preceding that and penalties were imposed on the concerned telecom providers, however, penalties haven't discouraged the mushrooming of such towers in close proximity to human and wildlife habitations.

The electromagnetic spectrum consists of ionizing and non-ionizing radiation. Ionizing radiation includes ultraviolet (UV) rays, X-rays, and gamma (ϒ) rays. Electromagnetic radiation (EMR) from cell phone towers is largely comprised of high-frequency radio waves or microwaves. Microwaves lie in the non-ionizing radiation portion of the electromagnetic spectrum which includes low-frequency (computers, power lines), medium-frequency (television, radio), and high-frequency (microwaves, mobile devices) radio waves.

Due process be followed to assess the possible health and environmental effects

of the EMF radiation which could be caused by the tower in question. This should be undertaken in consultation with the relevant groups of citizens in this case, which comprise the residents of the adjacent societies, school authorities and shop owners in the adjoining market area

all of whom run the risk of serious health hazard in the event that the tower in installed in contravention of a just, fair and transparent procedure.

The company operators should be instructed to furnish clear and correct information regarding the radiation levels of the said tower to the aforementioned group of citizens. The authorities must ensure that there is no falsification of facts or figures in the information so furnished. In the event that this information is proved to be authentic and satisfactory beyond reasonable doubt, it should be examined by a non-partisan group of experts, who the citizens should be informed about and then agreed upon for examining the possible health hazards caused by the tower radiation. Only if this group of experts confirms that the tower radiation is not of any adverse health or environmental consequences for the human, flora and fauna of the area should permission be granted confirming such installation. If however, the expert examination proves otherwise, the permission for installation should be refused with immediate effect.

Reducing the power of the tower had increased the emission hazard for mobile-phone users, said Michael Repacholi, radiation expert and first coordinator of the radiation and environment health unit of WHO. “India’s decision to reduce the power of the base stations will not minimize any risk. If you reduce the power of a base station, your mobile handset transmits more frequency to stay connected to the network. As the handset is closer to the body, it could cause some health hazard.” The order had also made things costlier for telecom companies, as they would have to put in more towers.

In September 2012, the DoT had reduced the permissible radiation limits for tower firms, to 10 times lower than recommended by WHO. It had also asked the operators to maintain a certain distance from a building, depending on the number of antennae they want to install. India has about 800 million mobile users and a billion mobile handsets, connected through about 375,000 towers. In the past few years, health activists and residents’ organizations have repeatedly opposed establishment of telecom towers on rooftops and in densely populated areas, claiming radiation from such installations caused serious health risks, such as cancer.

Briefly, epidemiological data on the human effects of microwave radiation suggest a predominance of brain tumors and leukemia. In vivo and in vitro animal studies point to genotoxic effects that can trigger apoptosis and detrimental effects on the immune system. Human cell studies corroborate the genotoxic effects of microwave radiation and its ability to cause various kinds of DNA damage resulting in cell death. Possible immune effects are also recorded. These results are in keeping with a two-stage apoptotic model of carcinogenesis.

The induction of apoptosis by microwaves in human and rat neural cells and in human lymphocytes correlates well with the increased incidence of brain tumors and leukemia epidemiologically associated with the high-frequency radio waves emitted by cell phone towers. However, further studies need to be conducted on the apoptotic potential of microwaves in non-transformed neural and human lymphocytes at 1800–1900 MHz in order to test this parameter definitively since

significant biochemical differences can exist between transformed and non-transformed cells. Blood cells of children should also specifically be tested since they are susceptible to leukemia from high power voltage (HPV) lines, which emit low-frequency radio waves. The developing tissues of children have already been found to be more susceptible to the penetration of cell phone radiation. According to a new approach to cancer risk assessment, if apoptosis is induced in these normal tissues from adults and children, along with the epidemiological data, this would be sufficient criteria to establish cell phone tower EMR as a complete carcinogen providing that microwave exposure is at a high enough specific absorption rate (SAR).

As an example, sufficiently high SAR levels for microwave radiation are likely to be achieved only very close to or directly in front of cellular antennas mounted on a roof, whereas a distance of up to 400 meters from cell phone towers, which emit more EMR, has been found to be associated with an increased cancer incidence. In any case, access to such rooftop areas with cellular antennas should be restricted or limited. Actually, defraying the total EMR load in this way may be one potential method of decreasing total human exposure in urban neighborhoods. Dividing up the EMR load between several buildings in an urban area could help to minimize overall individual microwave exposure, while having one large cell phone tower in the same area would tend to maximize the microwave exposure of a few.

According to various animal studies, there appears to be a significant effect of microwaves in the cell phone tower frequency range on mammals, avian species, and insect pollinators such as honey bees. There also appears to be a negative impact on plant life in the vicinity of cell phone towers. Decreases in fruit and other crop yields could translate into economic losses. As a result, some countries like India have already taken positive action against the potential threat of cell phone tower EMR to wildlife by proposing to have EMR levels audited and recognized as a pollutant and passing a special law to safeguard the surrounding environment. Other countries should also follow suit in setting safe environmental limits on EMR emission levels from cell phone towers in order to preserve the urban flora and fauna. Such safety standards should always be based on the latest research and must be subject to constant revision as new data become available.

In the last few years, Electro Magnetic Frequency exposure effects on environmental pollution have been extensively studied worldwide. With the drastic increase of wireless electromagnetic radiation exposure, contradictory experimental proofs have been reported. Research studies on health risks, due to EMF radiation from cell-phone, cell towers and base stations are still contradictory. All over the world, people have been debating about associated health risk due to radiation from cell phone and cell towers. Recent studies on the radiation from cell phone towers have prompted serious concern about their radiation hazards. Several radiation effects of non-thermal have been. Reports on exposure to electromagnetic radiation of

900 MHz from mobile phones showed that it could induce lipid peroxidation in human erythrocytes in female and male rabbits and in the hippocampus and brain cortex of rats as well as oxidative stress and histopathological changes in the rats' endometrium induces a transient alteration of epidermal homoeostasis effects which were reversed by antioxidants. However, very few studies have been specifically focused on environmental pollution from cell- phone towers radiations, especially for people who live in crowded residential areas nearby the base stations or cell-phone towers. Recently, awareness about the effect of EMF radiation on human life is notably increasing. There are now growing claims (scientific, medical and public) that living close to power lines has a harmful health and environmental effects on human life. Mapping and monitoring EMF radiation levels are still considered to be in its early stage. In this regard, more studies are needed using a highly sensitive measurement and mapping system for better understanding and minimizing the risk factors related to human health and environment. GIS and Global Positioning System (GPS) are known to be the most reliable method is used to identify and locate the various sources of EMF radiation. GIS is a scientific tool, involving the use of particular software, associated with hardware tools and digital geographic data in order to advance some specific scientific research objectives. These modern techniques have been applied to many applications to provide accurate positioning, data capturing, storing, analyzing, retrieving, and end ups with mapping and statistical modeling. Many studies in different countries concentrated on mapping the pollution of the EMF radiation with different standards for the radiation limits.

Recent studies on environmental pollution from cell-phone towers have prompted a serious concern about their radiation hazards. Investigations in the present project are based on mapping the Electromagnetic Field radiation levels in various locations in the north Jordan, which was shown to be highly radiated due to large number of cell-phone towers distributed throughout the region. Radiations coming out of these towers were measured using spectrum analyzer, power strength meter and Geographic Position System. The present study focused on EMF radiation intensity measurement in crowded residential areas and public buildings and facilitated using far-field equation. The data of EMF radiation in the selected regions were processed and represented by digital map (2D and 3D) with interpolated using ArcGIS 9.3 software. Modeling and statistical analysis of the obtained results was compared with the international standards. In addition, this study demonstrated that both spatial and temporal factors contribute to residential EMF exposure and GIS technologies can be used to improve EMF exposure assessment and to guide the decision makers in Jordan to take serious and solid steps toward reducing radiation exposure limits and thus reducing health risks as much as possible.

Cell phone towers in the United States are most lenient and least protective in the world - US allows 580 to 1,000 $\mu W/cm^2$. Durduran et al. (2010) studied the effect of EMF radiation of cell-phone towers, in

order to map the pollution of the EMF radiation in Turkey. They found that the most intense area of EMF fields was in the center of the city and concluded that there is a strong relationship between the levels of EMF pollution and health. Giliberti et al. in 2009 studied the EMF radiation effect of radio base station (RBS) in Italy. They found that the exposure produced by electric field was less than the exposure limits stated by Italian standards. In contrast, effect mobile radiation is harmful and more destructive on liver tissue, 2.1 GHz W-CDMA modulated

MW radiation inhibited cell viability and induced apoptotic cell death via the mitochondrial way.

Recently, World Health Organization international research agencies has classified electromagnetic fields from mobile phones and other sources "possibly carcinogenic to human" and advised the public to adopt safety measures to reduce exposures, like use of hand-free devices or texting. Mobile towers are being built in a haphazard manner without any prior planning and regulation.

The transmission towers are based on the electromagnetic waves, which over prolonged usage have adverse impacts on humans as well as on other fauna. The adverse effects of electromagnetic radiation from mobile phones and communication towers on health of human beings are well documented today. However, exact correlation between radiation of communication towers and wildlife, are not yet very well established. The Ministry of Environment and Forests usually receives several questions regarding this issue

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Occurrence of larval parasitoids, *Apanteles* species in sal defoliator, *Paectes subapicalis*

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Abstract

Paectes subapicalis Walker (Lepidoptera: Noctuidae) is a major insect defoliator of sal, Shorea *robusta* Gaertn. f. (Family: Dipterocarpaceae). The larvae of *P. subapicalis* have recorded to be parasitized by *Apanteles* species in in sal forests of Odisha. The present article deals with diagnostic characters of *Apanteles* species identified on target insect pest and field parasitization potential.

Key words: Larval parasitoids, *Apanteles* species, sal defoliator, *Paectes subapicalis*

Introduction

Paectes subapicalis Walker (syn. *Ingura subapicalis*) (Lepidoptera: Noctuidae) is a potential insect defoliator of sal, Shorea *robusta* Gaertn. f. (Family: Dipterocarpaceae) (Beeson, 1941), found in India and Pakistan (Browne, 1968). The larvae are semilooper and observed to be voracious feeder, principally feed on young foliage (Roychoudhury et al., 2007; Roychoudhury and Mishra, 2021) (Fig. 1). The head, pronotum and pygidium were observed to be yellowish with moderately distinct one pair of white lines on the middle of the dorsal side of the body. The full-grown larvae are about 26 mm in length (Fig. 2).

Fig.1. Sal defoliation by *Paectes subapicalis*

Fig.2. Freshly moulted last instar larva of *Paectes subapicalis*

The larvae of *P. subapicalis* are found to be parasitized by *Apanteles* species in nature, as recorded by Roychoudhury et al. (2020) in sal forests of Odisha. The genus *Apanteles* Foerster belongs to the order Hymenoptera, family Braconidae and sub-family Microgastrinae. The parasitic wasps, *Apanteles* species are important larval parasitoids of several lepidopterous pests of agricultural crops, commercial cash crops and forest tree species. Adult wasps are free-living and females insert their eggs beneath the skin of the host larvae, where eggs hatch and their young ones feed. The final instar larvae consume almost the entire host, except skin and head capsule (Boodryk, 1969). Finally, mature larvae leave the hosts and spin cocoons before larval-pupal transformation. After pupal-adult transformation wasps emerge from the cocoons. It is the most conspicuous single group of endo-parasitoids of Lepidoptera in the world, both in terms of species richness and economic importance. In India, considerable work has been carried out on identification of *Apanteles* species (Wilkinson, 1928a, b). *Apanteles* species are well distributed in central India (Roychoudhury, 2010, 2013, 2016; Roychoudhury *et al.*, 2020). The present article deals with *A. aristolochiae*, *A. endymion* and *A. prosper* as parasitoids of sal defoliator, *P. subapicalis.* The diagnostic features and parasitization potential of these *Apanteles* species are mentioned as hereunder.

***Apanteles aristolochiae* Wilkinson**

Apanteles aristolochiae Wilkinson, 1928a: 84

(Fig. 3)

Diagnostic features : Fore-wings with breadth of stigma, first abscissa of radial,equal to or rather less than the

breadth of stigma.roundly angled with and rather longer than the transverse cubital which latter is about equal to the recurrent all nearly equal; apical portion of first abscissa of cubital shorter than recurrent but longer than the pigmented portion of second abscissa of cubital, and also equal to or rather longer than the upper portion of basal vein; stigma equal to or just shorter than metacarp. Hind legs with longer tibial spurs 3/5 and sorter tibial spur somewhat less than 1/2 the length of basal joint of hind tarsus. First abdominal tergite and second tergites closely approximating in shape, apparently punctuate; Ovipositor sheaths about equal than hind tibial spur.

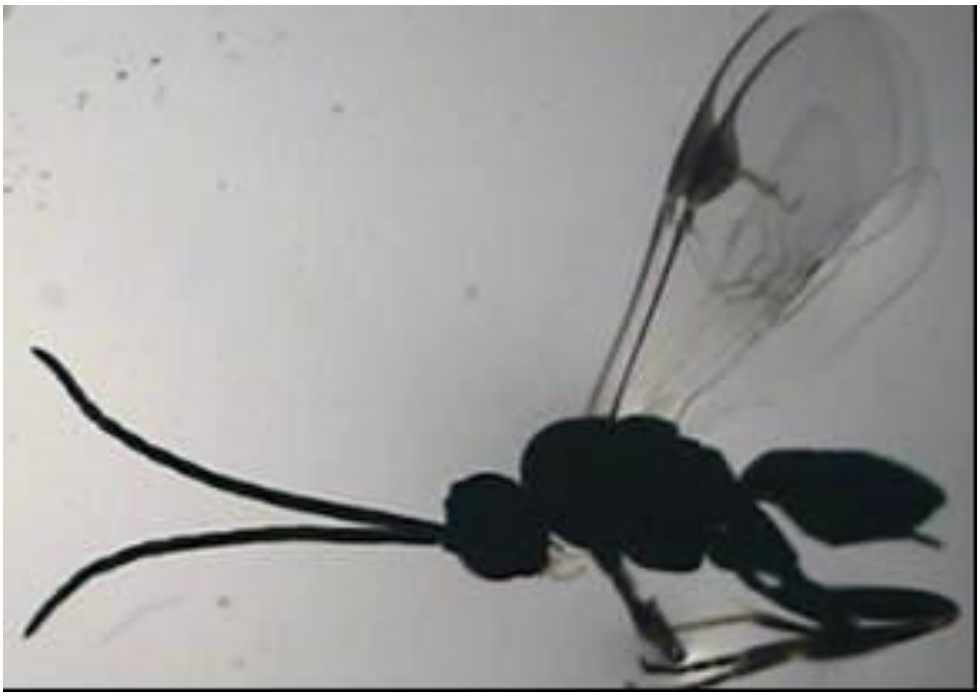

Fig. 3. ***Apanteles aristolochiae***

***Apanteles endymion* Wilkinson**

Apanteles endymion Wilkinson, 1928b : 322

(Fig. 4)

Diagnostic features

Fore-wings with first abscissa of radial and transverse cubital straight, distinctly angled with each other,their point of junction normally slightly thickened, more usually equal to each other in length but often the radial rather longer than the transverse cubital which is four fifths the breadth of the stigma, equal to the recurrent and 1.5 times as long as the apical portion of the first abscissa of the cubital is shorter than transverse cubital,this latter equal to or rather longer than the pigmented portion of the second abscissa of cubital; the upper portion of basal vein shor; pterostigma is equal than metacarp. In hind legs, longer tibial spur half and shorter spur is two fifth the length of basal joint of hind tarsus. First tergite shining smooth to minutely and very indefinitely sculptured, and with some, indefinite, punctuation in and apical fourth, very decidedly turned over and diwn but medianly not tumescent, in the basal half of the tergite. Apical breadth of the tergite is equal to its breadth at thebase of the apical half, is less than its breadth at the middle of the apical half, and is greater

than the breadth of its extreme base (18:18:20:16), Ovipositor sheaths barely longer than basal joint of hind tarsus. The median length apparently about 1.4 times the apical breadth (25:18). Second tergite with an occasional minute puncture, its apical margin very slightly curved to nearly its lateral sulci widely divergent at extreme base and then nearly parallel.

Fig.4. *Apanteles endymion*

***Apanteles prosper* Wilkinson**

Apanteles prosper Wilkinson, 1928b: 319 (Fig. 5)

Diagnostic features

Fore-wings with pterostigma equal to or just sorter than the metacarp; first abscissa of radial and transverse cubital sufficiently rounded so that point of junction with is indeterminable, their combined length considerably greater than the breadth of the stigma; pigmented portion of second abscissa of cubital; sorter than than upper portion of basal vein;which is distintly shorter than the apical portion of first abscissa of cubital ;this latter shorter than the recurrent; In hind legs hind tibial spur subequal; longer tibial spur half the length of basal joint of hind tarsus; ovipositor sheaths shorter than hind femora, first metasomal tergite with some indefinite sculpture in the apical third; ovipositor sheaths apparently not much longer than the basal joint of the hind tarsus.

Fig.5. *Apanteles prosper*

Field parasitization of *Apanteles* species on *P. subapicalis*

Based on the emergence of *Apanteles* species, the natural field parasitisation percentage of different species on target insect pests revealed that *A. prosper* showed the highest parasitisation (50.00%), followed by *A. aristolochiae* (33.33%) and *A. endymion* (13.33%) (Roychoudhury, 2013; Roychoudhury et al. 2020). Percentage parasitisation in field and laboratory tests play an important role in the selection of bio-control agent for the biological control programme of an insect pest.

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Published by:

Tropical Forest Research Institute
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