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IFGTB NEWS

Quarterly Newsletter on societal applications of research Interventions in Forestry, Genetics and Tree Breeding from the Institute of Forest Genetics and Tree Breeding, Coimbatore.

(A national institute of the Indian Council of Forestry Research and Education, Ministry of Environment, Forest & Climate Change, GOI)

From the Director's Desk

It is extremely gratifying to share that IFGTB has been ranked first among the ICFRE institutes for the year 2020-21. Since the inception of the rankings by ICFRE in 2017-18, IFGTB has been consistently ranked first, except for 2019-20 when we ranked second. IFGTB would continue to strive to meet the aspirations of all its stakeholders, including farmers, forest department, wood, pulp and paper industries.

This edition of IFGTB News is a continuation of the special issue on teak (*Tectona grandis*), and provides insights into genomic selection strategies, understorey vegetation in plantations and pest management approaches, with a highlight on the recently published novel RNAi based control of teak defoliator. Further, the edition also brings out news on the recently released high-fruiting *Calophyllum inophyllum* clones, high - biomass yielding Eucalyptus hybrid clones, and an interesting insight on how wider spacing in clonal plantations of Casuarina can reduce disease incidence. This issue thus showcases IFGTB's advanced basic and applied research to enhance wood security of the nation.

Dr. C. Kunhikannan
Director, IFGTB

Teak Ecology

Advantageous effects of teak plantations on ground flora diversity and soil microbes

Kunhikannan C.✉, Veeramani T., Mohan V. and Sasidharan K.R.

Studies on ground flora diversity in teak plantations in Nilambur (Kerala) and Sadivayal (Tamilnadu) revealed that these plantations support regeneration of semi evergreen and moist deciduous species including trees like *Alangium salviifolium, Albizia lebbeck, Bombax ceiba, Butea monosperma, Cassia fistula, Ficus hispida, Grewia tiliifolia, Holarrhena pubescens, Lagerstroemia lanceolata, Macaranga indica, Mallotus philippensis, Naringi crenulata, Olea dioica, Polyalthia longifolia, Polyalthia cerasoides, Pterospermum reticulatum, Radermachera xylocarpa, Sapindus trifoliatus, Schleichera oleosa, Strychnos nux-vomica, Tectona grandis, Terminalia bellirica, Wrightia tinctoria* and *Ziziphus rugosa*. The ground flora were similar to the nearby natural vegetation, and ranged from 44 to 73 species, of which more than 50 % were found to be medicinally important. *Aristolochia indica, Asparagus racemosus, Celastrus paniculatus, Clerodendrum serratum, Curculigo orchioides, Entada rheedei, Gloriosa superba, Helicteres isora, Hemidesmus indicus, Holarrhena pubescens, Justicia adhatoda, Phyllanthus amarus, Piper longum, Rubia cordifolia, Sida rhombifolia, Strychnos nux-vomica, Terminalia bellirica* and *Wrightia tinctoria* were important among them. Thus, these plantations can be managed for extraction/ cultivation of medicinal plants as intercrops, thereby increasing the economic benefits as well as reduction of weeds in such plantations. Soils of these plantations also supported greater populations of Plant Growth Promoting Rhizobacteria (Azotobacter, Azospirillum and Phosphate Solubilizing Bacteria) and Arbuscular Mycorrhizal (AM) fungi, when compared to open locations and other species plantations. Thus, advantageous effects of teak over other species plantations include improved ground flora, soil microbial population and soil quality. However, it may not be ideal to raise teak plantations after removal of native forest vegetation.

Teak plantations were observed to support regeneration of native flora including medicinal plants.

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Teak Pest Management

Teak pests and their management

Jacob J.P.✉

The major pests of teak are defoliator *(Hyblaea puera)*, skeletoniser *(Eutectona macharalis)* and the stem borers *(Sahyadrassus malabaricus* and *Cossus cadambae)*. Other occasional pests include Myllocerus beetles, grasshoppers and mite *(Tetranychus urticae)*. IFGTB has developed a Pest Calendar, which provides the period and level of infestation in teak raised as trees outside forest areas and as seedlings in forest nurseries. Management strategies include the use of pesticides; formulations of entomopathogenic fungus *(Metarhizium anisopliae)*; release of egg parasitoid *(Trichogramma raoi)* and application of *H. puera* nucleopolyhedrovirus and *Bacillus thuringiensis.* Pesticides application is neither eco-friendly nor economically viable. The quantitative

Research advances in the development of control measures for various teak pests.

impact of biocontrol agents on the defoliator is meagre, and natural enemy populations are unable to respond numerically to the pest density due to the mobile nature of teak defoliators. Concealed nature of teak stem borer hinders pesticide delivery or access to pest by natural enemies. Planting of clonal teak provided opportunity for identification of clones tolerant to teak defoliator through long term field screening. Attempts made at IFGTB to target chitin metabolism in teak defoliator could be a potential strategy for RNAi-based control. Similarly experiments with insecticidal mannose binding lectin gene of *Withania somnifera, WsMBP1* has potential as a novel gene resource for development of transgenic strategies. Work on use of teak leaf volatiles as lures for attracting and trapping adult moths is in progress at the Institute.

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Identification of target genes for RNAi-based control of the teak defoliator, *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae)

Sowmiya R.K-S., Jacob J.P., Balasubramaniam A., Merzendorfer H. and Nambiar-Veetil M.✉

Teak defoliator is reported to cause complete defoliation, forking of leading shoot, up to 44 % loss in potential volume and height increments, and delay in harvesting age. RNAi technology has been applied in agriculture crops to develop species-specific pest control measures. It involves disruption of key metabolic pathways through knockdown of insect genes using dsRNAs designed based on species-specific sequences of these target genes.

IFGTB Scientist Dr. Mathish and team have identified genes in chitin metabolism as targets for control of *H. puera*.[*Pest Management Science* 2022; 78 (IF : 4.85)]

A well timed interplay of chitin synthesis and degradation is crucial for insect metamorphosis. The late larval instars were therefore, reared on teak leaves coated with 100, 300, and 500 ppm of diflubenzuron (DFB), a chitin synthesis inhibitor, to evaluate if disruption of chitin metabolism affects *H. puera*. DFB treatments resulted in morphological deformities. The genes involved in chitin metabolism were therefore, selected as targets for RNAi. Gene sequences of *Chitin synthase 1* (*HpCHS1*), *Chitinase-h* (*HpChi-h*), and *Ecdysone receptor* (*HpEcR-B1*) were determined so as to design dsRNAs cognate for these genes. These dsRNAs (100 ng–3 µg) were fed to the 1st instar larvae of *H. puera*. Highest mortality of 45.9 % was observed in case of *HpEcR* dsRNA treatment that resulted in growth inhibition and molting arrest. ds*HpChi-h* and ds*HpCHS1* treatments resulted in mortalities of 32.4 % and 29.7 %, respectively. Improving RNAi efficacy through developing better formulations and delivery strategies would enable field application of these results. This is the first report of efficient RNAi in *H. puera.* The study had enabled Dr. Sowmiya Rani to avail DAAD PhD Sandwich scholarship to pursue RNAi approaches in other insect species in Prof. Merzendorfer's lab in the University of Osnabrück, Germany.

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Teak Breeding

Genomic selection strategies in Teak

Yasodha R.✉, and Ani E.

Advances in genomics - based breeding of teak enables high efficiency selection of better genotypes and increased timber production.

Teak wood has a variety of properties that make it an excellent choice for versatile applications. Teak has a simple genome with 2n = 36 chromosomes with genome size of around 340 Mb. Traditional approaches for genetic improvement such as mass selection, pedigree selection, and bulk population improvement are commonly applied. Recent advances in tissue culture-based clonal production, wood technology, and molecular markers will make it easier to deploy improved teak germplasm varieties. Teak populations harbour lot of genetic diversity, as proven by the DNA markers. Teak genome sequence assembly on a chromosomal scale, as well as transcriptome resources, are published.

One of the most serious concerns impacting timber availability is temperature and drought stress. Therefore, the ability of teak to adapt to climate change is becoming increasingly significant. As the temperature rises, the growth environment becomes more unfavourable, as do pest and disease conditions. Therefore, the application of genomics-based breeding approaches is being investigated in order to provide an economically viable harvest. Genomic selection (GS) overcomes intrinsic hurdles in tree breeding and accelerates genetic gain. DNA marker arrays and phenotypic parameters are integrated to predict the phenotypes early. GS research in tree crops have so far yielded promising results in terms of capturing long-term genetic gain for traits such as wood quality, growth, and pest resistance. With the continual improvement of high throughput phenotyping technologies and less expensive genomic resources, we expect the capability of GS to ensure genetic gain to greatly exceed that of traditional selection methods.

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Clonal Variety Release

Release of high yielding *Calophyllum inophyllum* varieties for farmlands

Anandalakshmi R.✉, Suresh Kumar K., Rajesh C., Geetha S., Sathish A., Manivachakam P. and Krishnakumar N.

IFGTB Scientist Dr. Anandalakshmi and team have developed six high - fruiting clonal varieties

Calophyllum inophyllum (Punnai) is a Tree Borne Oilseed (TBO) species found in the riverine belts and along the coasts of southern parts of India. It supports apiculture, and can be grown in agroforestry systems, as shelterbelts plantations, and as an ornamental tree for urban forestry. Its seed is a rich source of non-edible oil called Tamanu oil, having medicinal and biodiesel properties. It is sold online at a high price of Rs. 5000 - Rs. 8000 / L, and has promising international market.

IFGTB has developed six high fruit yielding varieties namely IFGTB-CIM1, IFGTB-CIM2, IFGTB-CIM3, IFGTB-CIM4, IFGTB-CIM5 and IFGTB-CIM6. They were released by Shri. Subash Chandra, Director General of Forests and Special Secretary, MoEF&CC, in the Variety Release Committee Meeting of ICFRE on 18th Nov 2021. These clones start yielding by the 6th year with a higher fruit yield of 6 kg /tree and with seeds containing a higher oil content of > 50 % when compared to the unimproved seedlings that start yielding after 8 years. A higher income by 50 % is expected by cultivating these improved varieties.

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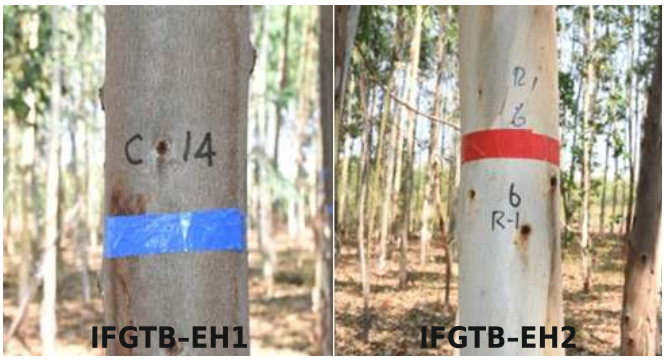
Release of high-biomass yielding Eucalyptus hybrid clones for plantations

Raja Suguna Sekar D.✉, Nagarajan B., Modhumita Dasgupta, Sivakumar V., Mayavel A., and Yasodha R.

IFGTB Scientist Dr. Raja Suguna Sekar and team have developed two high yielding hybrid clones, IFGTB -EH1 and IFGTB –EH2.

Two interspecific hybrids of Eucalyptus, viz., IFGTB-EH1 and IFGTB–EH2 were released during the Variety Releasing Committee Meeting of ICFRE held on 18th Nov 2021. These were developed through controlled pollination of elite selections of *Eucalyptus tereticornis*, *E. camaldulensis* and *E. grandis.* A total of 36 hybrid clones and 5 control clones including commercial varieties were field evaluated for 4 years in 3 different sites viz., Neyveli, Nellore and Thuvarankuruchi. The clonal hybrid IFGTB-EH1 exhibited superior performance across the sites, followed by IFGTB–EH2, IFGTB–EH3 and IFGTB-EC4. The overall ranking was calculated based on the mean volume production considering both height and diameter for each site. In terms of growth, IFGTB-EH1 and IFGTB–EH2 were found superior respectively by 28.6 and 9.5 % to the IFGTB-EC4 clone, a mass selection phenotype.



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Clone	Yield (t/ha)	m^3 /ha/y	Returns(Rs)/ha at Rs.4500/t
IFGTB-EH1	65	21.6	2,92,000
IFGTB–EH2	60	20.0	2,70,000
IFGTB-EC4	50	16.0	2,25,000

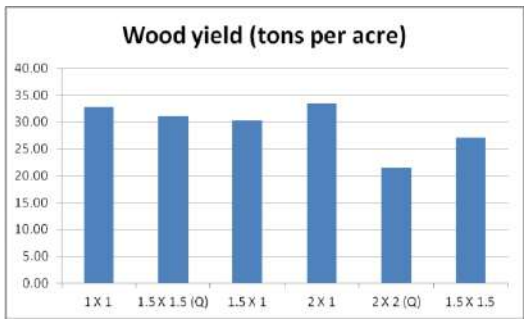
Casuarina Disease Management

Disease management through optimum spacing in clonal plantations of Casuarina

Buvaneswaran C.✉, Mayavel A., Karthikeyan A. and Nicodemus A.

Wider spacing reduces incidences of diseases and lodging besides improving pulpwood yield.

Casuarina hybrid clones (IFGTB-CH1, IFGTB-CH2 and IFGTB-CH5) are currently planted in around 50,000 acres. Farmers prefer these clones due to the high yield of ~ 60-70 tonnes of pulpwood/ acre in 3-4 years rotation. However, these clonal plantations, particularly with clone IFGTB-CH2, are affected by collar rot (*Diplodia* sp.) and bacterial wilt (*Ralstonia solanacearum*) resulting in lodging of trees especially in waterlogged clayey soils. Extensive field surveys revealed that disease incidences were higher in plantations that adopted closer spacing (> 3500 trees / acre). Further evidence came from the spacing trial at Chityala, Andhra Pradesh. No incidence of collar rot or lodging was observed at a wider spacing of 2 x 1 m at 2 years of age. This may be attributed to greater space for root development, sunlight reaching over the root zone, and air circulation between trees. Wider spacing also enabled greater pulpwood yield of 33.4 t / acre when compared to 32.8 t / acre under 1x1 m spacing (See figure). A stocking between 2000 to 2400 trees / acre (2 x 1 m or at the least 1.5 x 1.2 m) is therefore recommended for healthy clonal plantations.



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Events : Oct – Dec 2021

- **MEETINGS :** Research Advisory Committee Group (08th Oct), Variety Releasing Committee (VRC) of ICFRE (18th Nov), IBSC meeting (30th Dec).
- **SEMINARS :** Basics of Molecular Biology and Biochemistry (25th Oct), Urban Forestry (12th Nov), Kedharnath Memorial Lecture 2021 (29th Nov).
- **TRAININGS :** Development of Tree Rich Biobooster (01st Oct), GSDP - Plant Tissue Culture and its Applications (8th Nov - 31st Dec), GSDP - Quality Planting Material Producer (22th Nov – 31st Dec).
- **PRAKRITI PROGRAMME :** Avoid Single Use plastics (09th Oct), Cancer curing medicinal plants (23rd Oct), Quality planting stock production and cultivation of *Neolamarckia cadamba* (30th Oct), Urban Forestry Research and Development & Overview of Carbon Foot Prints (13th Nov).
- **OTHER EVENTS:** Wildlife week 2021 (07thOct), Vigilance Awareness week (26th Oct – 01st Nov), Iconic Week Celebration – Avoid Single Use Plastics (04th Oct – 10th Oct), Rashtriya Ekta Diwas & Swatch Bharat Campaign (29th Oct), Green Deepavali (03rd Nov), Samvidhan Divas (26th Nov), Release of Short Film - Recycling Waste and Supporting Livelihoods (2nd Dec), World Soil Day (03rd Dec), International Mountain Day (11th Dec), Good Governance Week (27th Dec).
- **NEW RECRUITS :** *MTS* : Ms. Dilmol Baiju (Oct), Mr. N. Bathmanaban (Dec).
- **SUPERANNUATION :** Sh. R. Balasundaram, UDC (30th Nov).


Sh. R. Balasundaram

About IFGTB

The Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore, is a national institution of the Indian Council of Forestry Research and Education (ICFRE), an autonomous council under the Ministry of Environment, Forest and Climate Change, Government of India. IFGTB has a mandate to develop new varieties, management and silvicultural techniques to maximize productivity of natural and planted forests under different ecological considerations and changing environment.

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Cover Photo : Teak plantations in Topslip, Tamil Nadu by **Dr. R. Yasodha,** Scientist G.

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