ABOUT IFGTB

Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore is a National Research Institute under the Indian Council of Forestry Research and Education. IFGTB envisions a wood secure society. The Institute primarily aims to carry out research to improve productivity of forest tree species through conventional breeding programmes and biotechnological interventions. The major areas of research include tree improvement , breeding, planting stock improvement, marker assisted selection, genomics, clonal propagation, agroforestry systems, climate change research, integrated disease and pest management, seed handling and testing, eco restoration and conservation.

ABOUT ENVIS

ENVIS established by the Government of India, in 1982 has been on providing environmental information to decision makers, policy planners, scientists and engineers, research workers, etc. all over the country. It is a comprehensive decentralized information system on environment involving effective participation of institutions / organisations in the country actively engaged in work relating to different subject areas of environment. A large number of nodes, known as ENVIS Centres, have been established in the network to cover the broad subject areas of environment with a Focal Point in the Ministry of Environment, Forest and Climate Change.

INSTRUCTIONS TO CONTRIBUTORS

Dear Author/ Subscriber/ Contributor,

We invite contributions to the ENVIS Newsletter issues! The ENVIS Resource Partner at IFGTB focuses on Forest Genetic Resources and Tree Improvement. It aims to act as a window for quality scientific publications and a forum for presenting your thinking on the challenges in the fields of FGRs and tree improvement. The ENVIS Newsletter, Van Vigyan, a quarterly publication, publishes original research articles, reviews, reports, research highlights, news-scan etc., related to the thematic area of the ENVIS Resource Partner. Original research and review articles, notes, research and meeting reports are invited for the newsletter. Details of forthcoming conferences/ seminars / symposia / trainings / workshops also will be considered for publication in the newsletter. Articles may be sent in Times New Roman (with font size 12) in double spacing with a maximum of 5-6 typed pages. Photographs/line drawings and graphs need to be of good quality with clarity for reproduction in the newsletter. Only electronic submission will be accepted.

Details may be sent to: ifgtb@envis.nic.in.

Steps to Install the **"Mobile APP"** on **"Disease Management in Forest Nurseries & Plantations"** (Android Version)

1. Go to the "**Google Play Store**"
2. Search as **"IFGTB-ENVIS"** in the search button.
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4. Icon will appear in the desktop as **"Forest tree diseases"**

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ENVIS Newsletter

Forest Genetic Resources & Tree Improvement

VAN VIGYAN

INSTITUTE OF FOREST GENETICS AND TREE BREEDING

(Indian Council of Forestry Research and Education)

From the

Director's Desk

The ENVIS Resource Partner at IFGTB aims to reach out to school and college students through awareness programmes on the importance of trees and their services to mankind. Through the newsletter we provide information on various tree improvement activities being carried out, for enhancement of productivity so that more wood is produced by small land holders. This helps the nation to meet its wood demand for paper, plywood, timber and saves the country significant foreign exchange on account of reduced imports. Information available on our heritage in terms of forest genetic resources is also provided. It is our continuous endeavour to be in touch with all research organisations, state forest departments, universities/colleges, wood based industries and farmers' groups through this newsletter which serves as a platform to share meaningful information among stakeholders.

Mohit Gera
Director, IFGTB

In this issue

VAN VIGYAN

Know Your Trees - *Neolamarckia cadamba*

Know Your Trees
Neolamarckia cadamba

Taxonomic classification: Kingdom- Plantae; Division- Magnoliophyta; Class- Magnoliopsida Order- Gentianales; Family:-Rubiaceae; Genus: Neolamarckia; Species: cadamba.

Common Names

Kadamb (Hindi); Vellaikattambu (Tamil); Katampu (Malayalam); Kaduavalatige (Kannada); Rudrakskamba (Telugu).

Introduction

Neolamarckia cadamba (Family Rubiaceae) is a large deciduous tree, native to India, found along the slopes of evergreen forests, Sub-Himalayan tract from Nepal eastwards, lower

hills of Darjeeling terai in West Bengal, Chota Nagpur (Bihar), Orissa, Andhra Pradesh, Andamans. It is widely spread in banks of streams, low level wet places of Western Ghats in Karnataka and West coast in Kerala (Dubey *et al.,* 2011). It has been successfully introduced into Costa Rica, Puerto Rico, South Africa, Surinam, Taiwan, Venezuela and other tropical and subtropical countries (Gautam *et al.,* 2012) and in countries like China, Australia, Malaysia, Papua New Guinea, Philippines, Singapore and Vietnam. It is an early-succession species which grows best on deep, moist, alluvial sites, often in secondary forests along riverbanks and in the transitional zone between swampy, permanently flooded and periodically flooded areas (Pollard, 1969). The timber is moderately strong and is rather soft. It saws and works easily under tools and readily on a rotatory veneer lathe (Trotter, 1944; Sekhar and Bhatia, 1957). *N. cadamba* is a favoured plantation species inside and outside its native range. In Sumatra it has been cultivated in plantations, where the rotation period is 4 years. Pulp obtained from the wood is suitable for cheap paper (Troup, 1921; Rodger, 1943). Kadam is chiefly employed for cheap boarding and for packing cases and tea boxes. In Burma, it is used in the match industry, for splints and boards (Pearson and Brown, 1932; Niranjan *et al.,* 2000; Rafiqual Hoque *et al*., 2004).

Distribution and Habitat

Being a high economic value species, it is cultivated in patches by industries and farmers and planted as ornamental tree. *Neolamarckia cadamba* has a broad umbrella crown and straight cylindrical bole. The tree may reach a height of 45 m with girth of 100-160 cm. The bark is grey in colour and texture is smooth in young trees and longitudinally fissured in old trees. Leaves are glossy green, opposite, simple, petiolate, ovate to elliptical.

N. cadamba is a tropical species with light demanding nature and grows normally with a maximum of 37.5° to 47.5° C and minimum 0° to 15°C temperature. The young plants need protection from sun and the seedlings are frost sensitive and liable to damp off during excess moisture in the soil (Bijalwan *et al.,* 2014). The species requires moist well drained alluvial soil. The species can grow well in a mean annual rainfall of 1500 to 5000 mm (Luna, 1996) however can also grow in xeric condition with low rainfall. The species grows in the altitudinal range of 300 to 1000 m and sometimes up to 1400 m (Martawijaya *et al.,* 1989).

Growth Characteristics and Phenology

Flowers orange, small, in dense, globose heads, appear like solid, hairy orange balls. The fruits are small capsules, packed closely together to form a fleshy, yellow or orange coloured infructescence containing approx. 8,000 seeds. The small capsules split into four parts releasing the seed at maturity.

Fruit collection and processing

Flowering starts from the fourth year onwards during the month of June to December. Fruits should be collected when it becomes dark yellow or orange in colour. Average dry weight of

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each fruit is 11.5 gm and wet weight 50 gm. The collected fruits are allowed to rot for three to four days and crushed into small parts and allowed to dry to separate the seeds. Seeds are separated by crushing with hand and dried under sunlight. One gram has around 23,000-25,000 seeds. The seeds are allowed to dry in shade and stored in air tight container for 9 –12 months at -20°c.

Germination

Seeds don't require any pre-sowing treatment, but need special care during watering, due to minute nature of seeds. The seeds can be broadcast on sand medium. Germination starts after 8-12 weeks. The seedlings should be pricked out when it attains four leaf stage / 5 cm height and transplanted into polythene bags (20 x 11 cm). These seedlings will be ready for planting when they reach 45 cm height.

Vegetative propagation

Coppice shoots (15-20 cm) collected from selected CPTs by girdling or felling trees, are dipped in root hormones to induce rooting.

Cuttings treated with IBA or NAA (500 ppm) gave 81% and 62% respectively. Rooting can be observed after 30 days. The rooted plants can be transplanted to polybags. The rooted cuttings have to be watered twice a day with monthly NPK application (1 gm/lit).

Planting techniques and post planting operations

Spacing of 2 x 2 m for pulp wood purpose and 3 x 3 m or 4 x 4 m for plywood/match/pencil wood should be maintained. Size of pits should be 45 x 45 x 45 cm and 3-5 kg of FYM or vermicompost per pit should be applied. When the space is more, survival percentage increases (Singh and Lal, 1982) and Luna, (1996) reported that spacing adopted in Arunachal Pradesh and West Bengal was 5.0 x 5.0 m and 2.0 x 2.0 m respectively. The closer spacing provides protection against grazing animals.

Watering should be done twice weekly in the initial years. Weeding has to be carried out once a month during summer and at fortnightly intervals during rainy season. Urea and Triple Super Phosphate can be used for manuring low fertile lands. According to Soerianegara and

Lemmens, (1993) applying urea (15 g per plant) in a ring around the seedling results in much faster growth. To get quality wood there should be knot free timber and clear bole. This can be achieved by pruning the side branches. In cadamba pruning is natural process. Thinning for plantations with a spacing of 3×2 m, 3 thinnings conducted at 2, 4 and 8 years of age are sufficient to obtain a high timber volume; for plantations with 3×3 m spacing, thinning should be conducted at 2, 4 and 7 years of age with a 13-year rotation (Krisnawati *et al.,* 2011).

Agroforestry practices

It has no adverse effects on the understorey crops. A wider spacing of least 5 x 5/6 x 6 m is advisable paddy can be cultivated up to 3 years. Once the trees attain max height, it is desirable to change the cropping pattern i.e. ginger, turmeric etc besides vegetables, pine apple, arhar and pulses. Trees are also planted in the boundaries of the field. In north eastern states, especially in Assam, *Neolamarckia cadamba* is generally grown along boundaries. It is one of the most promising plantation trees in India. The species is also sporadically used as shade tree in tea and coffee plantations. *N. cadamba* plantation at spacings of 4 x 4 or 5 x 5 m increase the yield of seasonal crops in agroforestry (Lubis, 2014).

Wood Properties/ Utilisation

The hardwood is lightweight with no clear differentiation from sapwood which is white with a yellow tinge darkening to creamy yellow on exposure (Martawijaya *et al.,* 1989). The wood has a fine to medium texture and is easy to work with hand and machine tools, cuts cleanly, gives a very good surface and is easy to nail and has no characteristic odour or taste. The wood density is in the range 290–560 kg/m^3 at 15% moisture content (Krishnawati *et al.,* 2011). Due to low lignin and high holocellulose contents, *N. cadamba* produces high pulp yield at milder cooking conditions. (Lal *et al.,* 2010). It is very easy to preserve and is rated as non-durable. Graveyard tests in Indonesia show that the average life of wood in contact with the ground is less than 1.5 years. The timber air-dries rapidly with little or no degradation. Sudarmo, (1957) indicated that *N. cadamba* plantations growing in good-quality sites reach a maximum volume mean annual increment (MAI) of 20 m^3 /ha/year

Know Your Trees - *Neolamarckia cadamba*

by the age of 9 years, producing up to 183 m^3 /ha over the rotation.

Growth and Yield

N. cadamba exhibits fast growth IFGTB studied the economics of cadamba cultivation which is presented here.

Rotation (Yrs.) / ha	Number of trees (kg)	Mean yield /tree (tone)	Wood yield /ha	Sale price /tone	Income /ha	Cost incurred /ha	B/C Ratio
8	500	225	112	Rs.7000	Rs.7,84,000	128050	2.06

Initial two to three years, there will be profit by cultivating seasonal crops by agroforestry methods.

Pest management

Young *N. cadamba* species are susceptible to common stem borer (*Cossus cadambae*) which bores the stem during August - January. Anon, (1985) also report insects such as *Aristobia approximator* (bark feeder), *Dihamnus cervinus* (Stem borer) and *Dirades adjutaria* (Defoliator). These can be controlled by spraying 0.2% carbaryl, acephate, fenvalerate and permethrin in young plants.

Tree Improvement

Tree improvement studies in this species are sparse**.** Institute of Forest Genetics and Tree Breeding, Coimbatore and Forest College & Research Institute, Mettupalayam are working on tree improvement of cadamba. Thirty open pollinated genetic resources of N. cadamba collected from 11 natural populations in Tamil Nadu, Assam, Bihar, Nagaland, Uttarkhand, Telangana, Uttar Pradesh, Maharastra, Karnataka, Kerala and Tripura were planted. Twenty five superior performers from these were felled. Coppice shoots were planted and evaluated. Two clones Khowai (AC17) and Mettupalayam (AC15) have been identified as best clones (Selvan and Parthiban, 2018).

Currently, IFGTB is working towards popularization of cadamba among farmers, industries, forest corporation and forest department as an alternate species for pulp& paper, Pencil/Plywood and match wood. Outperforming individuals selected from progeny trials and are being tested in multilocations to identify superior performers.

Uses of Cadamba

The wood is extensively used for ceiling boards, light construction work, packing cases, planking, carving and turnery. The wood makes good veneers and plywood suitable for the manufacture of commercial grade plywood and tea chest plywood. In Assam wood is mainly used in the plywood industries. It is also suitable for the manufacture of pencils, match boxes, pulpwood and splints. Suitable for writing and printing paper giving 48.6% yield and over 6000 m breaking length. Brown wrapping paper can also be prepared by sulphate process. Bark used for relieving fever and extract of leaves are used for mouth gargle. It has high medicinal value of all parts of the plant, ornamental, fodder for livestock, edible value for fruit, bark, leaves, root etc, used for hair oil , fragrance scent, attar, soap, face cream, shampoo, wine, green tea etc. It has the largest number of phytochemicals and secondary metabolites (*viz*., cadambagenic acid, cadamine, quinovic acid, *β*-sitosterol, cadambine, etc.) having pharmacological and biological properties. It can be used as an alternative to various synthetic chemical compounds in the prevention as well as the treatment of several incurable diseases such as cancer, liver injury, cardiovascular diseases, cellular damage, and the aging process. It has antioxidant properties that are found particularly in its leaves. Its leaf extract shows higher antifungal activity than the bark extract.

REFERENCES

Annon, 1985. Troup's Silviculture of Indian Trees. Vol VI. Controller of Publications, Delhi.

Bijalwan, A., Manmohan, J.R. Dobriyal, Bhartiya J.K. 2014. A Potential Fast Growing Tree for Agroforestry and Carbon Sequestration in India: *Anthocephalus cadamba* (Roxb.) Miq. American Journal of Agriculture and Forestry. 2(6): 296-301.

Dubey, A., Nayak, S. and Goupale, D.C. 2011. *Anthocephalus cadamba*: A Review. Pharmacognosy Journal. 2(18): 71-76.

Gautam, R., Irchhaiya, R. and Swarnakar, R. 2012. *Anthocephalus cadamba* (ROXB): An Overview. IJPRD, 2011; 4(04): 169 - 173.

Krisnawati, H., Kallio, M. and Kanninen, M. 2011. *Anthocephalus cadamba* Miq. Ecology, silviculture and productivity. CIFOR, Bogor, Indonesia. ISBN 978-602-8693-38-7.

Lal, M., Dutt, D., Tyagi, C.H., Upadhyay and, J.S. and Upadhyay. S. 2010. Characterization of *Anthocephalous cadamba* and its delignification by kraft pulping. TAPPI Journal, 3: 30-33.

Luna, R.K. 1996. Plantation trees, IBD Publisher, Dehradun, India.

Martawijaya, A., Kartasujana, I., Mandang, Y.I., Prawira, S.A. and Kadir, K. 1989. Atlas kayu Indonesia Jilid II. Pusat Penelitian dan Pengembangan Hasil Hutan, Bogor, Indonesia.

Niranjan, P., Sahu, Koilke, K., Banerjee, S.S., Nirup, B. and Nikaido, M.T. 2000. Triterpeneglycosides from the bark of *A. cadamba*. Journal of Chemical Research. 22: 22-23.

Pearson, R.S. and Brown, H.B. 1932. Commercial timbers of India, 2: 621.

Pollard, J.F. 1969. A note on the nursery treatment of ten species in Sabah. Malay Forester 32: 269-271.

Rafiqual Hoque, A.T.M., Hossain, M.K., Mohiddin, M. and Hoque, M.M. 2004. Effect of inorganic fertilizers on the initial growth performance of *A.chinensis* (Lam) Rich. Ex. Walp. Seedlings in the nursery. Journal of Applied Sciences 4: 477-485.

Rodger, A. 1943. A hand book of the Forest Products of Burma. P-81.

Sekhar, A.C. and Bhatia, D.N. 1957. Physical and mechanical properties of woods species for the tropics. Indian Forest Records (Timber Mechanics) 1(9): 155-157.

Singh, S.P. and Lal, P. 1982. Effect of different spacing treatments on yield from *Anthocephalus chinensis* plantations. Indian Forester, 108(12): 734-740.

Soerianegara, I. and Lemmens, R.H.M.J. 1993. Plant resources of South-east Asia 5 (1): Timber trees: Major commercial timbers. Pudoc Scientific Publishers, Wageningen, Netherlands.

Soerianegara, I. and Lemmens, R.H.M.J. 1993. Plant resources of South-east Asia 5 (1): Timber trees: Major commercial timbers. Pudoc Scientific Publishers, Wageningen, Netherlands.

Sudarmo, M.K. 1957. Tabel hasil sementara Anthocephalus cadamba Miq. (jabon). Pengumuman No. 59. Lembaga Penelitian Kehutanan, Bogor, Indonesia. 13.

Thirunirai Selvan, R. and Parthiban, K.T. 2018. Clonal evaluation and genetic divergence studies in *Neolamarckia cadamba* roxb. Electronic Journal of Plant Breeding, 9(2): 692-704.

Trotter, H. 1944. The Common Commercial Timbers of India. P- 51.

Troup, R.S. 1921. The Silviculture of Indian Trees. Vol, II, Oxford, 614-623.

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Draft Genome Sequence of Indian Sandalwood, *Santalum album* L.

Santalum album L. (Indian sandalwood) is renowned for its high quality fragrant oil extracted from the heartwood of stem and root. The species is indigenous to the tropical belt of the Indian peninsula, eastern Indonesia and northern Australia. The threat to this species in India has reached critical level due to over exploitation, illegal harvesting, monopoly in trading, lack of established plantations, habitat loss and lack of regeneration due to fire and grazing and incidence of spike disease. The species is considered to be approaching commercial extinction, widening the gap between supply and demand.

Motivation for whole genome sequencing of *S. album*

Inspite of its commercial and cultural relevance to India, the sandalwood improvement program has been limited and research addressing the two commercially important traits including heartwood formation and essential oil yield has not generated significant output to support the breeding program. The genomic resources for this species are limited and no microsatellite markers are developed till data for population analysis of *S. album*.

A team of scientists including Dr. Modhumita Dasgupta, Prof. K. Ulaganathan and Dr. Suma Dev from Institute of Forest Genetics and Tree Breeding, Coimbatore; Centre for Plant Molecular Biology, Osmania University, Hyderabad and Kerala Forest Research Institute, Peechi, Kerala respectively generated the first draft genome sequence of Indian sandalwood.

Sequencing, *de novo* assembly and annotation

Chloroplast genome of *S. album* SSR profiles in *S. album* genotypes

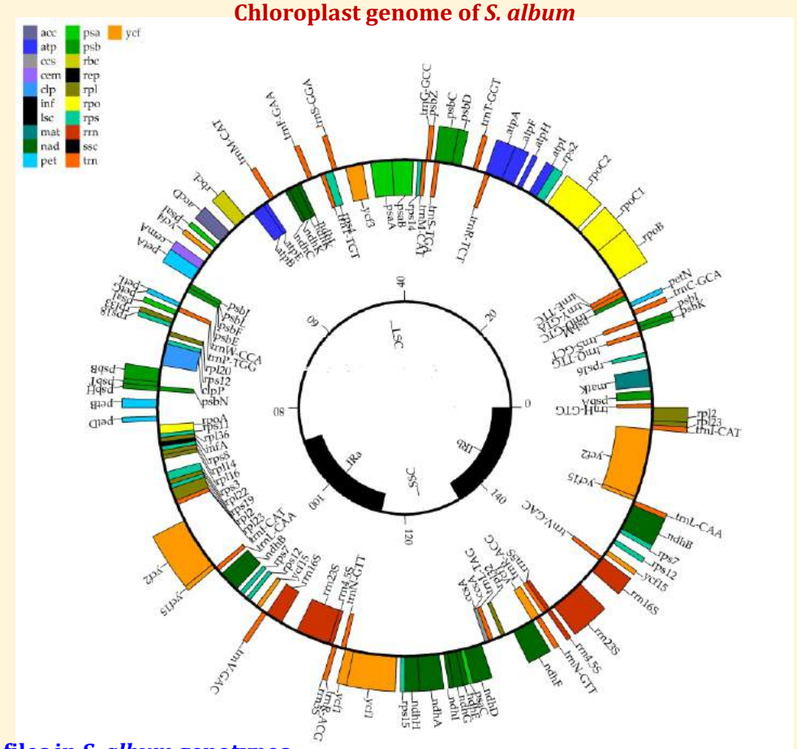
The genotype representing the natural population from Kerala, India was used for sequencing and *de novo* assembly.

Whole genome sequencing was conducted using Illumina NextSeq 500 and *de novo* assembly predicted 74,900 major scaffolds with N50 of 12,068 bp and estimated genome size of 286 Mb. A total of 37,500 genes were predicted including 30 genes from terpene synthase gene family. Repetitive sequence was mined and spanned 12.52% of the sandalwood genome. The draft genome encoded for 574 miRNAs belonging to 23 families including two miRNAs associated with terpenoid biosynthesis pathway. Further, the consensus chloroplast genome of 147. 25 Kb size was re-constructed and phylogenetic analysis with forty plastid genes grouped members of Santalales with Asterids in accordance with its taxonomic status recommended in APG III and APG IV. A total of 2,68,998 SSRs were predicted and six primer pairs flanking di nucleotide repeat motifs were amplified in 10 genotypes.

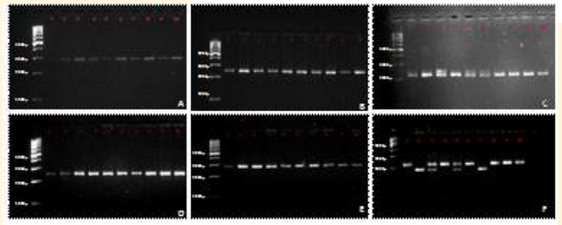
Implications

The draft genome of *S. album* will be the first reference for Santalales and will aid in

Chloroplast genome of *S. album*



SSR profiles in *S. album* genotypes



- Understanding the unique sesquiterpenoid biosynthetic pathway governing santalol production.
- Estimating genetic diversity and population structure using the genome-wide microsatellite markers.
- Accelerating breeding programs targeting heartwood formation and santalol content through genomic predictions and association genetics.
- Development of extended next generation DNA barcodes using organelle genome and nuclear ribosomal DNA sequences.

Publication

Dasgupta, M.G., Ulaganathan, K., Dev, S.A., and Balakrishnan, S. (2019) Draft genome of *Santalum album* L. provides genomic resources for accelerated trait improvement. Tree Genetics & Genomes 15: 34.

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Recent literature on FGRs & TIP

Adhikari, B., Lodhiyal, N., Kapkoti, B., Lodhiyal, L.S. and Rawat, P.S. 2018. Population Structure and Regeneration of *Mallotus philippensis* in Sal Forests of Kumaun Himalaya. Indian Forester 144(12): 1158 -1161.

Anshul Chandra. 2018. Evaluation of *ex-situ* Demonstrations of high quality Bamboo plantations in Uttarakhand. Indian Forester 144(12): 1166-1171.

Bakshi, M., Chauhan, A. and Vichitra, A. 2018. Tissue culture (Micropropagation) of *Dalbergia sissoo* Roxb. as affected by Genotypic configuration. Indian Forester 144(9): 852-856.

Chauhan, J.M.S., Bhandari, A. and Bhandari, M.S. 2018. Effect of Hormones on Rooting Potential of *Hippophae salicifolia* (Seabuckthorn) in Agro-Climatic Zone of Dehradun, Uttarakhand. Indian Forester 144(9): 863-868.

Hayatgheibi, H., Fries, A., Kroon, J. and Wu, H.X. 2019. Estimation of genetic parameters, provenance performances, and genotype by environment interactions for growth and stiffness in lodgepole pine (*Pinus contorta*). Scandinavian Journal of Forest Research. 34(1): 178-188. https://doi.org/10.1080 /02827581.2018.1542025

Hegde, N., Zonunsanga, E. and Suresh Kumar. 2018. Studies on Moisture Excluding Effectiveness of Different Finishes on *Michelia champaca* and *Terminalia myriocarpa* Woods under Absolute Humid Conditions. Indian Forester 144(11):1102 -1106.

Mohapatra, S.R., Bhol, N. and Nayak, R.K. 2018. Influence of Potting Mixture on Growth and Quality of Sandalwood (*Santalum album* L.) Seedlings. Indian Forester 144(11): 1049 -1053.

Nawa Bahar. 2018. Influence of Accelerated Ageing on Indian Pines Seed. Indian Forester 144(12): 1188-1193.

Negi, B.L. 2018. Eco-tourism an Opportunity for Conservation of Forests and Livelihood in State of Himachal Pradesh: A Critical Analysis with Reference to T.N. Godavarman Case. Indian Forester 144(12): 1136-1143.

Poonam, Bawa, R., Sankhyan, H.P. and Nayak, D. 2018. Biodiversity Loss and Conservation of Natural Resources in Cold Desert Ecosystem of Himachal Pradesh, India. Indian Forester 144(9): 817-824.

Rytter, L. and Jacobson, S. 2018. Clonal variation in root suckering ability of hybrid aspen (*Populus tremula* L. ×*P. tremuloides* Michx.). Scandinavian Journal of Forest Research. 33(6):523-528. https://doi.org/10.1080/02827581.2018. 1447144.

Skrøppa, T. and Solvin, T.M. 2019. Genetic variation and in heritance in a 9×9 diallel in silver birch (*Betula pendula*). Scandinavian Journal of Forest Research. 34(3): 178-188. https://doi.org/10.1080/02827581. 2019.1576921

Tiwar, P. and Sharma, J.V. 2018. Managing Harvests of Fuel Wood and Fodder: Major Drivers of Forest Degradation in Sariska Tiger Reserve, Rajasthan. Indian Forester 144(12): 1144-1150.

Tomar, A. and Dinesh Kumar. 2018. Propagation of *Ulmus wallichiana* from Divergent Sources of North India. Indian Forester 144 (12): 1162-1165.

Tun, T.N., Guo, J., Fang, S. and Tian,Y. 2018. Planting spacing affects canopy structure, biomass production and stem roundness in poplar plantations. Scandinavian Journal of Forest Research. 33(5): 464-478. https://doi.org/10.1080/02827581. 2018.1457711

Uusitalo, J., Ylhäisi, O., Rummukainen, H. and Makkonen, M. 2018.Predicting probability of A-quality lumber of Scots pine (*Pinus sylvestris L.*) prior to or concurrently with logging operation. Scandinavian Journal of Forest Research. 33(5): 464-478. https://doi.org/ 10.1080/02827581.2018. 1461922.

Verma, R.K. and Meshram, P.B. 2018. Biotic Factors Responsible for Damage of Khamer (*Gmelina arborea*) Plantations in Central India. Indian Forester 144(11): 1063-1071.

Wani, M.A. 2018. Rooting Responses of Hardwood Stem Cuttings of Juniper to Exogenous Hormone Treatment. Indian Forester 144(12): 1179-1187.

Zahirul Islam, S.M., Mansur Chowdhury, M.A. and Misbahuzzaman, K. 2018. Mathematical Models for Estimating Tree Site index for Agar Tree (*Aquilaria malaccensis* Lamk) Plantations in Bangladesh. Indian Forester 144(12): 1172-1178.

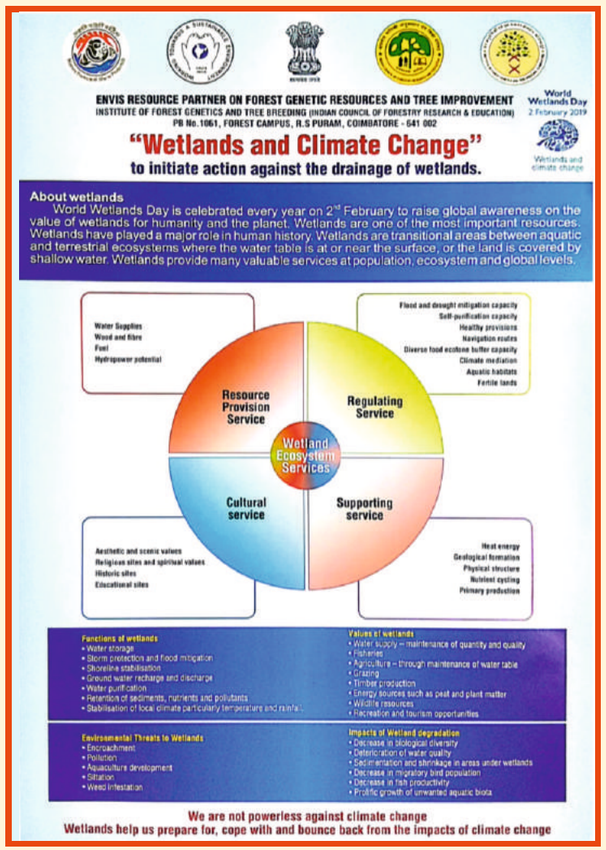
UPCOMING EVENTS

Event	:	18th Symposium on Systems Analysis in Forest Resources (SSAFR)
Venue	:	Puerto Varas, Chile
Date	:	March 3-7, 2019
Symposium details	:	http://www.ssafr2019.cl/13/en/inicio
Event	:	World Conference on “Forests for Public Health”
Venue	:	Athens, Greece,
Date	:	May 8-11, 2019
Conference details	:	https://fph2019.org/
Event	:	IAWA-IUFRO International Symposium: Challenges and Opportunities for Updating Wood Identification
Venue	:	Beijing,China
Date	:	May 20-22, 2019
Symposium details	:	http://www.iawa-website.org/en/Meeting/Future_Meetings/IAWA_IUFRO_ International_Symposium_for_ Updating_Wood_Identification_ May_20_22_2019_Beijing_China.shtml
Event	:	4th World Congress on Agroforestry
Venue	:	Le Corum Conference Centre Montpellier, France
Date	:	May 20-22, 2019
Congress details	:	https://agroforestry2019.cirad.fr/
Event	:	Transforming approaches to forests and forestry through Indigenous and Local Knowledges: Reciprocity, relationship-building, and Traditional Ecological Knowledge (TEK) in forest ecosystems
Venue	:	University of British Columbia, Vancouver, Canada
Date	:	June 24-28, 2019
Conference details	:	https://ubc.ca1.qualtrics.com/jfe/form/SV_6D4zplu8pBeGiWN
Event	:	21st International Nondestructive Testing and Evaluation of Wood Symposium
Venue	:	Freiburg, Baden-Württemberg, Germany
Date	:	September 24-27, 2019
Symposium details	:	https://ndtesymposium.org/
Event	:	The Sixth International Casuarina Workshop Climate-resilient Casuarina for Bioenergy Production
Venue	:	Kasetsart University, Bangkok, Thailand
Date	:	October 21- 25, 2019
Conference details	:	

ENVIS ACTIVITIES

OBSERVANCE OF "WORLD WETLAND DAY "

ENVIS Resource Partner on Forest Genetic Resources and Tree Improvement, IFGTB, Coimbatore observed the 'World Wetland Day - 2019' on 4th February 2019 at Coimbatore Corporation School, Tamil Nadu Agricultural University, Coimbatore to create awareness among the students about the importance of wetlands and how wetlands respond to climate change. The programme was inaugurated by Head Mistress in the presence of students and other staff of the school. Mr. S. Vigneswaran, Programme Officer and Mr. V. Thangavel IT Officer, IFGTB ENVIS participated in the event. An awareness poster on the theme "Wetlands and Climate Change" was released on the occasion.



OBSERVANCE OF "INTERNATIONAL DAY OF FORESTS "

ENVIS Resource Partner on Forest Genetic Resources and Tree Improvement, IFGTB, Coimbatore observed the 'International Day of Forests - 2019' on 21st March 2019 at the Government School, P.N.Pudur, Coimbatore to create awareness among the students about the importance of forests and how people are dependent on forest resources for their livelihoods. An awareness poster on the theme **"Forests and Education"** was released on this occasion. IFGTB ENVIS also distributed the awareness handouts to the school students who participated in the programme **"Talk to Your Scientists"** organized by IFGTB, Coimbatore at the Gass Forest Museum.