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VAN VIGYAN

INSTITUTE OF FOREST GENETICS AND TREE BREEDING

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From the
Director's Desk

With heavy demand for primary timbers in the country, and a decline in the supply of raw materials, secondary timber species with similar properties can provide the solution. Several secondary timbers, that could substitute the scarce traditional timbers, exist in tropical forests. Information on their properties and uses are hardly available to local producers, which affects their popularity among timber users. The ENVIS–FGR-TIP aims to create a general awareness on such timbers, and provide comprehensive information on the work carried out. This issue deals with one such species, *Thespesia populnea,* which finds good use as a timber. Alongside, the country also focuses on advanced research in forestry. Technologies such as next-generation sequencing makes it possible to investigate the role of genes, access sequence-based markers for breeding at the genome scale, and to study the evolutionary history of tree species, which would otherwise take a long time through conventional breeding. This issue provides an insight into the teak gemome. ENVIS wishes all its readers a Happy and Fruitful New Year 2018!

Dr S. Murugesan
Director

In this issue

Know Your Trees - *Thespesia populnea* (L.) Soland ex. Correa

Taxonomy and nomenclature

Thespesia populnea (L.) Soland ex. Correa (Synonym: *Hibiscus populneus* L.) belongs to the family Malvaceae and is commonly referred as Portia Tree. The name Thespesia is derived from the Greek word *thespesios*, which means divine or sacred. In ancient times, trees were planted around places of worship. In Tahiti, the tree was associated with the God of prayer and chanting. Branches were attached to canoe masts as a token of peace and the leaves were used by priests in ceremonial offerings (Friday and Okano, 2005). In English it is called as Indian Tulip Tree, Portia Tree, Cork Tree, Umbrella Tree or Pacific Rosewood. Other vernacular names are Gajahanda, Paras-pipal, Parsippu, Bhendi (Hindi); Parisha Sanskrit; Puvarasam, Puvarassu, Poris, Purasia, Pursa, Porsung, Kallal, Karvarachu (Tamil); Gangareni, Gangarava, Gangaravi, Gangaregu, Galgaiovi (Telugu); Poovarasu, Sheelanthi, Pupparutti, Chandamaram (Malayalam); Asha, Hurvarshi, Huvarsi, Bugari, Arasi, Hoovarasu (Kannada) (Troup, 1921).

Curved trunk and branches of the tree

Botanical descriptions

It is an evergreen tree (6-12 m in average height) with a broad dense crown with often crooked stem.

A young tree grown in the homestead in Kerala.

The tree grows in short twists and turns with numerous limbs. Clear bole around 2 to 2.5 m, Girth (at breast height) around 0.6 to 1.2 m. It has fissured gray / dark brown bark, and a dense crown of green glossy heart shaped leaves. It is easily recognized by its large yellow flowers with purple centre, its heart shaped leaves and the turban shaped capsules. Leaves are glossy, green heart shaped resembling those of poplar. 8-15 cm X 6-10 cm. Broadly ovate with the lower corners rounded off, cordate at the base, acuminate, entire. Flowers are yellow, bell shaped, hibiscus type flowers, 5 to 7.5 cm in length with five overlapping broad, rounded petals. Axillary, solitary or two together, bisexual. Maroon / purple spot can be observed at the base of each petal with star shaped hairs on outer surface. The yellow flowers turn dark red, purple or pink as the day progresses. Fruits, five celled globose capsules 2.5 to 5 cm in diameter, flattened, covered with minute peltate scales with disc like persistent calyx at the base, black when ripe. Seeds about 1 cm long, ovoid (Troup, 1921).

Distribution and environmental conditions

World

The species has been planted throughout the tropics and is naturalized in tropical climates throughout the world. It is a typical coastal species of South Asia, Africa and the Pacific Islands. Naturalized in Florida and West Indies. Cultivated occasionally in Central and South America (Francis, 2004).

India

It is a common species in the coastal tracts of the Indian Peninsula and in mangrove swamps. It is especially common and perhaps wild in South Kanara, Malabar, deltas of Godavari and Mahanadi and in Cuttack. It is also found in the Sunderbans of West Bengal and in Andamans. It is more often cultivated as an avenue tree in cities and towns near sea coast such as Kolkata, Mumbai and Chennai. It has also been successfully grown as an avenue tree and extensively planted in Chandigarh (Troup, 1921).

Native range

Coastal areas of Indian and Pacific Oceans from east Africa and India to mainland South- east Asia, Indonesia and the Philippines. In the Pacific it grows from Papua New Guinea and the northern coast of Australia through the Solomons, Vanuatu and Fiji. In Micronesia it grows in Guam and the Mariana Islands, the Gilbert Islands and in Palau, Yap, Chuuk, Pohnpei, Kosrae and the Marshalls. In Polynesia it is found in Tonga, Samoa, Niue, the Cook Islands, Tahiti, the Society Islands, the Tuamotos and the Marquesas. It is documented on the Hawaiian Islands also. In India it occurs in the littoral forests of Andamans and Sunderbans ($4A/L_1$). In Andamans, it occurs in the third storey in association with *Hibiscus tiliaceus* and *Pandanus tectorius*, the overwood consisting mainly of *Manilkara littoralis* with species like *Pongamia pinnata*, *Erythrina variegata*, *Calophyllum inophyllum* and *Terminalia catappa* in the second storey. In Sunderbans, it forms the overwood in association with *Hibiscus tiliaceus*, *Erythrina variegata*, *Trewia nudiflora*, *Tamarix troupii* and *Vitex* spp (Troup, 1921).

It thrives well on sandy coastal soils, but also grown on volcanic soils, soils derived from limestone and rocky headlands. It does not grow well in upland acidic clays. It comes up in sands, sandy loams, loams, sandy clay loams, clays, clay loams and sandy clays. Tolerates occasional tidal inundation and saline soils (Iqbal *et al*., 2002). Preferred soil acidity: 6.0 to 7.4. Once established it develops a deep root system and tolerate long periods of drought. It prefers full sun. It is cold sensitive, restricted to areas with minimum temperatures above 1.7°C but can stand mild frosts (Morton, 1966; Fryxell, 1966; Troup, 1921). Reported that it shifts into the more efficient C_4 photosynthesis under saline conditions (Anon, 2003).

Seed collection, processing and nursery techniques

Fruits are available nearly round the year. Fruits and seeds buoyant, adapted to long-distance dispersal by tides and ocean currents. 1 to 11 seeds per fruit (mean 5.7 ± 0.4 seeds per fruit). Fertile seeds/fruit may range from 3 to 5. Germination percent varies from 65 to 80%. Germination begins

Leaves, Flowers and fruits of Thespesia populnea.

about 8 days after sowing (may extend to 10 weeks) and the germination is epigeal (Kader and Chacko, 2000). Seed weight is 6500 per kg. Data is lacking on seed storage requirements. However, in general it is reported that short-term storage in sealed containers is successful. Seed may remain viable for 24 months. Refrigeration in sealed containers is recommended for long term storage. Germination can be hastened by nicking / sand paper rubbing followed by soaking the seeds overnight in cool water. Scarifying the seed coat for 20-60 minutes using 95% sulfuric acid followed by 24 hours soaking in tap water was also proved to improve germination (Friday and Okano, 2005). Seeds may be sowed and lightly covered in fine sand, well-drained soil or potting mixture. Seeds are normally germinated in germination trays or beds and transplanted into nursery bags later. (Troup, 1921).

Silviculture, plantations and management

Seeds may be sown in July. Seedlings are ready to be outplanted when they reach 15 to 25 cm in height in about 12 to16 weeks. Seedlings should be hardened off with reduced watering and exposure to full sunlight for 4 to 6 weeks before being outplanted. Around 1 to 1.5 kg of seeds can be used for standard bed. Stump planting has been attempted, but not a successful method (Jha and Choudhary, 1990). Shoot or branch cuttings of upto 2 m length and 10 cm diameter have been used, although smaller cuttings (30 cm long) are preferred and observed to produce healthier trees (Basak *et al*., 2000; Parthiban *et al*., 1999; Basak *et al*., 1995). It is a slow coppicer (Troup, 1921). Pure plantations of this species are not reported. Tamil Nadu Forest Department has raised *Thespesia* in mixed plantations at Thangachimadam, Pamban (Rameswaram), Kumbakonam, Nazreth range (Tiruchendur) and Tirupur.

Clonal plantlets of Thespesia

Clonal propagation of Thespesia

Important insect-pests and diseases

It is a host to several important pests of cotton including the cotton stainer bug (*Dysdercus* sp.) the cotton boll weevil (*Anthonomus grandis*), *Pyroderces simplex* and the Indian dusky cotton bug (*Oxycarenus laetus*). In adult trees, the fungus *Fomes pachyphloeus* causes heart rot. The tree is also susceptible to fungal stem and root rot caused by *Phellinus noxius.* Fungus, *Scytalidium dimidiatum* is reported to cause Dieback in Oman. Bacterium, *Xanthomonas campestris* pv. *Thespesiae* causes leaf spot and blight disease (Patil and Kulkarni, 1981). *Phomopsis thespesiae* causes leaf spot. Spiralling whitefly, *Aleurodicus dispersus*, were observed infesting the leaves (Sundararaj *et al*., 2000).

Reproductive biology and breeding system

T. populnea is usually propagated artificially by seed, but propagation by stem or root cuttings or by air-layering is also possible. Seed storage behaviour is orthodox, retaining viability when dried and stored. Germination can be difficult due to the hard seed coat, and is improved by scarification. Direct sowing is common, but stump planting and transplanting wildings is also practised (Oudhia, 2007).

Flowers more or less throughout the year, mainly during December to March. Mature fruits may usually found on trees year round, mainly during March to May. Mating system is open pollination and entomophily has been reported. Chromosome number is reported to be 2n = 26 (Das *et al*., 1995; Jarolimova, V. 1994).

Agroforestry practices

Since ancient times, the tree has been planted in homegardens. It is used to stabilize bunds of ponds for prawn cultivation. The species has been used as a living fence post also (Harikrishnan and Ramesh, 1993). It is an excellent windbreak in coastal areas due to its dense crown and tolerance to wind and salt spray. It is being used as a standard for pepper vines (Ceccolini, 2002)

Growth, yield and economics

It is regarded as a fast growing species having a height growth of 0.6 to 1.5 m per year in general for the first few years. At an age of 7 to 10 years, growth in height slows down. Stem diameter growth ranges from 1 to 3 cm per year.

Wood properties/utilization

It is a timber of great local utility, being used for furniture, agricultural implements and small canoes. It is an easy timber to saw and work and can be brought to a smooth surface and also takes a high polish. The wood is highly valued in Travancore area, Kerala because it does not split (Troup, 1921). Highly resistant to dry wood termites (Grace *et al*., 1996). The wood can be carved into bowls, tools and figures. Timber is in demand for turnery and toys. It is also suitable for helves, tool handles, shuttles and other textile accessories. Wood is used for food containers, slit drums and cabinetry. It is also used as fuelwood. Density: 770 kg/m^3, Specific gravity: 0.55 to 0.89. Weight: 113, Strength as a beam: 122, Stiffness as a beam: 92, Suitability as a post: 101, Shock resisting ability: 182, Retention of shape: 78, Shear: 131,

A wooden item made out of Thespesia wood.

A chair made out of Thespesia wood

Hardness: 124, Refractoriness: 91, Nail or screw holding property: 109. (Comparative suitability as a timber with teak taken as 100). The wood does not offer any difficulty in seasoning provided it is protected against too rapid drying. Shock resisting ability: 182, Shear: 131 (Teak 100). The bark thickness is 0.3 to 0.8 cm (Sanyal and Saxena, 1982; Stefanov, and Naidenova, 1975).

Medicinal uses

Extracts from roots are applied externally for scabies, psoriasis and related skin diseases. Heart wood used in indigenous medicine for skin diseases

(Girach *et al*., 1994). In Mauritius, the bark is described as depurative and as a cure for dysentery and Haemorrhoids. Decoction of the bark is used for washing skin diseases. Ground bark mixed with coconut oil is also applied for skin diseases. Bark extracts have been reported to possess antioxidant and hepatoprotective activity (Ilavarasan *et al*., 2003a; Ilavarasan *et al*., 2003b). Leaf extracts are applied on inflamed and swollen joints. Cytotoxic activity of methanol extracts of leaves has been reported on human leukaemia cells (Masuda *et al*., 2002). Bioassay results have showed that the extracts of flowers have anti-bacterial activity (Hewage *et al*., 1998). Flavonoids have been isolated from the ether and ethyl acetate fractions of the ethanol extract of the flowers (Shirwaikar and Srinivasan, 1996). Antihepatotoxic (Shirwaiker *et al*., 1995) and antisteroidogenic activities (Kavimani *et al*., 1999) of flower extract have been reported. The fruit abounds in a viscid, yellow juice which the natives of south India use as an excellent application in psoriasis. It is also used to treat insect bites, gonorrhoea, ringworm, migraine, fistula, sprains and wart removal. Fruit extracts has wound healing properties also (Nagappa and Cheriyan, 2001). Irular tribal community of Anaikkatty Hills, Kerala use the seed extracts for prevention of pregnancy (Nadanakunjidam, 2003). Plant extracts have been reported to have significant anti-malarial activity (Vasanth *et al*., 1990). Vasudevan *et al*. (2007) has proved the antinociceptive and anti-inflammatory effects of its bark extract.

Social Benefit

Flowers and young leaves are reported to be eaten and are listed as famine foods, though other reports indicate that they are mildly poisonous. In some Pacific Islands it is regarded as a sacred tree and was cultivated around temples. Elsewhere, it is planted as a street tree and ornamental and, producing dense shade and much leaf litter, it is also used as a living fence (Little and Skolmen, 1989). Foliage is also used as fodder. Rope is made from the tough fibrous bark, which also contains up to 7% tannin and is used for curing leather. A fruit extract is used as a dye, seeds contain oil, and all plant parts are used to prepare traditional medicines (Oudhia, 2007).

Genetics and tree improvement

The major problem with *T. populnea* is that the stem is often crooked. The tree grows in short twists and turns with numerous limbs, therefore lumber is generally found in short lengths. No systematic tree improvement programmes have been undertaken in this species and no efforts have been put for identification of superior germplasm through variability studies. Systematic tree improvement programme has been initiated in *T. populnea* at the Institute of Forest Genetics and Tree Breeding since 2011.

Plus Trees with good form traits numbering 139 have been selected from Tamil Nadu, Kerala and Puducherry. Tree height, clear bole height, girth at breast height, straightness and freedom from pests and diseases were the criteria used for selection. Stem straightness was given more weightage during the selection process.

Bud sprout was observed in all the cuttings subjected to rooting in the polytunnel. The rooting percentage was observed to be 60. All the rooted cuttings were hardened in the shade house. Subsequently, a Clonal Multiplication Area (CMA) was established at Panampally Research Station of IFGTB near Palakkad, Kerala for further production of the clonal plantlets. In addition, these clones could be used for establishing clonal seed orchards for quality seed production.

Other relevant information

The wood yields a yellow dye which is used to dye wool in the east and south east Asia and the leaves are used to make a black dye. The bark

contains high levels of tannins and has been used for tanning leather. Dark red resin exudes from the bark. Seeds yield lamp oil. Seed oil is reported to contain palmitic, oleic and linoleic acids. The species can be effectively utilized as carbon sink in saline soils. Leaf extracts (10% w/v) of the species caused 100 per cent mortality on *Meloidogyne javanica* larvae causing root-knot disease on tobacco (Murty *et al*., 1989). Ether extracts of the fruit pericarps of *T. populnea* exhibited antifeedant and antibiosis activity against spotted bollworm, *Earias vittella* (Dongre and Rahalkar, 1992).

It is used for fodder purposes and has nutritive value (NUTTAB, 2007). The flower buds and young leaves are edible (Shekhawat and Murdia, 2000). Leaves are used as green manure. Cork is made from inner bark. The tough fibrous bark can be made into ropes. The bark is also used to caulk boats. It has been identified as a suitable woody plant species for site rehabilitation in Tsunami affected areas in Sri Lanka. In Ghana, food products namely 'Abolo' (Baked or steamed maize dough) and 'Apitsi' (Mixture of baked ripe plantain and maize flour) are baked and sold in *Thespesia populnea* leaves (Friday and Okano, 2005). *T. populnea* bark appears to be a promising candidate for improving memory and it would be worthwhile to explore the potential of this plant in the management of Alzheimer patients (Vasudevan and Parle, 2006).

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Kannan C.S. Warrier
Institute of Forest Genetics and Tree Breeding
Coimbatore

Genomic resources of Teak

Introduction

Teak (*Tectona grandis* L.f.) belonging to the mint family Lamiaceae is one of the world's highly valued tropical timber species, occurs naturally in India, Laos, Myanmar, and Thailand. Teak timber is highly appreciated because of its high durability, strength and stability as well as resistance to pests, chemicals and water. Thus, the wood is used in ship building, railway carriages and sleepers, construction, furniture, veneer and several other wood products. Teak has been successfully established as pure plantations in India and several exotic locations since 1850s. The estimated planted area of teak in the tropical countries is about 4.25 to 6.89 million ha with 1.7 million ha in India (Kollert and Kleine, 2017). Though market share of teak timber is less than 2 per cent of tropical round wood production, the high value continuously attracts new planters. At the same time, natural populations are continuously diminishing due to illegal logging, anthropogenic pressures and climate change. A recent study on climate change effects on teak expressed concern over the risks of biological invasion in the teak habitats and recommends conservation of crucial teak growing areas and suitable forest management planning (Dab *et al.,* 2017). Molecular studies on teak genetic structure revealed that the landraces of introduced locations have comparatively narrow genetic diversity (Hansen *et al.,* 2017), thus demanding exploration and conservation of natural populations.

Teak has several intrinsic genetic qualities that allow its genetic improvement for timber production. Wide and discontinuous distribution of natural teak across broad edaphic and climatic conditions in India offers enormous potential for capturing the adaptive genetic variation for genetic improvement. As the first step in the genetic improvement program in teak, a total of 75 international provenance trials co-ordinated by Danish International Development Agency (DANIDA) were established during 1973-76 in 16 countries. Co-ordinated evaluations showed variations for survival, growth rate, stem form, flowering, seed yield and wood characteristics. The results of genetic improvement in teak showed an overall positive trend, existence of non-additive genetic control for economically important traits is observed (Chaix *et al.,* 2011). Further, it was suggested that within-provenance selection for teak stem size can be carried out at the age of 3 years, wherein indirect selection on flowering age will improve forking height (Callister, 2013). Clonal propagation through budding, rooting of cuttings and in vitro propagation have been established to facilitate tree improvement and deployment of superior performers for large scale cultivation to increase timber yield (Monteuuis and Goh, 2015). Although clonal seed orchards were established for production of quality seeds, fruit production in clonal seed orchard (CSO) is continue to be a challenge.

Teak is a diploid species (2n=36; 1C=0.48pg) with the small genome of about 465 Mbp (Ohri and Kumar, 1986) has very limited genomic resources. Recently the Department of Biotechnology (DBT), Government of India has supported a program on

conservation of natural teak genetic resources (TGRs) in the states of Tamilnadu, Kerala and Karnataka Under this program, an attempt was made to develop genomic resources using next generation sequencing (NGS) technology, covering different popular provenances of teak in collaboration with Kerala Forest Research Institute, Thrissur, Kerala and College of Forestry, University of Agricultural Sciences, Dharwad, Karnataka. Next generation sequencing based whole genome sequencing (NGS-WGS) would yield more information on genomic scans of polymorphism to precisely estimate various population genetic parameters.

Genome resources

Whole-genome sequencing was performed using the Illumina HiSeq2000 platform and Oxford Nanopore Technologies MinIONTM device. The processed Illumina paired end reads along with mate pair and nanopore reads were assembled using MaSuRCA denovo assembler and the estimated genome was ~317MB. Genome annotation and SSR discovery was made from the genomic scaffolds. The final draft genome had 2993 filtered contigs (>1 Kbp) with maximum, minimum and average contig length of 1,718,606 bp, 1,100 bp and 106,098 bp respectively. The N50 value of the assembly was 357,576 bp. Functional annotation was carried out using the hard masked draft genome for gene prediction. A total of 36172 proteins were predicted of which 31126 (86%) proteins were annotated against Viridiplantae. Gene ontology analysis revealed that 48 per cent genes were related to molecular functions, 34 per cent genes were related to cellular components and 13 per cent genes were involved in biological processes.

A total of 182712 microsatellite sequences were identified from 2993 scaffolds, where perfect SSRs were represented in maximum numbers (170574). Compound, complex and interrupted forms of SSRs constituted 7 per cent of the genome. The major repeat motifs which over 5000 loci were (A)n, (T)n, (C)n, (G)n, (AC)n, (AT)n, (AG)n, (GT)n and (CT)n. (AT)n repeat motif was the most predominant dinucleotide SSRs, accounting for over 51.3% of the total dinucleotide SSRs.

Conclusion

Genomic resources of teak can provide a platform for functional analyses of genome components and their application in breeding programs. SSR markers developed in this study will propel the genetic and genomic research in teak, hitherto unavailable for the valuable timber yielding tropical hardwood species.

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R. Yasodha
Institute of Forest Genetics and Tree Breeding
Coimbatore 641 002

Recent literature on FGRs & TIP

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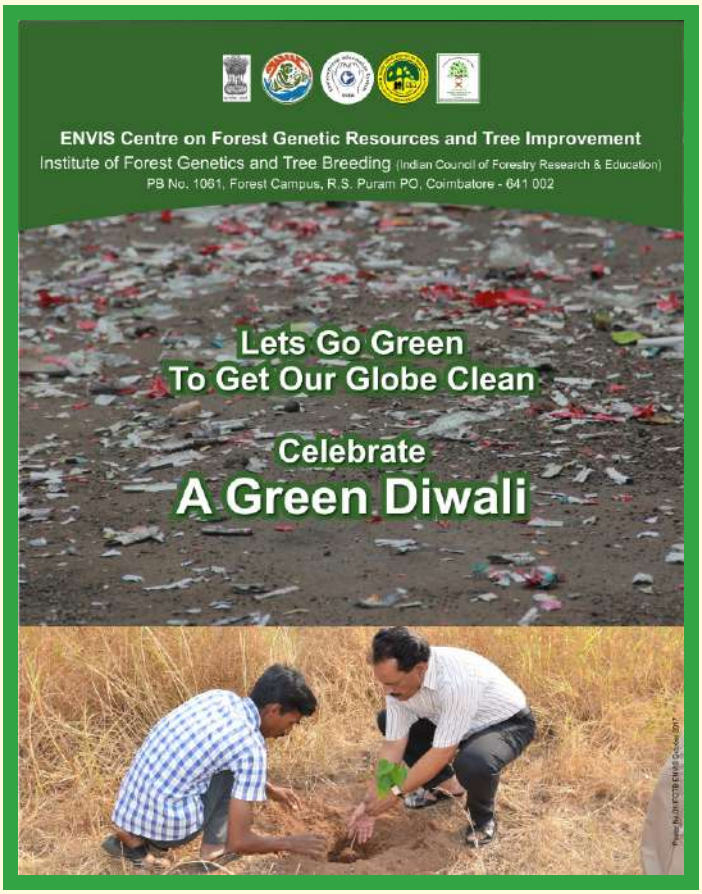
Upcoming Events

Event	:	7th International Symposium on Cecidology Ecology And Evolution Of Gall -Inducing Arthropods.
Venue	:	Transilvania University, Brasov, Romania
Date	:	3 – 8 March 2018
Symposium details	:	http://www.letsgall.tw/
Event	:	The 5th Asia-Pacific Forestry Education Conference – Call for Abstracts Main Theme: Globalization of Higher Forest Education in a Digital Era
Venue	:	Beijing, China
Date	:	27-28 March 2018
Conference details	:	http://apfecm.forestry.ubc.ca/news-events/2018-2/the-5th-asia-pacific -forestry-education-conference-call-for-abstracts/
Event	:	6th International Forest Engineering Conference (FEC2018): "Quenching our thirst for new knowledge"
Venue	:	Rotorua, New Zealand
Date	:	16th - 19th April 2018
Conference details	:	http://www.foresteng.canterbury.ac.nz/FEC2018.shtml
Event	:	Tree Motion and Wind Measurement Workshop
Venue	:	Roskilde, Denmark
Date	:	23-25 April 2018
Workshop details	:	http://www.conferencemanager.dk/TreeMotionandWindMeasurement Workshop/event.html
Event	:	Sustainable Forest Management for the Future - The Role Of Managerial Economics And Accounting
Venue	:	Zagreb, Croatia
Date	:	10th and 12th May 2018
Conference details	:	http://www.sumins.hr/iufro-form/

ENVIS ACTIVITIES

The ENVIS Centre on Forest Genetic Resources and Tree Improvement at the Institute of Forest Genetics and Tree Breeding, Coimbatore conducted activities under the Swach Bharat Mission during the third week of October 2017 as per the instructions from the Ministry of Environment Forest and Climate Change, Government of India. A planting programme was conducted on 17.10.2017 near to the office premises of the Institute. Dr Kannan Warrier, Scientist E and Coordinator ENVIS welcomed the gathering. The planting programme was inaugurated by Shri R.S. Prashanth, IFS, Director of IFGTB. Tree saplings of *Mimusops elengi*, *Ficus racemosa, Manilkara hexandra, Thespesia populnea* etc were planted by the scientists, officers and staff of the Institute. Greetings of Diwali were exchanged digitally.



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 Centre 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 Centre. 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.

ENVIS Team

Dr S. Murugesan
Director

Dr Kannan C.S. Warrier
Scientist E and Coordinator, ENVIS

Dr Rekha R. Warrier
Scientist E and Editor

Dr T. Vamadevan
Information Officer

V. Thangavel
IT Officer

INSTITUTE OF FOREST GENETICS AND TREE BREEDING

Forest Campus, P.B. No. 1061, RS Puram HPO, Coimbatore - 641 002
Phone : 91 422 2484100; Fax : 91 422 2430549
Email: ifgtb@envis.nic.in, kannan@icfre.org; Web : http://envis.nic.in/ifgtb/index.html, ifgtb.icfre.gov.in