

Report of the monthly Seminar on

**“Molecular Breeding Approaches for Tolerance to Abiotic Stresses”**

**at IFGTB Coimbatore : 3<sup>rd</sup> September 2019**

In the recent past, India has witnessed farm distress arising out of extreme climate conditions like drought and flooding. To alleviate the suffering of farmers and to increase rural employment, the Government has recently initiated programmes to productively utilize 50 Lakh hectares of barren land. In line with the government initiatives, the ICFRE has enlisted the theme “To identify and develop clones of tree species suitable for drought prone areas and restoration of salt affected lands ” as one of the 14 transformative works to be accomplished in the next 5 years. One of the major mandates of IFGTB is to develop tree varieties to maximize the productivity of planted forests under different ecological considerations and changing environment. Biotechnological tools can hasten the process of breeding trees with desirable traits for the farming community. It is in this context that the monthly seminar on the topic “Molecular Breeding Approaches for Tolerance to Abiotic Stresses” assumed significance.

The inaugural session of the seminar started with a **welcome address by Dr. R. Yasodha, Scientist – G and Head**, PBT division. Welcoming the lead speakers, Dr. V. Chinnusamy, Head, Plant Physiology, Indian Agricultural Research Institute (IARI), New Delhi and Prof. M. Raveendran, CPMB, Tamil Nadu Agricultural University, Coimbatore, it was advocated that the advanced technologies used in crop breeding be applied in forestry crops as well to accelerate tree breeding for desired traits.

In the **inaugural address, the Director, IFGTB, Dr. S. Murugesan**, emphasized that technologies needs to be developed for predicting future risks due to biotic and abiotic stresses,

and also for increasing the capability of minimizing and managing stresses. The Director cited the case of Fall Armyworm infestation that was recently reported in nearly 10 states across India and 17 districts of Tamil Nadu since 2018 whereas; its incidence had been reported in the USA and other countries as early as 2008. The Director impressed on the fact that tree species are best suited for planting in areas affected by abiotic stresses. IFGTB aims to maximize their productivity of wood species under different environmental conditions. In this context, tree improvement programmes are ongoing for 15 tree species. Superior clones of trees have been released and molecular breeding approaches for biotic and abiotic stress tolerance have been taken up in various divisions of IFGTB.

### **Technical Session – 1: Ongoing research at IFGTB**

In the **first technical session**, ongoing research at IFGTB on salt, drought and high CO<sub>2</sub> stresses were deliberated. The first talk was delivered by the Seminar Coordinator, **Dr. Mathish Nambiar-Veetil, Scientist- F** on “**Enhancing salt tolerance in trees: molecular breeding programmes at IFGTB**”. Calling attention to the mandate of IFGTB for developing new varieties to maximize productivity of planted forests under different ecological considerations and changing environments, the speaker reminded that India has recently witnessed rural distress due to weather vagaries, and in this context seminar provides an opportunity for researchers to brainstorm on the approaches used for providing solutions to these issues. It was reasoned that high atmospheric CO<sub>2</sub> concentrations may exacerbate drought, salt and other abiotic stresses, and consequently India’s drought and salt affected arid and semi arid regions would be the only areas available for tree plantations.

The speaker then elucidated the research carried out by Dr. R. Yasodha and team in using molecular marker approaches for hybrid production and generation of linkage maps through mapping populations generated from four different crosses using a highly salt tolerant clone EC-7 as the main parent. In order to achieve these objectives, grafting technique was used for inducing early flowering and facilitating crossing work by bringing down the height at which *Eucalyptus* flowers.

The speaker appraised about the research carried out to identify a candidate gene for enhancing salt tolerance in *Eucalyptus* via transgenic approaches. Salt stress response studies in *Casuarina* and *Eucalyptus* provided the required insights to target sodium transporters in the roots. The function of the *EcHKT1;1* gene was therefore, evaluated by downregulating its expression specifically in roots using RNAi approaches. The insights gained from the study are being used to take up molecular marker and transgenic approaches in *Eucalyptus* for enhancing salt tolerance. A new project has been initiated to identify new genes that help restrict sodium uptake in the roots of mangrove species of *Rhizophora sp.*

The second talk on, **“Screening of *Eucalyptus* clones for water stress response”** was delivered by **Dr. Modhumita Dasgupta, Scientist- F**. The speaker informed that *Eucalyptus* clones were screened for water stress response and variation at morphometric, physiological, biochemical and molecular levels were documented. She informed that the results indicate that susceptible clones allocated higher biomass in roots when compared to the tolerant clones, where the shoot growth continued under stress condition. Use of several parameters as stress indices for nursery screening of *Eucalypt* clones was also enumerated.

The third talk on **“Response and adaptation of tree species to high CO<sub>2</sub> stress”** was delivered by **Dr. Rekha R. Warriar, Scientist-F**. The correlation between increased carbon dioxide in atmosphere and increase in atmospheric temperature was explained. Though a number of studies have been reported in crops to understand their adaptation to high CO<sub>2</sub> conditions, studies in tree species are sparse. Different examples of adaptive responses to high CO<sub>2</sub> stresses of indigenous and exotic tree species as revealed by physiological and biochemical studies were described. The speaker mentioned instances wherein trees responded with increased growth and nitrogen fixation during high rainfall conditions but decreased growth during low rainfall. The need for studies to evaluate the effect of high CO<sub>2</sub> during seed germination, pest incidence and microbial association was emphasized.

#### **Technical Session – 2: Presentation by external resource persons**

The **second technical session** started with a talk by the **lead speaker, Dr. Viswanathan Chinnusamy, on “Phenotyping for abiotic stress tolerance of plants”**. The speaker highlighted the role played by IARI in developing crop varieties with improved traits. The importance of measuring the actual stress levels in plants while studying plant responses and phenotypic effects to abiotic stress was emphasized”. The importance of providing the same environmental conditions, and critically measuring these parameters in the open and in greenhouse conditions was reiterated. The spectroscopy and imaging systems used at the “Nanaji Deshmukh Plant Phenomics Centre” at ICAR-IARI, New Delhi for studying crop stress responses and developing climate resilient varieties of crops elucidated. The use of drones or fixed cameras to record a host of information such as chlorophyll content, water required and

utilized, stomatal conductance, biomass, leaf curling, diurnal cycle, and transpiration rates was described. The use of wearable phenomics for plants that use a sensor attached to the base of the leaf to monitor the rate of transpiration, rate of respiration and plant elongation was also made briefed. He concluded that accurate measurement of plant responses is crucial for identification, characterization and utilization of novel genetic stocks in crop improvement.

This was followed by a talk by the **lead speaker, Prof. M. Raveendran, TNAU, on “Accelerating stress gene discovery through Genomics and Bioinformatics”**. The critical demand for food in the coming years necessitates deployment of advanced genomic technologies like GWAS and genome editing in developing water and labour saving rice with high yield potential, and tolerance to pests and diseases. Breeding improved crops or trees has been become through rationale assembly of superior alleles of candidate genes. New genome editing tools now enable development of new varieties by removal of unwanted traits from wild varieties as has been demonstrated in Tomato. The speaker showed evidences for the sequence variations in the promoter regions enabling plant’s ability to cope with stress. He concluded that combining genomics, bioinformatics, and genome editing tools could potentially accelerate breeding programmes.

### **Panel Discussion**

Following the technical sessions, panel discussion was initiated by the Director, IFGTB. The Director sought clarifications on the strategies adopted for enhancing salt tolerance in *Eucalyptus*. Dr. Mathish explained that *Eucalyptus* accumulates higher percentage of sodium in the leaves, therefore, the strategy of limiting sodium uptake at the roots was taken up by targeting *EcHKT1;1* gene. He added that the strategy has shown promise considering the

preliminary research findings. Dr. Viswanathan Chinnusamy suggested that sodium transporter genes like *SOS1* could also be targeted. Prof. Raveendran suggested studying *EcHKT1;1* in populations to identify desirable alleles and potential markers. Finding the weaker allele of *EcHKT1;1* and comparing it with *HKT1* in mangroves could provide insights for genome editing and gene replacement strategies for improving salt tolerance. He added that in mangroves root membranes play an important role in limiting sodium uptake. Prof Raveendran also suggested taking up genome editing approaches for enhancing biomass quality by suitably modifying cell wall composition so as to increase pulping efficiency. Dr. R. Yasodha enquired on the possible reasons for varying stress tolerance levels observed in the same Eucalyptus clones in different experiments. Dr. Viswanathan Chinnusamy explained that the initial selection of clones for stress tolerance needs to be stringent. Different environmental conditions during the different experiments creates varying vapour pressure deficits leading to these differences, necessitating the need to be perform experiments under the similar conditions. These variations could also be attributed to differing microbial associations in the roots of these genotypes.

The Director inquired about the clones that were used for the experiments in measuring stress responses to high CO<sub>2</sub>. Dr. Rekha Warriar informed that four commercially released clones of IFGTB have been tested. Dr. Modhumita Dasgupta queried regarding the parameters which could be used as screening indices. Dr. Viswanathan informed that hormones may not be suitable as screening index and suggested leaf surface temperature as a parameter for nursery screening. Dr. N. Senthil Kumar, Scientist E, enquired if advancing flowering in rice would lead to any pest incidence. Prof. Raveendran opined that the improved genetic stocks derived through marker assisted breeding programme would be genetically close to the wild type and therefore they are expected to have the same degree of tolerance to pests. To another query by Dr. Rajagunasekar,

Scientist F, Prof. Raveendran informed that more than 100 varieties of rice have been released by TNAU of which only few are popular. Dr. V. Mohan, Scientist G, cautioned that in upcoming years, there will be water scarcity and sought a solution for this problem. Dr. Viswanathan Chinnusamy suggested growing plants with higher water use efficiency and added that drought tolerant tree species could be used for afforestation of arid and semi arid lands.

### **Research Gaps**

Tree species are ideal for planting in lands affected by abiotic stresses. In this context, the following research gaps and strategies for accelerated breeding of better trees emanated from the seminar deliberations.

1. Efforts need to be continued to develop clones/ varieties that yield higher rate of biomass production per unit area and time under abiotic stress conditions like drought, salinity, flooding and high CO<sub>2</sub> stresses.
2. Greater integration of molecular breeding tools like GWAS and Genome editing into tree breeding programmes would accelerate development of tree varieties with enhanced abiotic stress tolerance.
3. Accurate measurement of plant's stress responses to abiotic stresses at molecular and physiological level is important for developing molecular breeding approaches for enhancing tolerance to abiotic stresses.

The seminar ended with a formal vote of thanks by the Seminar Coordinator, Dr. Mathish Nambiar-Veetil, Scientist- F.

Glimpses of the Monthly Seminar on  
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**Inaugural Address : Dr. S. Murugesan, Director**



**Welcome address : Dr. R. Yasodha, Scientist G & Head, PBT**



**Lead speaker: Dr. M. Raveendran, Professor & Head, TNAU**





**Lead speaker: Dr. V. Chinnuswamy, Principal Scientist & Head, IARI**



**Talk by Dr. Modhumita Dasgupta, Scientist F, IFGTB**



**Talk by Dr. Mathish Nambiar-Veetil, Scientist F, IFGTB**



**Talk by Dr. Rekha Warrier, Scientist F, IFGTB**