

## ONGOING: EXTERNALLY AIDED PROJECTS

**Project 1: Identification of suitable tree species and other vegetation for biodrainage in Bargi command area (Jabalpur, M.P.). [087/TFRI/2005/Ecol-1(MOWR)(6)].**

**Status:** Dead seedlings were replaced by the healthy seedlings of the same age during rainy season in the plantation raised along Left Bank Canal (LBC) of Bargi Command Area, Jabalpur. Seedlings of *Jatropha curcas* and *Agave americana* were planted surrounding the plantation area as biofencing.



Lysimetric experiments

Forty lysimetric tanks were constructed in the institute's campus to simulate the experiments being conducted along LBC. The experiments were set up in the lysimetric tanks with same tree species planted along the canal. The water levels maintained in the lysimetric tanks were : 0-0.25 m, 0.26 to 0.52 m, 0.52 to 0.75 m and irrigated (control). In another experiment, the tolerance of *Eucalyptus hybrid* with different salinity levels was tested.

Growth data of planted seedlings were regularly collected along LBC of Bargi Command Area and lysimetric tanks. These data were collected at an interval of 3 months along LBC and at monthly interval in lysimetric tanks. Biomass studies were also conducted at regular interval.

Under ground water table below plantations of different tree species and control area was regularly measured with the help of observation wells. The effect of different tree species on water table was observed and compared with control.

Soil samples from different plantation sites were collected and analyzed for their physico-chemical characteristics including pH, EC, CEC, organic carbon, available N,P,K, exchangeable Na, K, Ca and Mg, mechanical analysis *etc.*

Training on 'Bio-drainage' was organized at village Dabhola along Left Bank Canal (LBC) of Bargi Command Area, Jabalpur (M.P.) for farmers and tree growers. Field trip for the trainees was conducted to plantation area raised under the project.

**Project 2 : Lead institution for Achanakmar-Amarkantak Biosphere Reserve, Chhattisgarh. [102/TFRI/2006/Ento-1/MoEF (12)] *Principal Investigator***

**Status:** Updated list of various flora consisting of fungi, lichens, ferns and angiosperm and fauna and the information disseminated to B.R. managers. Data on the population of different communities existing in Achanakmar-Amarkantak Biosphere Reserve also collected. Prepared saville strategy based on Madrid Action Plan and submitted to Ministry of Environment & Forests. UNESCO nomination form and supporting documents for designation of B.R. in World Network drafted and submitted to State Forest Department of Chhattisgarh for their suggestions.

**Project 3 : Development of integrated insect pest and disease control system for major economically important forest tree species. [112/TFRI-2006/ Ento.- 4 (MPFD) 15]**

**Status:** Survey was conducted at 8 selected localities of Madhya Pradesh to monitor the insect pests and diseases of aonla and teak. Incidence of teak leaf skeletonizer, *Eutectona machaeralis* and aonla shoot gall forming insect, *Betousa stylophora*, leaf roller, *Garcillaria acidula*, fruit sucker *Scutellera nobilis*, and wilt / root rot / foliar diseases, *Fusarium solani*, *Pseudomonas tectonae*, *Polyporus zonalis*, *Rigidoporus lineatus* and *Peniophora* species and *Olivea tectonae* were recorded in nurseries, plantations and natural forests. Experiments were laid out on IPM of skeletonizer *E. machaeralis* in teak plantations at Kanjai (Lamta Forest Project Division, Balaghat). Bio-insecticides / fungicides were used against *E. machaeralis*.

**Project 4: Development of model for the management of white grubs in teak nursery, under the concept of Integrated Pest Management. [ID No. 113-2007/Ento-1(FDCM, MS)(16)]**

**Status:** Monitoring, observations and experimentations on *H. rustica*, *H. mucida* and *S. ruficollis* since the initiation of the emergence of beetles in the field revealed relationship of beetles emergence and rising relative humidity. Data indicated that in all years there was a marked increase in humidity (approx 40 – 60% increase over a few days) along with a noticeable decrease in temperature (approx. 5 °C over the same period, 6-9 days prior to the first emergence of beetles). Rainfall 2 - 3 weeks prior to the date of emergence did not induce beetle emergence, due possibly to the lower atmospheric relative humidity (< 50%). After the increase in RH, even moderate amount of rains induced the emergence of beetles.

Beetles attract preferably to *Z. jujuba* or *Z. mauritiana*. Foliar spraying of monocrotophos or dimethoate 0.05% kills the beetles resulting into less number of egg laying. Entomopathogenic nematode (EPNs) proved effective to kill the whitegrubs in laboratory. Phorate/ methyl folidol @ 300g/ bed (size 12 m X 1.25m) in combination and alternately with the cadavars of EPN *H. indica* and *S. carpocapsae* @ 250 – 300/ bed in good watering conditions proved effective in reducing the incidence of seedling mortality caused by white grubs damaging teak seedlings. The juveniles of nematodes L. were recovered after 1 month of its release proving their survival in the field.

**Project 5: Isolation, identification and evaluation of insecticidal phytochemicals from *Annona squamosa* L. (Annonaceae) against *Hyblaea puera* Cram and *Eutectona machaeralis* Walker, two major pests of teak (*Tectona grandis* Linn). [ID No.122-2007/Ento-3(CSIR) (18)]**

**Status:** The seeds of *Annona squamosa*, were extracted in six solvents viz. petroleum ether, ethyl acetate, ethyl alcohol (ethanol), acetone, methanol and water, using Soxhlet's Apparatus. Bioassays for antifeedant, growth inhibitory effects of the extracts were carried out against the larvae of teak defoliator, *Hyblaea puera* and teak skeletonizer, *Eutectona machaeralis* with preliminary testing of six crude extractives of *Annona* seeds, viz., petroleum ether, ethyl acetate, ethyl alcohol (ethanol), acetone, methanol and water. For feeding inhibition property

concentrations/ doses ranging from 25ppm to 3000ppm of each promising extractive tried. Probit analysis has been performed. Based on bioassay results, further bioassay-directed-separation of the active compounds is in progress. Extracts/ fractions were subjected to Ultraviolet (UV) and Infra Red (IR) Spectroscopy for further elucidating the compounds. Further fractions of petroleum ether and ethyl acetate crude extracts were obtained by subjecting the crude extracts to column chromatographic separation serially in different organic solvents. Chemical profiles of the fractions were frequently analyzed using Thin Layer Chromatography (TLC). The bioassays for evaluating efficacy of these chromatographic fractions and determination of  $EC_{50}$ ,  $EC_{90}$ / $LC_{50}$ ,  $LC_{90}$  values of the promising fractions are in progress.

**Project 6: Studies on taxonomy of Braconid parasitoids (Hymenoptera: Braconidae) from central India. [123 / TFRI / 2007 / Ento-4 (CSIR)(19); funded by CSIR, New Delhi / 2007-2010]**

**Status:** Taxonomic survey of important forest and agro-forestry areas of Chhattisgarh (Rajnandgaon) and Maharashtra (Bhandara, Gondia, Chandrapur, Gadchiroli, Nagpur, Wardha, Amravati, Ahmadnagar, Pune, Raigad, Ratnagiri, Sindhu Durg, Kolhapur, Sangli, Satara, Yavatmal, Buldana, Jalgaon, Nandurbar, Dhule, Nashik, Thane, Aurangabad and Jalna) were carried out for Braconid collection. In all, twenty two species of Braconids viz. *Apanteles agilis*, *Apanteles detrectans*, *Apanteles creatonoti*, *Apanteles effereus*, *Apanteles hyblaeae*, *Apanteles tachardiae*, *Apanteles bambusae*, *Apanteles cajani*, *Apanteles caniae*, *Apanteles platyedrae*, *Apanteles lamprosomae*, *Apanteles antipoda*, *Apanteles significans*, *Chelonus dwibindus*, *Chelonus narayani*, *Chelonus notauli*, *Chelonus indicus*, *Eutropobracon granulatus*, *Cassidobracon castrus*, *Habrobracon brevicornis*, *Homolobuospond spgalphus sp.* were identified.

**Project 7: Studies on the natural enemies of teak pests, *Hyblaea puera* and *Eutectona machaeralis* and their role in suppressing the population of insects in Madhya Pradesh. [127/TFRI/2008/Ento-1(MPCST)(20)]**

**Status:** Periodical surveys were conducted in teak forests of Madhya Pradesh for collection of natural enemies of major insect pests of teak, *Hyblaea puera* and *Eutectona machaeralis*. The natural enemies recorded include 6 species of parasitoids (*Apanteles machaeralis*, *Apanteles* sp., *Brachymeria* sp., *Sturmia* spp., *Trophocampa indubia* and *Xanthopimpla cera*), 5 species of predators (*Calleida splendidula*, *Canthecona furcellata*, *Corvus macrohynchos*, *Erthesina fullo* and unidentified spider) and 2 species of fungal pathogens (*Aspergillus flavus* and *A. niger*). Carried out laboratory rearing of a predator, *C. furcellata* and culture of 2 pathogens, *A. flavus* and *A. niger* for tests against target insect pests.

**Project 8: Varietal improvement of *Rauvolfia serpentina* and *Tinospora cordifolia* through germplasm selection, evaluation and breeding. [ID No. : 100/TFRI/2006/Gen-1 (MoHFW) (10)]**

**Status:** Data recorded after 24 months of planting from introduction trial of *R. serpentina*, laid out at TFRI, Jabalpur in December 2006, showed that CW-MP accession belonging to Chhindwara (M.P.) recorded maximum root diameter (1.62cm). The maximum root length (47.17cm) was recorded in JS-OR accession belonging to Jassipur, Orissa. The maximum

number of root branches (12) and total bio-mass (266.54 gm) were recorded in NN-WB accession belonging to Nanungeria (WB) and root yield per plant (129.06gm) in ZR-CG accession belonging to Zora (C.G.).

The spectrophotometric method for estimation of total alkaloids was standardized for both species (*R. serpentina* and *T. cordifolia*). Total alkaloids (%) in 15 accessions of *R. serpentina* were estimated. The results on total alkaloids clearly exhibited some promising accessions of *R. serpentina*, viz., KL-AJ (1.88%) belonging to Anjanakund, Kerala, ZR-CG (1.67%) belonging to Zora, (C.G.) and AG-OR (1.52%) belonging to Anugul, Orissa which contained higher amount of total alkaloid than JS-OR (1.00%) belonging to Jassipur, Orissa. Reserpine content in 15 accessions of *R. serpentina* was also estimated through HPLC method, data being analyzed.

The multi-location evaluation of germplasm of *R. serpentina* was established at Chandrapur (Maharashtra) in July, 2008 (Fig a), Raigarh ( Chhattisgarh) (Fig b) and Jabalpur, (M.P.) (Fig c). These trials were established in randomized block design with three replications. Each accession was represented by nine plants per replication. Observations on the survival of the plants at Raigarh exhibited better survival than the remaining two localities.

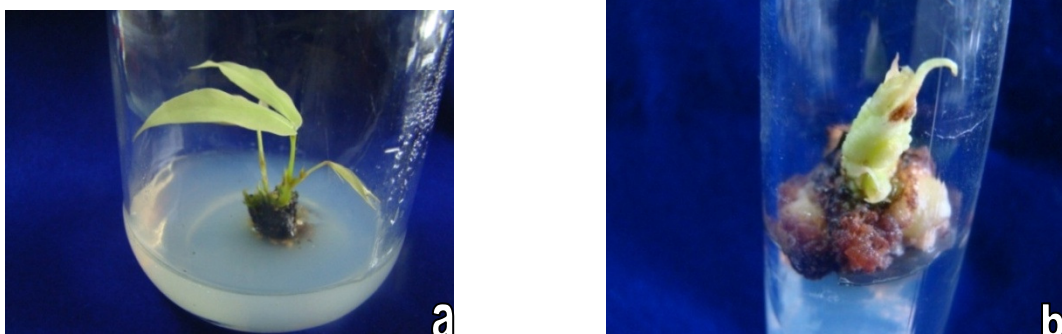


Establishment of multi location field trial at (a) Chandrapur (M.S.),  
(b) Raigarh (Chhattisgarh) and (c) Jabalpur (M.P.)

**Project 9: Studies on *in-vitro* regeneration of plantlets and their genetic (molecular) fidelity in *Saraca indica* Linn., a vulnerable medicinal tree. [ID No. 111/TFRI-2006/Gen.-2(CSIR)(12)]**

**Status:** Seeds were collected from mature trees from Jabalpur and Pipariya. They were germinated under *in-vitro* conditions on MS basal semisolid medium. In all, 60-70 % germination was obtained. Shoots were further multiplied on MS semisolid medium supplemented with 10  $\mu$ M BA (Fig.a). The effect of different seasons and sterilizing agents on aseptic culture establishment were studied taking nodal explants from 2-3 year old seedlings and terminal buds from 20 year old tree. Highly significant effect of seasons was observed on sprouting of buds with maximum sprouting (35.18 %) obtained in summer season in 2-3 year old plants. Sterilizing treatments also had significant effect on sprouting of buds with 0.2 %  $HgCl_2$  treatment resulting in maximum sprouting (38.89 %). During surface sterilization of terminal buds from 20 year old mature tree, 0.2 %  $HgCl_2$  treatment resulted in maximum alive bud during autumn and winter season. Shoot formation from embryonic axis of immature seeds was obtained on B<sub>5</sub> medium supplemented with 2.5  $\mu$ M BA. Zeatin doses and interaction between zeatin and BA did not significantly affect number of shoots. Maximum callus

formation (64%) on embryonic axis was obtained on B<sub>5</sub> medium supplemented with 2.5 μM BA. In another experiment with embryonic axis, the interaction between 2, 4-D and TDZ had a significant effect on number of shoots with 3.56 shoots obtained on 2 μM 2, 4-D and 10.0 μM TDZ. On medium containing 2 μM 2, 4-D + 10 μM TDZ + 10 μM zeatin, well formed shoots were obtained on embryonic axis along with callus (Fig. b). Leaf pieces were tried for organogenesis. Significant effect of various auxins was observed for callus formation on leaf pieces with picloram resulting in maximum (62.50 %) callus formation. Zeatin doses and their interactions with auxins did not have any significant effect on callus formation on leaf pieces. On B<sub>5</sub> medium supplemented with 13 μM NAA, 6 % rooting of shoots was obtained.



(a) Multiple shoots obtained on 10 μM BA from cotyledonary nodes in *Saraca indica*; (b) Formation of shoots from embryonic axis on B<sub>5</sub> medium supplemented with 2 μM 2, 4-D, 10 μM Zeatin and 10 μM TDZ in *Saraca indica*.

**Project 10: Evaluation and prediction of oil bearing capacity of Sandal (*Santalum album* L.) germplasm using physio-morpho-molecular marker. [ID No. : 120/TFRI/2007/Gen-3/DSAE (15)]**

**Status:** In all, 47 mature sandal trees were selected at IWST, Bangalore, marked and their GBH, heartwood ratio and percentage of oil content were estimated. A lot of variation with respect to growth and oil content of selected sandal trees was recorded. Tree IW53 had the highest GBH of 97 cm and Tree IW23 exhibited the lowest value for GBH of 32 cm. The heartwood/sapwood ratio was maximum in Tree IW24 (0.75) and minimum in Tree IW23 (0.14). Tree IW57 had the highest oil content of 3.25% and Tree IW3 had the minimum oil content of 0.19%. The oil content did not show significant correlations with GBH or heartwood/sapwood ratio.

Genomic DNA from leaves of the selected sandal trees of IWST, Bangalore was extracted following the modified method of Doyle and Doyle (1990). Tree IW36 yielded maximum genomic DNA of 651 ug/500mg fresh leaf, whereas Tree IW20 had minimum genomic DNA of 18.86ug/500mg fresh leaf. The quality (A<sub>260</sub>/A<sub>280</sub>) of genomic DNA ranged from 1.41 to 2.0, which was adequately purified for setting PCR-ISSR assay.

Genomic DNA in three replicates was extracted from thirty trees each of TP and TO following the modified method of Doyle and Doyle (1990). Tree TP- 27 yielded maximum genomic DNA of 323 μg/ 100mg fresh leaf, whereas tree TP-7 had minimum genomic DNA of

6.47  $\mu\text{g}/100\text{mg}$  fresh leaf. The quality (A260/A280) of genomic DNA ranged from 1.08 to 1.98, which was adequately purified for setting PCR-ISSR assay

Nitrate reductase activity in the second and third quarter was determined in leaves of selected 30 trees each from TP and TO plantation area. In the second quarter, Trees from TP selection exhibited more enzyme activity than those from TO selection. Tree TP-15 and Tree TO-16 had maximum enzyme activity. On the other hand, the lowest enzymatic activity was recorded in Tree TP-3 and Tree TO-22 among their respective selections. In the third quarter, Tree TP-8 and TO-9 had maximum enzyme activity but Tree TP-28 and Tree TO-21 recorded the lowest enzymatic activity among trees of their respective selections.

27 sandal trees of TP and three trees of TO were sampled at 50 -150cm above ground for collection of eight wood core samples per tree. The wood core samples are being analyzed for oil content. Genomic DNA of 24 IWST sandal trees graded on the basis of oil content was amplified using 26 selected ISSR primers

### **Project 11: Molecular characterization of *ex-situ* conserved germplasm and identification of molecular associated with wood quality traits in *Tectona grandis* L.f. [ID No: 125/TFRI/2007/Gen-4(DBT)(16)]**

**Status:** Field visits were conducted to collect branches from three ramets each of 97 plus trees of *Tectona grandis* maintained at National Teak Germplasm Bank, Chandrapur (Fig. 1a). The trees represented 12 teak growing states of the country. The collected branches (Fig. 1b) were cut into small shoot cuttings of around 8 inch length and treated for 5 minutes with 0.1 %  $\text{HgCl}_2$ . The surface sterilized cuttings were administered 200 ppm IAA and 200 ppm thiamine solution for 4 hours at their base, followed by sealing of top cut end with wax. The auxin treated five cuttings each of three ramets per plus tree were planted in polybags filled with potting mixture (Fig. 1c). After 1 month of the planting, the cuttings produced sprouts to the tune of 40% (Fig. 1d). Young leaves of sprouts were harvested for the extraction of genomic DNA.

Field visit was also undertaken to collect ten branches with dormant buds from 15-31 progenies (half sib families) of nine plus trees (A-5,A-4,A-3,A-7, A-16,A-17,A-10,A-21,A-35), which were raised in a trial comprising three replicates each of 16 trees at National Germplasm Bank Lohara, Chandrapur, Maharashtra (Fig. 2a,b).

Genomic DNA of leaves of plus trees and apical bud of progenies was extracted taking 100 mg fresh leaves using modified method of Doyle & Doyle (1990). To avoid RNA contamination, 20 $\mu\text{g}/\text{ml}$  RNase was used. Integrity and quantity of the extracted DNA were estimated spectrophotometrically and visualized on 0.8 % agarose gel (Fig. 1e). The average yield of genomic DNA of plus trees was 70  $\mu\text{g} \pm 57.61 \mu\text{g} / 100 \text{ mg}$  fresh wt ( Range: 14.0  $\mu\text{g}$  - 250.0  $\mu\text{g}$ ), whereas

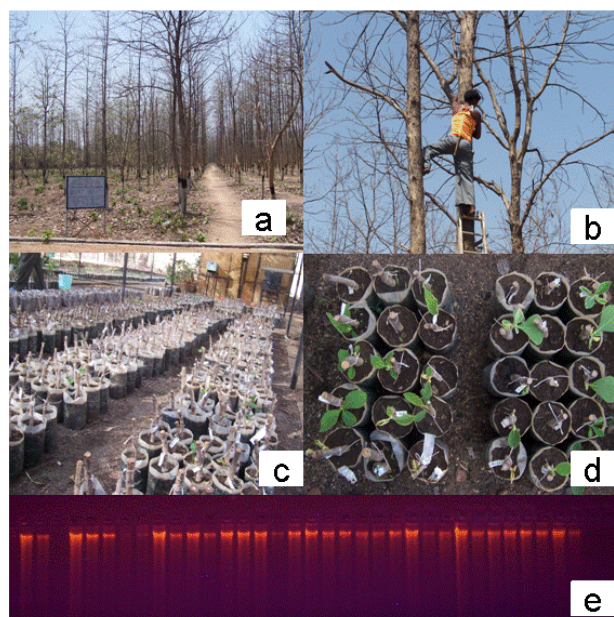


Fig. 1. Plus trees of teak (*Tectona grandis*): (a) A view of germplasm bank at Chandrapur; (b) Collection of branches from plus trees; (c) Planting of branch cuttings; (d) Emergence of sprouts for genomic DNA extraction; (e) Visualization of genomic DNA of plus trees on 0.8% agarose gel.

the quality of DNA (A260 / A280) was  $1.74 \pm 0.15$  (Range: 1.40 – 1.95 ). The quantity of genomic DNA of progenies ranged from 27.12  $\mu\text{g}$  to 71.34  $\mu\text{g}$  and visualized on 0.8 % agarose gel (Fig. 2c) and the quality (A260/A280) of genomic DNA extracted from apical bud of progenies, from 1.09 to 1.81. STMS primers were designed and tested for amplification and STMS assay for genomic DNA, standardized.



Fig. 2. Progenies of plus trees of teak (*Tectona grandis*): (a), (b) Collection of apical bud of plus tree progenies from the trials and (c) Visualization of genomic DNA of progenies on 0.8% agarose gel.

### **Project 12: National Network on Integrated Development of Jatropha and Karanj. [73/TFRI-2004/NWFP-3(NOVOD)(11)**

**Status:** *Jatropha curcas*: Multilocational trials in the form of national, zonal, progeny and package of practices established at the institute campus, experimental area at Barah, Jabalpur and in Chhindwara are being maintained. Third national trial of *Jatropha curcas* comprising of 14 accessions received from various network institutes/centres has been established at TFRI campus, Jabalpur. The observations on growth attributes like height, collar diameter, number of branches etc. are recorded on regular intervals. The trials are performing well and the survival is more than 90%. In national trial, accessions TNMC-5 and TFRI-2 performed best among all other accessions, whereas in zonal trial, IGAU-1 performed well among all other accessions received from different member institutions with respect to growth attributes. Maximum fruiting was observed in TNMC-5 (national trial) followed by TFRI-2 (zonal trial). Pruning operations in *Jatropha* induced more number of branches which lead to more production/fruits. The findings of package of practices trial shows that the seedlings planted on ridges in the last week of July 2005 performed better than the seedlings planted in pits.

*Pongamia pinnata* (Karanja): 10 CPTs of Karanja were selected in Dindori and Jabalpur district of Madhya Pradesh. Experimental trial in the form of national, zonal and progeny trials established in institute campus, Barah experimental area and Bhandamuri, Balaghat are being maintained. The observations on growth attributes like height, collar diameter, number of branches etc. are recorded on regular intervals. In national trial, accession number TNMP-6 received from TNAU, Mettupalayam, Tamilnadu performed best among all other provenances,

whereas in zonal trial, TFRI-2 performed best with respect to growth attributes. Progeny collected from Jhinhari, Katni-1 (height 241.71 cm; collar diameter 3.61 cm; number of branches 14) performed well among all other progenies in respect of growth attributes. Significant variation was observed in the growth attributes among different progenies.

### **Project 13: Integrated development of bamboos for economic upliftment in central India. [126/TFRI/2007/Agro-1(NBM)]**

#### **Sub Project - I: Sustainable development of new bamboo agroforestry techniques for increased income generation in the central Indian states.**

**Status:** Established Bamboo – Wheat Agroforestry trial as an On Station Research (OSR) trial at the Agroforestry Experimental Plot, TFRI, Jabalpur. The wheat crop had ripened fully and is ready for harvesting during April, 2009.

Seventeen progressive farmers in Chhindwara district of Madhya Pradesh and sixteen in Devipur sub –Division under the Raipur district of Chhatisgarh were identified using Participatory Rural Appraisal (PRA) tools during May and June 2008 and training on the benefits of adopting bamboo based agroforestry systems was imparted to them. Seedlings of *Dendrocalamus strictus* were provided to them for planting around their agricultural fields.

#### **Sub-project – II: Bamboo species suitability for different degraded non-forest areas in Madhya Pradesh.**

**Status:** Geoenvironmental survey and study of degraded lands at Dhuma, Damoh, Hoshangabad (Bagra), Bhopal (Ratapani), Katni (Kymore, SVIL Mines, Khitola) and Rewa (Sirmore) were conducted. The degraded lands are on Basalt and Sand stone as well as on Limestone. The water table is deep around 350' to 450'. The drainage is seasonal along shallow channels. The geomorphology varies from place to place, some areas belongs to rocky terrain with moderate slope, whereas other areas belongs to plateau. The soil is generally shallow with dry to low moisture and nutrient content. To know the performance of bamboo on these degraded lands, the bamboo plantations of 2005-06, wherever located nearby to these degraded lands, have been studied.

#### **Sub-project – III: Insect and diseases of bamboo occurring in central India and their management.**

**Status:**

##### **A. Identification of diseases and insect pests**

Seeds of *Bambusa nutans* and *Dendrocalamus strictus* were observed to be attacked by a bug, *Ochrophara montana*. The mature of seeds were examined for the fungi and insects. The seeds of *D. strictus* were damaged by an unidentified seed borer. The work on its identification is in progress.

Seeds of *Bambusa nutans* and *Dendrocalamus strictus* were sown in nursery beds and rhizomes planted at TFRI Jabalpur and bamboos grown by forest departments at selected localities of M. P. and Chhattisgarh were screened for different diseases and insect pests. It was observed that bamboo culms are attacked by 14 fungal pathogens. *Poria rhizomorpha* and *Cyathus* sp. infested clumps of *B. nutans* and *Curvularia lunata* is recorded to infest the leaves of bamboos in nursery stage. Dead standing bamboo culm in plantations were observed to be infested with 4 species of fungi.

In nursery and plantation seedlings of *Bambusa nutans* and *D. strictus* were recorded to be damaged by various insect pests. Rats observed to cause a great menace to the rhizomes of *B. nutans* and *D. strictus* in nursery beds, whereas hares observed to feed on leading soft branches of culms of bamboos in plantations.

## **B. Field trials against various diseases and insect pests**

A field trial was laid out at Kosabadi (Korba) in Chhattisgarh for the control of rhizome rot and fungal diseases attacking culms in bamboo, *Dendrocalamus strictus*. In all, 6 treatment combinations including one untreated control were taken. Each treatment was replicated five times. The second dose of above pesticides were given in September 2008. The observations on number of dead culms and numbers of new culms arise will be taken in last quarter of the year. The work is in progress.

Seven field trials were laid out to investigate the lowest effective concentration of 10 modern insecticides. The different insecticidal concentrations were formulated. Each treatment was uniformly sprayed on entire bamboo seedling bed having larvae bearing rolled leaves. Each treatment was replicated thrice. The observations on percentage of larvae died after 72 hrs of spray recorded. Data showed that foliar spraying of chlorpyrifos 0.05% is best followed by endosulfan 0.05%.

To investigate the efficacy of synthetic pyrethroids, two field trials were conducted. In all, 7 insecticidal concentrations and an untreated control were taken. Each treatment was replicated thrice. The data on the percentage of larvae died after 72 hrs of spray were enumerated. It was observed that foliar spraying of fenvalerate 0.01 % is best causing 94.83 to 95.37% killing of the larvae within 3 days of the spray.

## **Sub-project – IV: Nutritive value and value addition of some bamboo species of central India.**

**Status:** Surveys were conducted to various bamboo growing regions of Madhya Pradesh, Maharashtra and Chhattisgarh for collection of shoots of *Dendrocalamus strictus*, *D. asper*, *Bambusa bambos* and *B. tulda*. *D. strictus* is the major bamboo species of central India followed by *B. bambos*. *D. asper* and *B. tulda* was found growing only in nurseries and private plantations. The collected bamboo shoots were processed for estimation of various nutrients (proteins, carbohydrates, vitamins, minerals, fibre, tannins and total phenols) and anti-nutrients (cynogenic glycosides). Maximum edible portion (77.12% of its fresh weight) was found in *D. asper* shoots whereas highest anti-nutrient (cynogens 41.82 mg./100g fresh weight) was found in shoots of *D. strictus*. Bamboo shoots were processed, dried and stored for chemical analysis and

product development. Fresh bamboo shoots were treated with cold and hot water, saline and sodium bicarbonate solutions to study their effect on nutrients and anti-nutrients. 1% saline solution treatment was found best among all the treatments as it significantly reduces anti-nutrients like cynogens and retains all nutrients. The amount of nutrients in preserved bamboo shoots (1% sodium benzoate) and fresh bamboo shoots was found at par. Bamboo shoots can be preserved in 1% sodium benzoate solution as it did not have any adverse effect on their nutritional status. Two products namely bamboo pickle and bamboo vinegar have been prepared from fresh bamboo shoots.