Danida Forest
Seed Centre

IPGRI

THE PROJECT ON HANDLING AND STORAGE OF RECALCITRANT AND INTERMEDIATE TROPICAL FOREST TREE SEEDS

Newsletter - September 2002 10

Contents

Photo from the Workshop in Fiji on the use of the IPGRI/DFSC Desiccation Protocol. Mr Inoke Wainiquolo (third from right in front row), from the Fiji Forestry Department seed centre, with participants who attended the combined tree climbing and rainforest seed handling courses

This newsletter is a product of the "Project on Handling and Storage of Recalcitrant and Intermediate Tropical Forest Tree Seeds" coordinated by the International Plant Genetic Resources Institute (IPGRI) and financed by Danida.

For more information about the project please contact:
Dr. Ehsan Dulloo, Via dei Tre Denari, 472/a 00057 Maccarese, Rome, Italy
Phone: +39-066118206 Fax: +39-0061979661 Email: e.dulloo@cgiar.org

The newsletter is edited by Danida Forest Seed Centre. Articles of relevance to the project, comments, discussions, etc. are welcome from everybody. Please contact Dorthe Joeker, Danida Forest Seed Centre, Krogerupvej 21, DK-3050 Humlebaek, Denmark.

Phone: (45) 49 19 05 00. Fax: (45) 49 16 02 58. E-mail: doj@sns.dk and dfsc@dfsc.dk

The newsletter can be ordered free of charge at the same address and downloaded from the IPGRI/ DFSC internet site at www.dfsc.dk.

Danida Forest Seed Centre (DFSC) is a Danish non-profit institute which has been working with development and transfer of know-how in management of tree genetic resources since 1969. The development objective of DFSC is to contribute to improve the benefits of growing trees for the well-being of people in developing countries. DFSC's programme is financed by Danish International Development Assistance (Danida).

International Plant Genetic Resources Institute (IPGRI) is a member of the Consultative Group on International Agricultural Research (CGIAR). IPGRI's mandate is fulfilled by encouraging, supporting and undertaking activities to improve the management of genetic resources worldwide so as to help eradicate poverty, increase food security and protect the environment. IPGRI focuses on the conservation and use of genetic resources important to developing countries and has an explicit commitment to specific crops.

Editorial

Looking ahead

Dear all,

By the time you receive this Newsletter the second period of the IPGRI/DFSC Project on Recalcitrant and Intermediate Tropical Forest Tree Seeds will have come to an end. We would like to take this opportunity to thank everybody who has been involved in the project since its inception in 1995.

The network has been steadily growing and now numbers 519 members. We still receive letters from institutions that are interested in our protocol and reports with results from screening, some of which are printed in this Newsletter. Also, scientists working in related fields have shown interest in our project as can be seen from the two papers on fungal infection in seed published in this issue. This sort of collaboration between different fields could be an important component in future works with recalcitrant seeds. We do hope, however, that the publication of this Newsletter will not be the last, but will continue as long as we have a network.

During the second phase of the project, altogether 56 species of tropical forest trees have been screened within the project. For some species storage trials are still ongoing. But for many we have received the final reports which subsequently will be posted on DFSC's homepage.

We are now looking forward to seeing you all at the Final workshop of the second phase to be held in Chania, Crete from 16 to 19 September 2002 at MAICh who we would like to thank here. This meeting will be an important one for us where we hope to develop new ideas and a strategy for the continuation of our work on tropical forest seeds. This will be the fourth and last output in the second phase of our project. Moreover, we are pleased to announce that Danida has approved a no-cost extension of the project for a further 6 months to provide us adequate time for developing this strategy. At this workshop we shall need to reflect on the following questions:

- What further research activities are required to improve the handling of tropical forest tree species?
- How can we ensure that the species we have been working on over the last 3 years be integrated in planting programmes? How can this be achieved?
- Is there a need to expand the screening of other species or should we focus on the species that we have already screened?
- Is there a need for developing guidelines and/or fact sheets for seed collection, seed handling and processing seeds? Such guidelines would be ideal for translating the research results obtained so far into practical recommendations.

- How can the knowledge acquired on how to collect and process seeds of the selected species be linked with national reafforestation programmes, promoting large scale use of the species and consequent increase in landscape diversity? Concrete recommendations should be formulated and introduced into national forestry action plans and mechanisms found for large scale implementation.

- Do we need to address the issues of seed stock establishment? If we want the species to be included in replanting schemes, it is imperative that large sources of seed are available for planting. This is often perceived as a major bottleneck or impediment for large scale use. Once seed reserves are established, how can they be disseminated? Are there proper seed supply systems in place in countries or do they need to be strengthened?

- How can we still maintain the research efforts on tropical forest tree seeds? Would it be more effective to work in a network mode and build linkages with forest research institutions and universities to provide more visibility of initiatives on tropical forest trees seed research?

- Is there a need to maintain continuity in the dissemination of information in the form of a newsletter? What kind of information should the newsletter be providing? Who should be responsible for putting this information together?

- What funding mechanisms should be put in place to continue the important work we have started?

We will also endeavour to publish the proceedings soon after the workshop, and submit these together with our final report to the Donors as a major output of the project.

Finally, our thanks go to Danida for funding this project. We also wish to thank all of you for your continued collaboration as we look ahead for new opportunities to work together.

Ehsan Dulloo, IPGRI
and Dorthe Jøker, DFSC

Workshop in Fiji on the use of the IPGRI/ Danida Forest Seed Centre Desiccation Protocol

A total of ten participants from five countries, Tonga, Samoa, Solomons, Vanuatu and Fiji, attended a workshop on seed handling with a focus on the use of the IPGRI/DFSC Desiccation and Storage Protocol from the 26 – 30 November 2001. The workshop was held at the Fiji Forestry Department Seed Centre at Colo-I-Suva just out of Suva. The facility has a well equipped laboratory particularly well set up for processing *Swietenia macrophylla* (mahogany) seed.

The workshop was one of two courses presented to the participants as part of the Australian Agency for International Development (AusAID) project titled South Pacific Regional Initiative on Forest Genetic Resources Phase 2 (SPRIG). For further information on the project refer to the following website: http://www.ffp.csiro.au/tigr/atscmain/whatwedo/projects/projects.htm

The two concurrent courses provided the participants with the opportunity to gain an understanding of the process from seed collection including, tree selection, documentation and seed shipment through to activities in the laboratory associated with seed processing and storage. The first week focused on participants developing practical safe skills in advanced tree climbing techniques using equipment provided under the project.

The Rainforest Seed handling workshop was opened by Mr Inoke Wainiqolo Acting Principal Silviculturalist and in charge of the centre. He welcomed the participants and emphasised the importance of developing close links between the SPRIG countries. He also emphasised the importance of working on indigenous species which provided many challenges least of all in determining how to collect and handle the seed.

On day one, the participants were introduced to the course including the distribution of background literature and a discussion by participants regarding their involvement in seed handling and problems encountered. Background information was presented on seed handling and an introduction to the protocol. Fruit of three species, *Endospermum macrophyllum* (kauvula), *Cedrela odorata* (pencil cedar) and *Artocarpus heterophyllus* (jackfruit) were provided for the workshop. The latter two species were collected by the participants during their tree climbing course. During the afternoon of the first day, participants divided into three teams each working on a separate species. Seed was extracted after which the teams followed the protocol step by step to include gathering basic data on fruit seed size, weight and moisture content. By the end of the day initial moisture content tests were set up in the oven. An Excel template was created to enable the teams to maintain records of information gathered as well as calculating results from formulas. After extracting the seed, an exercise in fruit and seed anatomy was carried out to enable participants to identify the fruit type together with its components.

Mesek Sethy (Vanuatu) and Villisoni Nataniela (Fiji) extracting seed from *E. macrophyllum* fruit.

The remainder of the workshop was devoted to the practical hand-on work following the instructions contained in the protocol to include establishing and monitoring the desiccation trials, understanding the comparison between actual and target moisture content, conducting moisture content and germination tests and interpreting the results. The three species have markedly deferring seed characteristics. This enabled the participants, as a whole, to observe a range of different approaches consistent with the protocol. On the one hand jackfruit, which is one of the largest fruit in nature, averaging 9.63 kg with average seed weight of 5.4 g, whereas *E. macrophyllum* would have to be one of the smallest recalcitrant seed with an average weight of 0.05 g. Initial moisture contents was 62% for jackfruit, 58% for *E. macrophyllum* and 9% for *C. odorata*.

For *E. macrophyllum*, the team were able to reach the TMC for five of the six levels with 10% being the exception. By contrast, seed of jackfruit had only reached the first TMC of 60%. This enabled

the participants to have a reasonably complete understanding of the processes involved in desiccating seed. Because of the very small size of the *E. macrophyllum* seed and therefore small sample size (125 seeds/desiccation treatment), the error level between replicates was high. In following up on the trials started as part of the workshop it was reported that none of the seeds germinated. The problem of poor germination has been experienced with other seedlots of both *E. macrophyllum* and *E. medullosum*.

At the conclusion of the workshop, each team was required to present their findings on each respective species. This was used as a useful exercise to interpret the results presented for TMC vs actual MC and look at the size of the error difference between the replicates. Discussions then continued on to what should be regarded as an acceptable SD.

At both the commencement and conclusion of the workshop, participants were required to fill in a written assessment. It was gratifying to see that everybody improved their score with results between the pre and post assessment between 11–51%. The person who achieved the greatest improvement in their score received a copy of Lars Schmidt's book on 'Guide to Handling of tropical and Subtropical Forest Seed'. The main criticism was that the five day course was not long enough and that the course should have been eight days.

Maloni Havea (Tonga) entering desiccation trial data in the Excel spreadsheet

Team comprising Petele Pese (Samoa), Mesek Sethy (Vanuatu) and Peni Cawani (Fiji) determining moisture content

At the conclusion of the workshop a decision was made with each participant on which species they would work on for the desiccation and storage trials as part of the IPGRI/DFSC project. Table 1 provides information on the proposed schedule.

With countries in the Pacific region including Papua New Guinea being encouraged to become involved in the use of the protocol, the continuation of the IPGRI/DFSC Newsletter will be a very important to the region. It was therefore encouraging to read in the DANIDA Forest Seed Centre News No. 6 that the project newsletter has been accepted by CAB ABSTRACTS making it a more high profile international newsletter.

Table 1. Schedule of seed collections and desiccation/storage studies bySPRIG partners

Collecting partner	**Country**	**Rep. partner**	**Species (mth of collection)**	**Species (mth of collection)**
Mesek/ Richard	Vanuatu	?	*Santalum austrocaledonicum* (June)	*Endospermum medullosum* (March)
Vilisoni, Peni, Tevita	Fiji	?	*Santalum yasi* (Feb-March)	*Barringtonia edulis* (Dec-Feb)
Basil, Figert	Solomons	ATSC	*Octomeles sumatrana* (July)	*Calophyllum peekelii* (March)
Maloni	Tonga	?	*Garcinia sessilis* (Sept – Oct)	*Syzygium corynocarpum* (Dec-Jan)
Olivia, Peteli	Samoa	?	*Manilkara hoshinoi* (March)	*Syzygium inophylloides* (Feb-April, July-Aug)

international society
for seed science

School of Life and Environmental Science
George Campbell Building
University of Natal,
Durban 4041 South Africa

The 4th International Workshop on Desiccation Tolerance and Sensitivity of Seeds and Vegetative Plant Tissues

Desiccation-tolerance is actually an extraordinary survival mechanism but, because most people are familiar with the seeds in the context of crops, few consider just how remarkable a property this is! What is perhaps even less widely appreciated, are the desiccation-tolerant, so-called resurrection plants: these angiosperms that can dry down to a withered mass of dead-looking plant detritus will, when water becomes available, remarkably 'spring back'. The property of being able to withstand extreme desiccation as a vegetative plant, is not confined to angiosperms, as significant research on lower order plants - particularly on mosses - has shown. As far as seeds are concerned, it is suspected that a great many of the tropical and sub-tropical species may produce seeds that are not desiccation-tolerant in the strict sense. While not all may be truly recalcitrant - that is, highly desiccation-sensitive - many are likely not to be able to tolerate the generally familiarly-known extremes of dehydration typical of the *orthodox* category of crop seeds. In fact, reflecting on what is known about seed biology, most of the accepted dogma - until relatively recently - was derived from in-depth studies on about 20 crop species. Considering that there are in excess of 250,000 species of angiosperms, there is a lot to learn about seeds!

These considerations then, are part of the philosophy underlying the 'Desiccation Workshops', as they have come to be known. All have been held in South Africa, the first in 1994 in the Kruger National Park, then in 1997 at Franschhoek in the Cape Province, in 2000 at the Itala Game reserve in KwaZulu-Natal. The idea of holding these periodic workshops was born at the 4th International Workshop on Seeds in Angers, France, in 1993, when (after a few beers) a small group with a focused research interest in desiccation-tolerance and -sensitivity, decided that this topic tended to get lost in the bigger arena of seed biology. Since then, the 'Desiccation Workshops' have attracted a group of about 60-70 people, all with a thirst for progress in this specialised area, and have recently become recognised meetings of the International Society for Seed Science (ISSS).

It was decided early on, that seed biologists whose interests lay in the realms of desiccation-sensitivity and -tolerance, and those scientists focusing on these aspects in vegetative plant tissues, had a lot in common and would, in fact, react synergistically. This proved to be a good judgement, and in the opinion of all the delegates, has provided that extra 'something', as each group has learned much from the other. It is hoped that microbiologists with coincident interests might become involved in the future.

The settings chosen for the 'Desiccation Workshops' have been unique in more than one way: the venues have always been out-of-city, a choice made early on to limit the type of attraction that might lessen the focus of the meeting. However, these venues have always offered special features of their own, particularly when set in magnificent scenery - and with the special flavour (in the case of the 1st and 3rd Workshops) of an African nature reserve, abounding with indigenous plant species as well as animals of all sorts. The venue for 4th Workshop, planned for late August, 2003, is to be Nieuwoudville (Northern Cape Province, South Africa), the venue and time having been chosen to optimise on the renowned Namaqualand flower season, when the desert presents a spectacle without parallel (see e.g. Namaqualand and Southern African Pictures on www.afaly.com). The programmes have also been planned with the objective of enjoying good science, good company and ample opportunity to explore the unique surroundings.

In terms of the serious business of the Workshops, these are divided into themes, with no parallel sessions, and ample time given for real discussion. An early policy decision was not to publish proceedings as such, but to invite contributors to submit manuscripts which would, if accepted after the normal peer-review process, be published either in a special edition of *Seed Science Research* or *Plant Growth Regulation*, as appropriate. A similar procedure will be followed for the 4th 'Desiccation Workshop'.

The format of the Programme is broken down into the themes: General biology; Desiccation damage and limits to tolerance; Developmental aspects of desiccation tolerance; Current concepts of mechanisms conferring desiccation tolerance; and Applied aspects. Other themes, e.g. Evolutionary and ecological aspects, may be included when appropriate presentations are offered. Presenters are invited at the outset to chose presentation times from 15 to 30 minutes, as suits them, and posters too are welcomed. For the 2003 Workshop, in the context of the progress that has been made in seed science over the past decade or so, we plan also to have an open discussion session on the desirability of a revised system for seed categorisation.

Should you be interested in attending this meeting, please contact deswork@biology.und.ac.za. We would appreciate your response as soon as possible, to facilitate planning.

FIRST ANNOUNCEMENT

"Dipterocarps in the new millennium: Conservation, Domestication & Utilisation"

7th-11th October 2002,
Kuala Lumpur, Malaysia

Jointly organised by:
Asia Pacific Association of Forestry Research Institutes (APAFRI).
The International Union of Forestry Research Organization (IUFRO Working Party S1.07-17),
Forest Research Institute Malaysia (FRIM),
University Putra Malaysia (UPM)
Forestry Departments Penisular
Forestry Department Sabah
Forestry Department Sarawak

The organisers acknowledge the initial funding by CIDA through the Tree Link Project to prepare and distribute this first announcement. The organising committee will be a wide range of funding agencies seeking support to offset costs from the 7th Round Table Conference.

BACKGROUND

We have now stepped into the 21st century. The last Round Table Conference on Dipterocarps which was the sixth in the series was held at Banglore, India in 1999. At the Banglore meeting several resolutions was adopted by the participants. The resolutions covered the fields of conservation, domestication and utilisation of the family with the aim that more in-depth studies on these disciplines must be carried out and new knowledge generated in time for the next round table conference. We are now there after three years lapse and the time is just right for this Conference.

The Seventh Round Table Conference will be convened in Kuala Lumpur Malaysia. It is anticipated that at this Conference, new research information on the species in the family of Dipterocarpace will be actively deliberated upon The aspirations of this international conference therefore is to gather all researchers, policy makers, wood technologies, educationalists, conservators and foresters who work on this family from around the globe to participate and to exchange information at this Round table. The attendance of participants from all the regions will provide more net working opportunities for further collaborative work and a platform for fostering closer ties and exchange of information among all involved with dipterocarps.

OBJECTIVES OF THE 7TH ROUND TABLE CONFERENCE

a. To explore, exchange and update scientific and technological findings and information on dipterocarps;
b. To provide a forum for dipterocarp researchers to present the results of their research and projects relating to conservation, domestication, utilisation and products of dipterocraps;
c. To identify new directions and strategies for sustainable management of dipetrocarps.
d. To identify opportunities to develop collaboration among researchers and to strengthen the networking among them.

ENQUIRIES

The Secretariat
The 7th Round Table Conference on Dipetrocarps
APAFRI Secretariat
c/o Forest Research Institute Malaysia
Kepong
52109 Kuala Lumpur
Malaysia
(Attn: Dr Baskaran Krisnapillay / Mr Alias Abdul Jalil)
Tel : 60-3 6272 2516, 60-3 6277 3207
Fax : 60-3 6277 3249
E-mail : dipconf@apafri.upm.edu.my

Website :www.apafri.upm.edu.my

REGISTRATION FORM

Registration Form is available at the website at :
http:/www.apafri.upm.edu.my

You may online registrar.

The Seventh Round Table Conference on Dipterocarps

Seed Pathogens of *Dipterocarpus retusus* and Strategies for Their Management

A.N. Singh, T.R. Borah and G. S. Sarma
Rain Forest Research Institute, PB. 136, Deovan, Jorhat-1, Assam, India

Introduction

The main source of propagules in regeneration of forests and plantations is the seed and availability of good quality seed is of paramount importance. Tree seed is vulnerable to attack by various microorganisms (Mittal et al., 1990; Mehrotra and Mehrotra, 2000). The fungi are the most important group of organisms responsible for seed deterioration, loss of viability and diseases in nurseries. Various micro fungi may contaminate the seeds, while on tree, ground, transit, storage and during or after seed sowing (Mohanan and Sharma, 1991). Fungi may be classified as seed borne or seed transmitted according to the general terminology of pathogens. Seed borne fungi include all fungal types contaminating the seed surface or infecting its tissue. Seed transmitted fungi cause no infection of the seed itself but infect seedlings in the nursery or field (Neergaard, 1979). General management strategies for minimizing the fungal infestation during seed handling and storage have been outlined by Thomsen and Schmidt (1999).

Dipterocarpus retusus (Syn. *D. macrocarpus*) commonly known as Hollong is a tropical rain forest tree species in the family Dipterocarpaceae. In India, it is found in the forests of upper Assam, southeast Arunachal Pradesh and northern part of Nagaland (Champion & Seth 1968). It also occurs in Myanmar, Thailand, Vietnam, Malay Peninsula, Jawa, Bali, Lombok and Sumbwa. This is a choice species for quality plywood with higher demand in the market. A large number of fungal seed pathogens are recorded on different species of Dipterocarps (Elouard, 1998). However, there is no published record on fungal seed pathogens of this species. Although, a study on storage of the recalcitrant *D. retusus* seeds in relation to moisture content has been made very recently by Kundu (2001), yet no specific seed handling procedures is available. Due to the aforesaid reasons and the frequent upset of target seedling production imposed by seed deterioration in various nurseries of State Forest Department (Singh *et al*., 2002) and continuously decreasing seedling density in natural stand (personal communication), the present study was carried out.

Materials and Methods

Seed samples were collected from various forest areas of Assam and Arunachal Pradesh for the last three years during seed maturity period (February – April). Collection was made from forest floors and above ground by spreading out nets at a considerable height (20 feet, Figure 7). Seeds were first examined visually and sorted out in apparent damage categories incited by insects, fungi, birds and other agents. Isolation of diverse micro fungi, harboured by the Hollong seeds, were made using Potato Dextrose Agar medium. For this purpose, 100 seeds each from ground and net collection were examined. Identification was made following relevant literatures. The per cent frequency of occurrence of different fungal species was calculated by the following formula:

$$\text{Per cent frequency of occurrence} = \frac{\text{No. of seeds affected by a fungal species}}{\text{No. of total seeds examined}} \times 100$$

The seeds were dipped in different concentrations of aqueous fungicidal solutions for different durations to screen their efficacy against the seed borne pathogens. The treated seeds were sown in polybags containing untreated soil, sand and Farm Yard Manure mixture in the ratio of 1:1:1. In another experiment, untreated seeds were sown in the potting mixture amended with various organic and inorganic substances along with the different fungicides. Untreated seeds sown in untreated potting mixture served as control. The per cent seedling emergence was recorded in each treatment using the formula given below:

$$\text{Per cent seedling emergence} = \frac{\text{No. of seedling emerged}}{\text{Total no. of seeds sown}} \times 100$$

The Analysis of Variance for significance of the treatments was performed and further analyzed using Duncan's Multiple Range Test (DMRT) through SPSS Package.

Results and Discussions

Pathogen status:

The perusal of the Figure 1 & 2 indicates that the seeds of *D. retusus* are being heavily parasitised by a variety of agents like insect pests, fungal pathogens and birds. Seeds collected from forest floor yielded only 30% healthy seeds and remaining 70% seeds were found destroyed by the aforesaid agents. However, damage extent was minimized and percentage of healthy seeds increased by 15% when seeds were collected above ground using net (Figure 2). Although, the seeds may be infested by insect pest and fungal pathogens while on the tree, the deterioration is accelerated when it falls on the ground, which is the storehouse for insect and fungal inocula.

Altogether, 19 fungal species were found associated with the seeds (Table 1). These included both saprophytes and pathogens of which the dominant genera were of *Penicillium* (Figure 3 a, b), *Fusarium* (Figure 4) and *Phoma* (Figure 5 a, b, c). There were apparent differences in fungal composition of seeds both qualitative as well as quantitative, from ground and net collections. The high incidence of different fungi on *D. retusus* seeds might be due to prevailing ambient tropical temperature and relative humidity, which encourage the growth and development of these fungi (Mohanan and Sharma, 1991). Single or multiple infections by these species are responsible for quick deterioration and decay of the seeds. Species of *Fusarium*, *Pestalotia*, *Phoma* and *Rhizoctonia* encountered with seed samples in the present study, have also been recently reported as seedling pathogens of *D. retusus* causing diseases under favourable conditions (Singh *et al*., 2002).

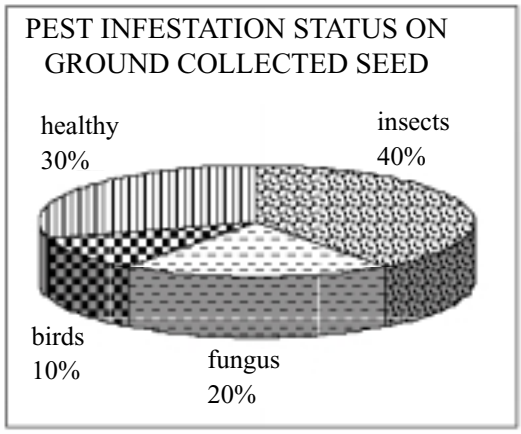

Figure 1

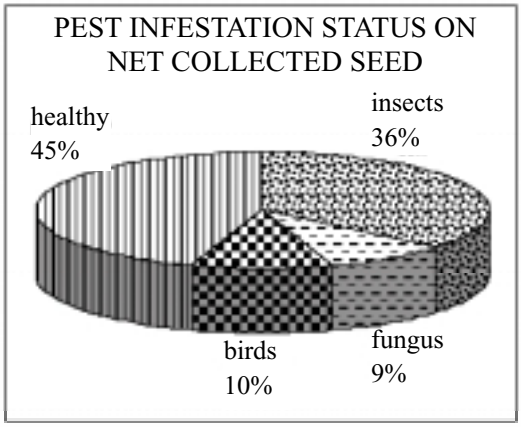

Figure 2

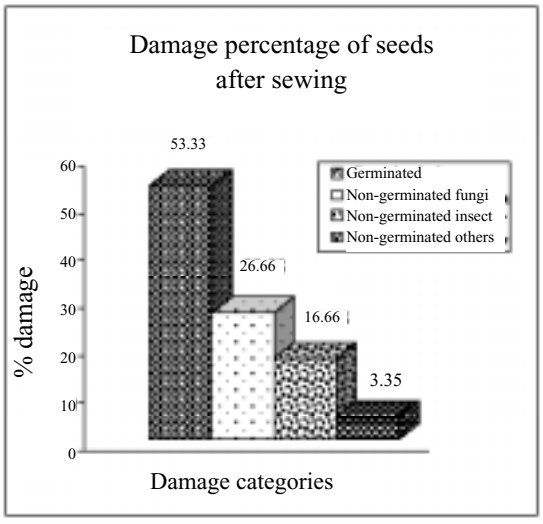

Figure 6

Figure 7

Table 1: Per cent frequency of seed borne fungi from ground and net collected seeds

SN.	Fungal species	% Frequencies	
		Ground collection	Net collection
1.	*Aspergillus niger*	15	09
2.	*Cephalosporium acremonium*	18	-
3.	*Cladosporium sphaerospermum*	06	26
4.	*Curvularia lunata*	25	46
5.	*Fusarium sp.*	50	-
6.	*Lasiodiplodia* sp.	25	32
7.	*Mucor sp.*	56	18
8.	*Mycena* sp.	10	-
9.	*Penicillium expansum*	66	71
10.	*Penicillium rubrum*	83	75
11.	*Penicillium* sp.	45	12
12.	*Periconia sp.*	-	08
13.	*Pestalotia sp.*	16	41
14.	*Phoma eupyrena*	50	-
15.	*Phoma tropica*	47	-
16.	*Phoma sp.*	60	13
17.	*Phomopsis* sp.	18	21
18.	*Rhizoctonia sp.*	27	-
19.	*Trichoderma sp.*	03	-
Total no. of fungal species		18	12

Apparent healthy seeds sown in the nursery could produce only 53.33% seedlings and a heavy loss in germination (46.67%) caused by the various agents was recorded (Figure 6). This additional loss incurred at the nursery can be attributed again to the large inocula build up from seed as well as soil. The damage at this stage, caused by fungi (26.66%) was greater than that by insects and others. The damage incited by insects and other agents were found curtailed at seed stage, while the fungal propagules in seed and soil served as primary and secondary inocula for seedling pathogens. At times failure to adopt appropriate prophylactic management strategies brings the entire seedling population under the grip of many destructive fungal diseases.

Management strategies

Keeping the damage extent in view, various prophylactic treatments of seed and potting media was tried. It is evident from the analysis of the data that some of the treatments are highly significant in enhancing the seedling emergence while others are less significant (Table 2 & 4). The highest significance value was observed in case of seeds treated with 0.2% aqueous solution of either Captan or Bavistin for 30 minutes (Table 3). Likewise, soil amendment with Bavistin + neem cake was found superior followed by Captan + neem cake, over the other treatments and control (Table 5). Bavistin and Captan are broad-spectrum fungicides that might have suppressed the growth and development of both seed and soil borne pathogens and in turn seed deterioration. However, these fungicides proved deleterious in higher concentration and longer duration probably by affecting the seed physiology adversely. Soil amendment with NPK and Humicil (Branded name for humic acid, De-Nocil Crop Protection Ltd.) alone or in combinations with the different fungicides were found ineffective. These might have encouraged pathogens build up as has been reported in some cases. An enhanced seedling emergence recorded in case of neem cake treatment may be due to its known toxicity towards insect and fungal pathogens.

Table 2.
Analysis of variance for % seedling emergence under different fungicidal treatment.

Source	Type III Sum of Squares	df	Mean Square	F	P
Treatment	4561.436	12	380.120	37.818	.000
Error	261.333	26	10.051		
Total	169208.000	39			

a R Squared = .946 (Adjusted R Squared = .921)

Table 3.
Per cent seedling emergence under different fungicidal treatments. Values marked by same line are not significantly different. (Duncans Multiple Range Test, P < 0,05, N = 3).

Treatment	Percent seedling emergence
Control	48.33
Bavistin @ 0.4% for 60 min	51.00
Bavistin @ 0.4% for 30 min	53.67
Fytolan @ 0.2 % for 60 min	59.33
Fytolan @ 0.2% for 30 min	59.67
Captan @ 0.4% for 60 min	60.00
Fytolan @ 0.4 % for 30 min	65.33
Captan @ 0.4 % for 30 min	66.67
Fytolan @ 0.2% for 30 min	68.33
Bavistin @ 0.2% for 60 min	71.00
Captan @ 0.2 % for 60 min	73.00
Captan @ 0.2% for 30 min	81.67
Bavistin @ 0.2% for 30 min	86.00

Table 4.
Analysis of variance for % seedling emergence under different soil treatments

Source	Type III Sum of Squares	df	Mean Square	F	P
Treatment	5303.026	12	441.919	31.976	.000
Error	359.333	26	13.821		
Total	156199.000	39			

a R Squared = .937 (Adjusted R Squared = .907)

Table 5.
Per cent seedling emergence under different soil treatments. Values marked by same line are not significantly different (Duncans Multiple Range Test, P < 0,05, N = 3).

Treatment	Per cent seedling emergence
Control	48.33
Fytolan + NPK	50.00
NPK @ 1 %	51.33
Humicil @ 0.1%	51.67
Fytolan + Humicil	52.33
Captan + NPK	60.67
Neem cake @ 3%	61.00
Captan (0.2 %) + Humicil (0.1 %)	62.33
Bavistin (0.2%) + Humicil	63.33
Fytolan (0.2%) + Neem cake	65.00
Bavistin + NPK	74.67
Captan + Neem cake	80.00
Bavistin + Neem cake	87.00

Conclusions and Recommendations

The intense pressure build up by a variety of pests is responsible for diminishing natural regeneration of *D. retusus*. The fungal seed pathogens are playing dominant and crucial role not only as seed deteriorating agents but also as primary and secondary incitants of the seedling diseases. By adopting suitable prophylactic measures starting from seed collection to seed sowing, the losses caused due to fungal pathogens in particular, could be minimized up to a great extent. Based on findings of the present study, following are the recommendations for prevention of fungal seed infestation and deterioration:

1. Weekly collection of seeds using net (above ground, Figure 7) is a better proposition than ground collection.
2. Seed treatment with 0.2% aqueous Bavistin or Captan solution for 30 minutes just after collection. The seeds should be sown immediately after treatment to avoid desiccatio as the seeds are of recalcitrant nature.
3. Amendment of growing media with 3% neem cake.
4. Drenching the growing media with 0.2% Bavistin or Captan.
5. The combination of neem cake and Bavistin or Captan is more effective.

Acknowledgement

Authors are thankful to the Director, RFRI, Jorhat for necessary help during the study.

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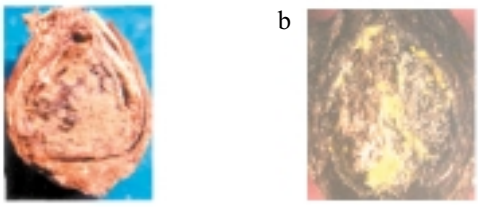

Figure 3. Seed deteriorated by
(a) *Penecillium rubrum* and
(b) *P. expansum*

Figure 4. Damage to seed due to *Fusarium sp.*

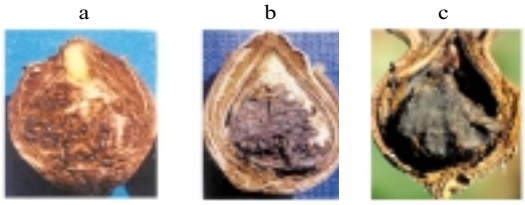

Figure 5. Seed deteriorated by
(a) *Phoma tropica*
(b) *P. eupyrena* and
(c) *Phoma sp.*

Use of Essential Oils as Seed Treatment

Vibeke Leth, Danish government Institute of Seed Pathology for Developing Countries (DGISP).

Pollution problems in the environment, and toxic effect from synthetic chemicals on non-target organisms have prompted investigations on exploiting pesticides of plant origin. Natural plant products and their analogues are an important source of new agricultural chemicals against insect pest, plant diseases, storage fungi, sapstain fungi, weeds, nematodes and as bird repellents[1,2,3,4,5,6,7,10]. These socalled "New Age Agricultural Products" could also be of great importance for small farmers in the developing part of the world where pesticides of local plant origin would be readily available compared to chemical pesticides which are scarce and too expensive for resource poor farmers.

Recent studies have shown that especially vapour extracted essential oils (EOs) of many different tropical and temperate plant species are highly potent biocides that in very low concentrations can control or kill fungi and/or bacteria by at least the same efficiency as syntetic anti-microbial compounds[1,8,9,10] and as such they can be applied as surface disinfectants or fumigants[4,13].

Essential oils contains specific compositions of volatile substances with monoterpenes as the major constituents of EOs from plants. The most bioactive oils have been found to contain high levels of oxygenated monoterpenes [2,10,11] and differences in anti microbial properties of essential oils from different clones of a specific plant species have shown to be related to variation in their chemical composition of the monoterpenes[2].

Essential oils are known to be a part of the allelopathic system in many plants. Especially aromatic plants are known selectively to influence the pattern of vegetation in the areas around them through inhibition of germination or seedling growth of plants belonging to other species or of own offspring[12]. This selectivity is also found when investigating the activity against fungi and bacteria. At DGISP recent studies carried out on seed-borne fungi have revealed an even higher degree of EO-specificity as isolates of the same fungal species are more or less sensitive when exposed to a specific EO[14,15].

At DGISP we are currently investigating the possibilities of applying EOs as seed treatment against seed-borne fungi and storage fungi of tropical crops. Our results so far from in vitro studies and growing on experiments under controlled conditions are so far very promising[14,15]. The schism that the EO can affect seed germination negatively as well as control harmful seed-borne fungi has been solved by identifying the right concentration of the EO. In our experiments we have seen that rice seeds are relatively sensitive to EOs from different herbs but choosing a suitable low concentration which in turn controls some of the most important seed-borne fungal rice pathogens the EOs can stimulate the germination and seedling growth. Whether these results hold under field conditions has to be seen when we have evaluated the first field experiments carried out this summer in Cameroon.

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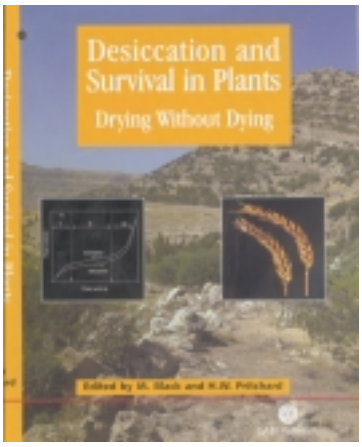

NEW BOOK

Desiccation and Survival in Plants: Drying without Dying

M Black, King's College, University of London, and H W Pritchard,
Royal Botanic Gardens Kew, UK

Publication Date: May 2002
Number of Pages: 416 Pages
Binding: Hardback
ISBN: 0851995349
Price: £75.00 (US$140.00)
NB! Discount for members of the International Society for Seed Science

Readership: Researchers, scientists and educators working in the field of seed science and plant physiology, also biological, agricultural, horticultural and ecological sciences.

Key Features

Covers main themes of desiccation and survival in plant life, including: ethodologies used for studying these phenomena, molecular, biochemical, physiological, biophysical and ecological bases of desiccation damage, repair and tolerance of desiccation.

Includes aspects of survival after desiccation in plants, i.e. seeds, pollens, spores and vegetative tissues. Written by leading international authors in the field.

In the past twenty years there has been a revolution in plant sciences, as new methods of molecular biology and biophysics have been applied to investigate environmental stress, particularly desiccation tolerance. Today, there is a good level of understanding of how plant cells cope with extreme water stress. This book is divided into four sections, dealing with 1) the technical background to desiccation tolerance studies; 2) the frequency and levels of dehydration stress tolerance in biological systems; 3) mechanisms of damage and tolerance, and 4) a brief prospect and retrospect. It covers orthodox and recalcitrant seeds, pollen and spores, vegetative parts, and other plant tissues.

Part I: Introduction

Drying without dying, *P Alpert and M J Oliver*

Part II: Methodology

Methods for study of water relations under desiccation stress, *W K Sun*

Experimental aspects of drying and recovery, *N W Pammenter, P Berjak, J Wesley-Smith and C Vander Willigen*

Biochemical and biophysical methods for quantifying desiccation phenomena in seeds and vegetative tissues, *O Leprince and E Golovina*

Part III: Biology of dehydration

Desiccation sensitivity in orthodox and recalcitrant seeds in relation to development, *A Kermode and B E Finch-Savage*

Pollen and spores: Desiccation tolerance in pollen and the spores of lower plants and fungi, *F A Hoekstra*

Vegetative tissues: Bryophytes, vascular resurrection plants and vegetative propagules, *M C F Proctor and V C Pence*

Ecological, taxonomic and phylogenetic aspects of desiccation tolerance in seeds and other plant tissues, *J Dickie and H Pritchard*

Part IV: Mechanisms of damage and tolerance

Desiccation stress and damage, *C Walters, J M Farrant, N W Pammenter and P Berjak*

Biochemistry and biophysics of tolerance systems, *J Buitink, F A Hoekstra and O Leprince*

Molecular genetics of desiccation and tolerant systems, *J Phillips, M J Oliver and D Bartels*

Rehydration of dried systems: Membranes and the nuclear genome, *D J Osborne, I Boubriak and O Leprince*

Part V: Retrospect and prospect

Damage and tolerance in retrospect and prospect, *M Black, H Pritchard and R Obendorf*

Preliminary Results

Anadenanthera colubrina

Collecting partner	Edilberto Rojas Espinoza Centro de Semillas Forestales BASFOR Avenida Atahuallpa Final 5453, Cochabamba Bolivia
Replicating partner	Jaime Magne Carrera Ingenieria Forestal Universidad Gabriel Rene Moreno Santa Cruz Bolivia
Collection date	July 9th 2001
Seed source	Tin Tin, Mizque, Cochabamba
Initial trials (BASFOR)	
Fruit weight ± SD	7.23 ± 2.3 gr.
Fruit size (length/width) ± SD	18 ± 3.3 cm. / 2.1 ± 0.2 cm.
Seed weight ± SD	0.27 ± 0.7 gr.
Seed diameter ± SD	1.66 ± 0.15 cm
Mc before processing	41.3
Mc after processing	38.2
Initial germination	**98%**

Desiccation trial (BASFOR)						
Mc after desiccation (%)	35.8	33.2	26.4	22.8	12.9	6.7
Germination (%)	**97**	**96**	**97**	**97**	**98**	**98**

Storage trial (BASFOR)					
Mc before storage (%)	38.2	12.8	10.2	7.1	4.3
Germination before storage (%)	**98**	**97**	**97**	**97**	**98**
Mc after 3 months storage at 18°C (%)	40.9	13.1	11.8	8.4	5.8
Germination (%)	**0**	**92**	**94**	**97**	**89**
Mc after 3 months storage at 4°C (%)	40.2	13.2	11.3	7.9	5.1
Germination (%)	**0**	**94**	**95**	**99**	**98**
Mc after 3 months storage at -20°C (%)	40.8	13.5	11.1	8.7	5.8
Germination (%)	**0**	**95**	**92**	**95**	**85**
Mc after 6 months storage at 18°C (%)	41.2	13.3	12.0	8.7	5.9
Germination (%)	**0**	**90**	**92**	**95**	**86**
Mc after 6 months storage at 4°C (%)	40.4	13.4	12.4	8.2	5.2
Germination (%)	**0**	**90**	**95**	**98**	**95**
Mc after 6 months storage at -20°C (%)	41.0	14.2	11.9	9.0	5.9
Germination (%)	**0**	**89**	**88**	**91**	**81**
Mc after 9 months storage at 18°C (%)	41.5	13.7	12.2	8.9	6.1
Germination (%)	**0**	**85**	**90**	**91**	**82**
Mc after 9 months storage at 4°C (%)	40.7	13.8	12.8	8.3	5.6
Germination (%)	**0**	**84**	**90**	**95**	**85**
Mc after 9 months storage at -20°C (%)	41.7	14.3	12.4	9.3	6.2
Germination (%)	**0**	**87**	**86**	**78**	**77**

/cont .....

Mc after 11 months storage at 18°C (%)	41.5	13.9	12.3	9.3	6.2
Germination (%)	**0**	**79**	**82**	**88**	**78**
Mc after 11 months storage at 4°C (%)	41.1	13.8	12.9	8.4	5.9
Germination (%)	**0**	**81**	**84**	**90**	**81**
Mc after 11 months storage at -20°C (%)	41.9	14.5	12.9	9.4	6.3
Germination (%)	**0**	**78**	**81**	**76**	**76**

Comments and conclusions

Seed of *Anadenanthera colubrina* shows orthodox storage behaviour. Seed that was desiccated down to 4.3% mc germinated 99%. After 11 months of storage the seed still retained high viability at all temperatures. These results support the observations made during the trials carried out the previous year.

Astronium graveolens

Collecting partner	William Vasquez CATIE 7170 Turrialba Costa Rica		
Replicating partner	Danida Forest Seed Centre Krogerupvej 21, 3050 Humlebaek Denmark		
Collection date	March 2001		
Dispatch to replicating partner	24 April 2001		
Initial trials (Costa Rica)			
Mc	10%		
Initial germination	**98%**		
Initial trials (Denmark)			
Arrival date	30 May 2001		
Mc at arrival	11.8 %		
Germination	**82** ± **2.06%**		
Seed weight	0.027 g		
Desiccation trial (Denmark)			
Moisture contents after desiccation (%)	6.9 ± 0.6	9.1 ± 0.4	
Germination (%)	**85** ± **4.9**	**88** ± **6.7**	
Storage trial (Costa Rica)			
Storage at 15°C			
Mc afte 6 months of storage (%)	7.4	5.3	3.5
Germination after 6 months of storage (%)	**88** ± **3.2**	**93** ± **6.0**	**97** ± **3.8**
Storage at 5°C			
Mc after 6 months of storage (%)	8.0	4.4	4.3
Germination after 6 months of storage (%)	**81** ± **2.0**	**95** ± **2.0**	**98** ± **2.3**
Storage at –17°C			
Mc after 6 months of storage (%)	7.1	5.7	3.7
Germination after 6 months of storage (%)	**72** ± **4.6**	**81** ± **2.0**	**85** ± **3.8**

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Storage trial (Denmark)			
Mc before storage (%)	Fresh	9.1	6.9
Storage at 15°C			
Mc after 3.5 months of storage (%)	9.9	8.8	5.3
Germination after 3.5 months of storage (%)	**65.0 ± 3.5**	**63.5 ± 14.7**	**75.0 ± 3.8**
Mc after 8 months of storage (%)	11.2	8.6	6.1
Germination after 8 months of storage (%)	**44.0 ± 7.5**	**66.0 ± 4.3**	**74.0 ± 2.8**
Storage at 5°C			
Mc after 3.5 months of storage (%)	11.6	10.1	6.3
Germination after 3.5 months of storage (%)	**13.5 ± 2.5**	**58.0 ± 11.2**	**76.0 ± 8.6**
Mc after 8 months of storage (%)	20.2	8.7	6.2
Germination after 8 months of storage (%)	**8.0 ± 4.9**	**55.0 ± 7.4**	**80.0 ± 1.6**
Storage at –18°C			
Mc after 3.5 months of storage (%)	11.2	9.0	6.3
Germination after 3.5 months of storage (%)	**47.0 ± 18.5**	**61.5 ± 9.0**	**81.5 ± 9.6**
Mc after 8 months of storage (%)	10.9	9.2	7.1
Germination after 8 months of storage (%)	**16.0 ± 2.5**	**69.0 ± 6.0**	**78.0 ± 5.1**

Comments and conclusions

The seed of *Astronium graveolens* are clearly desiccation tolerant but there seems to be a certain degree of temperature sensitivity. In the Costa Rica trial there was a small decline in germination for the seed stored at -17°C even at very low mc. The results from the replication in Denmark indicated temeperature sensitivity in seed with mc above 9-10%. which is in accordance with results from the previous year.

Buchanania lanzan

Collecting partner

S.C. Naithani.
Seed Biology Lab. School of Life Sciences
Pt. Ravishankar Shukla University
Raipur – 492 010 (M.P.)
India

Collection date

April 7th 2001

Seed source

Village Bagbahera, District Mahasamund (about 85 km from Raipur)

Initial trials

Fruit weight	0.7114 ± 0.68 g				
Seed weight	0.2052 ± 0.02 g				
Seed size	0.95 ± 0.07 x 0.69 ±0.03 cm				
Mc of seed before processing (%)	17.1 ± 1.16				
Mc of seed after processing (%)	16.3 ± 0.42				
Mc (%)	Fruit	Embryo	Cotyledons	Axis	Endocarp
	62.2 ± 3.3	15.4 ± 0.6	14.0 ± 0.55	16.7 ± 0.56	10.3 ± 0.46
Initial germination (%)	**100%**				

Desiccation trial

Mc after desiccation (%)	15.6	13.4	10.6	10.0	9.2	8.3	7.1	4.1	3.8
Germination (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**93**

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Storage trial							
Mc before storage (%)	16.3	15.6	13.4	10.0	7.1	4.1	3.8
Storage at 25°C							
Mc after 10 days of storage (%)	15.1	14.3	10.9	11.3	6.0	4.1	4.3
Germination after 10 days of storage (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Mc after 30 days of storage (%)	8.2	13.6	7.2	9.1	5.1	4.3	4.1
Germination after 30 days of storage (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Mc after 90 days of storage (%)	8.5	10.2	7.7	6.7	6.0	5.3	6.5
Germination after 90 days of storage (%)	**85**	**90**	**95**	**100**	**100**	**100**	**100**
Mc after 180 days of storage (%)	6.9	7.9	6.5	7.1	7.4	7.3	5.4
Germination after 180 days of storage (%)	**75**	**95**	**80**	**100**	**100**	**100**	**95**
Mc after 280 days of storage (%)	6.2	6.8	6.1	6.3	6.4	6.1	5.6
Germination after 280 days of storage (%)	**35**	**42**	**68**	**88**	**85**	**92**	**92**
Storage at 15°C							
Mc after 10 days of storage (%)	16.1	14.0	11.0	11.2	5.8	4.1	4.2
Germination after 10 days of storage (%)	**65**	**70**	**70**	**100**	**100**	**100**	**100**
Mc after 30 days of storage (%)	15.2	13.2	10.9	9.6	5.6	4.1	4.4
Germination after 30 days of storage (%)	**55**	**50**	**60**	**100**	**100**	**100**	**100**
Mc after 90 days of storage (%)	13.5	10.3	9.4	8.6	6.1	4.4	5.1
Germination after 90 days of storage (%)	**0**	**0**	**0**	**100**	**100**	**100**	**100**
Mc after 180 days of storage (%)	9.2	9.1	8.5	8.8	6.4	6.1	5.3
Germination after 180 days of storage (%)	**0**	**0**	**0**	**78**	**100**	**100**	**100**
Mc after 280 days of storage (%)	11.4	-	-	9.4	8.1	6.5	5.2
Germination after 280 days of storage (%)	**0**	**-**	**-**	**58**	**60**	**88**	**88**
Storage at 0°C							
Mc after 10 days of storage (%)	16.1	13.9	11.8	11.8	5.5	3.8	4.5
Germination after 10 days of storage (%)	**0**	**10**	**25**	**100**	**100**	**100**	**100**
Mc after 30 days of storage (%)	16.1	13.5	11.2	9.9	6.6	3.7	4.3
Germination after 30 days of storage (%)	**0**	**0**	**0**	**100**	**100**	**100**	**100**
Mc after 90 days of storage (%)	-	-	-	9.2	6.5	4.8	4.7
Germination after 90 days of storage (%)	**-**	**-**	**-**	**100**	**100**	**100**	**100**
Mc after 180 days of storage (%)	-	-	-	8.2	8.0	5.8	5.9
Germination after 180 days of storage (%)	**-**	**-**	**-**	**100**	**100**	**100**	**100**
Mc after 280 days of storage (%)	-	-	-	9.1	8.9	6.9	4.7
Germination after 280 days of storage (%)	**-**	**-**	**-**	**65**	**78**	**90**	**85**
Storage at -20°C							
Mc after 10 days of storage (%)	15.7	13.7	10.7	10.5	5.8	4.8	3.1
Germination after 10 days of storage (%)	**0**	**0**	**10**	**100**	**100**	**100**	**100**
Mc after 30 days of storage (%)	16.3	14.2	10.5	11.5	5.7	4.8	3.4
Germination after 30 days of storage (%)	**0**	**0**	**0**	**100**	**100**	**100**	**100**
Mc after 90 days of storage (%)	-	-	-	10.4	5.7	4.4	3.7
Germination after 90 days of storage (%)	**-**	**-**	**-**	**95**	**100**	**100**	**100**
Mc after 180 days of storage (%)	-	-	-	9,5	7,6	6,7	3,9
Germination after 180 days of storage (%)	-	**-**	**-**	**82**	**100**	**100**	**100**
Mc after 280 days of storage (%)	-	-	-	9,4	9,4	8,7	6,8
Germination after 280 days of storage (%)	-	**-**	**-**	**70**	**85**	**88**	**90**

/cont .....

Comments and conclusions	*Buchanania lanzan* seeds are shed at 17.1± 1.16% moisture content. They are desiccation and chilling tolerant. The control seeds showed no loss in germinability and mc up to 48 hrs of storage. Seed desiccated to as low as 4.1 % mc even showed 100% survival. In storage trials, seeds dried to 4.1 and 3.8 showed 95-100% germination up to 180 days of storage at all storage temperatures. Storage for 280 days led to slight reduction in germinability i.e. 85-92%. Hydrated seeds [16.3, 15.6, 13.4%mc] could not tolerate chilling temperature but storage of these seeds at 25^{0}C showed germination in the range of 35-68% after 280 days of storage. Further drying to 10 and 7.1% mc improve chilling tolerance in terms of germinability and longevity. These seeds exhibit 95-100% survival up to 90 days at all storage temperatures with gradual loss in germinability [58-88%] on 280 days of storage.

Diospyros melanoxylon

Collecting partner	S.C. Naithani. Seed Biology Lab. School of Life Sciences Pt. Ravishankar Shukla University Raipur – 492 010 (M.P.) India								
Collection date	March 5th 2001								
Seed source	Tehsil Bagbehara & Pithora								
Initial trials									
Fruit weight	28 ± 3.1 g								
Seed weight	1.30 ± 2.6 g								
Seed size	2.0 x 1.1 cm								
	Fruit			Axis			Cotyledons		
Mc (%)	58.0 ± 2.7			53.6 ± 2.4			36.3 ± 0.5		
Mc before processing (%)	38.4 ± 1.0								
Mc after processing (%)	38.0 ± 1.0								
Initial germination (%)	**93%**								
Desiccation trial									
Mc after desiccation (%)	37.2	30.7	21.8	17.8	15.3	10.6	6.9	4.4	4.2
Germination (%)	**97**	**97**	**97**	**97**	**93**	**97**	**100**	**100**	**100**
Storage trial									
Mc before storage (%)	37.2	27.3	21.8	17.8	15.3	10.5	6.9	4.5	
Storage at 25°C									
Mc after 5 days of storage (%)	36.7	26.8	23.0	19.8	17.2	12.1	6.9	3.8	
Germination after 5 days of storage(%)	**97**	**97**	**100**	**97**	**93**	**95**	**100**	**100**	
Mc after 20 days of storage (%)	35.3	24.8	20.5	18.3	15.8	10.8	6.5	3.6	
Germination after 20 days of storage %)	**97**	**97**	**97**	**97**	**90**	**95**	**95**	**90**	
Mc after 60 days of storage (%)	31.3	20.5	18.4	16.3	15.8	10.4	6.5	3.4	
Germination after 60 days of storage (%)	**95**	**95**	**95**	**95**	**9**	**95**	**95**	**85**	
Mc after 150 days of storage (%)	25.7	17.3	15.2	13.8	9.6	9.8	8.7	3.3	
Germination after 150 days of storage (%)	**60**	**10**	**50**	**75**	**100**	**90**	**95**	**85**	
Mc after 250 days of storage (%)	21.9	14.2	13.4	11.7	8.5	8.4	7.1	3.7	
Germination after 250 days of storage (%)	**0**	**0**	**0**	**25**	**65**	**83**	**94**	**88**	

/cont .....

Storage at 15°C								
Mc after 5 days of storage (%)	37.5	27.8	21.2	20.3	17.5	12.4	7.1	3.6
Germination after 5 days of storage (%)	90	97	100	95	93	100	100	100
Mc after 20 days of storage (%)	35.6	26.0	21.5	19.4	15.4	11.0	6.9	3.1
Germination after 20 days of storage (%)	**90**	**97**	**93**	**95**	**93**	**100**	**100**	**100**
Mc after 60 days of storage (%)	35.7	25.3	21.4	19.8	15.0	10.9	6.9	3.0
Germination after 60 days of storage (%)	**80**	**90**	**95**	**95**	**90**	**100**	**100**	**100**
Mc after 150 days of storage (%)	32.2	26.5	21.2	18.5	17.2	11.3	6.4	3.9
Germination after 150 days of storage (%)	**80**	**90**	**85**	**90**	**100**	**95**	**90**	**90**
Mc after 250 days of storage (%)	34.1	25.7	23.2	20.4	21.7	12.2	5.9	4.1
Germination after 250 days of storage (%)	**42**	**50**	**50**	**70**	**80**	**81**	**88**	**85**
Storage at 0°C								
Mc after 5 days of storage (%)	35.7	27.7	22.3	21.1	17.0	12.1	6.9	4.2
Germination after 5 days of storage (%)	**0**	**0**	**13**	**23**	**77**	**100**	**100**	**100**
Mc after 20 days of storage (%)	32.3	25.7	21.6	21.4	16.0	12.1	6.8	4.1
Germination after 20 days of storage (%)	**0**	**0**	**10**	**10**	**23**	**97**	**100**	**100**
Mc after 60 days of storage (%)	-	-	-	-	16.0	10.7	6.5	3.8
Germination after 60 days of storage (%)	**-**	**-**	**-**	**-**	**10**	**95**	**100**	**100**
Mc after 150 days of storage (%)	-	-	-	-	21.5	11.7	6.4	2.4
Germination after 150 days of storage (%)	**-**	**-**	**-**	**-**	**10**	**90**	**90**	**95**
Mc after 250 days of storage (%)	-	-	-	-	19.7	11.1	7.1	4.2
Germination after 250 days of storage (%)	**-**	**-**	**-**	**-**	**0**	**78**	**80**	**95**
Storage at -20°C								
Mc after 5 days of storage (%)	38.1	28.1	21.2	19.9	17.5	12.8	7.0	3.8
Germination after 5 days of storage (%)	**0**	**0**	**7**	**23**	**47**	**100**	**100**	**100**
Mc after 20 days of storage (%)	33.7	25.0	20.3	19.2	16.5	11.7	6.4	3.6
Germination after 20 days of storage (%)	**0**	**0**	**0**	**7**	**10**	**97**	**100**	**100**
Mc after 60 days of storage (%)	-	-	-	-	15.4	11.6	6.9	3.6
Germination after 60 days of storage (%)	**-**	**-**	**-**	**-**	**5**	**95**	**90**	**100**
Mc after 150 days of storage (%)	-	-	-	-	22.5	11.7	6.1	5.0
Germination after 150 days of storage (%)	**-**	**-**	**-**	**-**	**0**	**90**	**95**	**85**
Mc after 250 days of storage (%)	-	-	-	-	-	10.2	6.8	5.9
Germination after 250 days of storage (%)	**-**	**-**	**-**	**-**	**-**	**72**	**91**	**89**

Comments and conclusions

Diospyros melanoxylon seeds, which are shed at 38.4 ± 1.0 % mc, are desiccation and chilling tolerant. Seeds desiccated to 30.7, 21.8, 17.8, 15.3, 10.6, 6.9, and 4.4 and 4.2 % mc showed 100% viability. In storage trials, seeds with 37.2 and 27.3% could not tolerate chilling temperatures [0 and -20^{0}C] but further desiccation to 21.8 ± 1.3 and 17.8 ± 0.4 % showed gradual increase in survival [7-23 %] for 20 days. Seeds dried to 30.7, 27.3, 21.8, 17.8 and 15.3 were storable at 15 and 25^{0}C for 150-240 days although gradual loss in viability was observed. They exhibited substantial loss after 250 days of storage. Seeds desiccated to 6.9, and 4.5 % mc demonstrated highest rate of survival, with 85-95 % germination, at all storage temperatures up to 250 days of storage.

Gmelina arborea

Collecting partner	S.C. Naithani. Seed Biology Lab. School of Life Sciences Pt. Ravishankar Shukla University Raipur – 492 010 (M.P.) India
Collection date	May 4th 2001
Seed source	Village Kusumi, District Durg

Initial trials

Fruit weight	9.76 ± 2.52 g				
Seed weight	0.97 ± 0.17 g				
	Whole fruit	Endocarp	Seed*	Cotyledons	Axis	Seed coat
Mc (%)	75.03 ± 1.0	27.87 ± 1.29	24.45 ± 1.82	18.48 ± 2.97	28.79 ± 0.81	11.77 ± 1.67
Mc before processing (%)	27.82 ± 1.76					
Mc after processing (%)	26.7 ± 2.33					
Initial germination (%)	**60%**					

Desiccation trial I	depulped fruits i.e. seed + endocarp									
Mc after desiccation (%)	27.3	23.0	17.0	11.9	8.1	6.3	4.3	4.1	3.4	2.7
Germination (%)	**60**	**65**	**72**	**86**	**90**	**96**	**100**	**100**	**100**	**96**
Desiccation trial II	extracted seeds (- endocarp)									
Mc after desiccation (%)	27.3	23.0	17.0	11.9	8.1	6.3	4.3	4.1	3.4	2.7
Germination (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**95**

Storage trial

Mc after 5 days of storage (%)	23.3	16.2	10.9	6.3	4.0	2.1
Germination after 5 days of storage (%)	**100**	**100**	**100**	**100**	**100**	**85**
Mc after 20 days of storage (%)	19.5	14.9	8.4	5.7	4.1	2.9
Germination after 20 days of storage (%)	**90**	**100**	**100**	**100**	**100**	**95**
Mc after 60 days of storage (%)	17.0	12.0	8.9	6.5	4.6	3.7
Germination after 60 days of storage (%)	**80**	**90**	**100**	**100**	**100**	**78**
Mc after 90 days of storage (%)	15.3	11.2	8.9	7.0	5.8	5.7
Germination after 90 days of storage (%)	**62**	**86**	**100**	**100**	**75**	**88**
Mc after 150 days of storage (%)	11.2	10.0	9.3	7.1	6.6	6.6
Germination after 150 days of storage (%)	**35**	**72**	**80**	**78**	**55**	**65**
Mc after 200 days of storage (%)	10.0	9.7	8.6	7.8	7.3	7.1
Germination after 200 days of storage (%)	**10**	**54**	**70**	**65**	**65**	**44**
Mc after 270 days of storage (%)	10.3	9.9	8.9	7.8	7.2	7.0
Germination after 270 days of storage (%)	**0**	**20**	**60**	**45**	**45**	**22**

Storage at 15°C

Mc after 5 days of storage (%)	24.0	18.9	10.8	6.8	4.0	1.5
Germination after 5 days of storage (%)	**100**	**75**	**100**	**100**	**100**	**100**
Mc after 20 days of storage (%)	22.8	14.0	10.8	6.9	3.8	1.8
Germination after 20 days of storage (%)	**50**	**65**	**100**	**100**	**100**	**85**
Mc after 60 days of storage (%)	21.0	15.2	10.7	6.5	5.2	2.9
Germination after 60 days of storage (%)	**40**	**45**	**100**	**100**	**100**	**88**

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Mc after 90 days of storage (%)	20.3	14.8	14.6	7.2	3.6	2.1
Germination after 90 days of storage (%)	**20**	**35**	**70**	**95**	**90**	**75**
Mc after 150 days of storage (%)	18.1	13.3	10.8	7.3	5.1	4.4
Germination after 150 days of storage (%)	**15**	**40**	**70**	**80**	**95**	**70**
Mc after 200 days of storage (%)	20.0	13.9	10.7	8.4	6.6	5.2
Germination after 200 days of storage (%)	**0**	**10**	**65**	**70**	**78**	**52**
Mc after 270 days of storage (%)	17.9	13.2	10.5	7.9	6.3	5.7
Germination after 270 days of storage (%)	**0**	**0**	**50**	**25**	**72**	**25**
Storage at 0°C						
Mc after 5 days of storage (%)	25.2	17.9	10.6	6.3	3.7	1.4
Germination after 5 days of storage (%)	**40**	**60**	**70**	**100**	**100**	**100**
Mc after 20 days of storage (%)	24.2	13.1	10.9	6.2	3.9	1.4
Germination after 20 days of storage (%)	**0**	**65**	**60**	**100**	**100**	**100**
Mc after 60 days of storage (%)	21.0	14.3	11.8	8.2	4.9	1.9
Germination after 60 days of storage (%)	**0**	**30**	**85**	**94**	**100**	**90**
Mc after 90 days of storage (%)	-	15.5	12.7	7.0	4.6	2.4
Germination after 90 days of storage (%)	**-**	**0**	**75**	**78**	**95**	**85**
Mc after 150 days of storage (%)	-	15.9	12.8	7.4	6.0	3.8
Germination after 150 days of storage (%)	**-**	**0**	**45**	**60**	**90**	**95**
Mc after 200 days of storage (%)	-	-	14.1	9.0	7.9	5.8
Germination after 200 days of storage (%)	**-**	**-**	**10**	**65**	**85**	**60**
Mc after 270 days of storage (%)	-	-	14.6	9.3	8.9	7.2
Germination after 270 days of storage (%)	**-**	**-**	**0**	**50**	**90**	**65**
Storage at -20°C						
Mc after 5 days of storage (%)	22.4	17.7	11.5	6.9	3.8	1.8
Germination after 5 days of storage (%)	**0**	**20**	**60**	**100**	**100**	**100**
Mc after 20 days of storage (%)	24.6	16.0	11.6	6.6	3.7	1.5
Germination after 20 days of storage (%)	**0**	**25**	**65**	**100**	**100**	**98**
Mc after 60 days of storage (%)	24.4	17.7	11.9	7.0	4.2	2.1
Germination after 60 days of storage (%)	**0**	**15**	**70**	**100**	**100**	**90**
Mc after 90 days of storage (%)	-	21.6	11.5	6.4	3.6	1.2
Germination after 90 days of storage (%)	**-**	**0**	**50**	**100**	**90**	**80**
Mc after 150 days of storage (%)	-	19.8	11.7	7.4	4.5	2.8
Germination after 150 days of storage (%)	**-**	**0**	**30**	**85**	**80**	**68**

Comments and conclusions

Gmelina arborea seeds are shed at 27.82 ± 1.76% moisture content. The seeds are desiccation tolerant. The desiccated seeds tolerate low temps. [-20, 0 and 15°C] as well. Seeds dehydrated to 3.9 ± 0.1% mc exhibited highest survival [72-95%] at –20, 0,15°C after 270 days of storage. The survival rate was reduced to 40-65% in seeds desiccated to 5.9 ± 0.6 % or 1.9 ± 0.2 % mc only at –20, 0°C. In general the seeds with 26.0 %, 18.5 % could not survive chilling temperatures [–20, 0°C] and became non-viable within 90 days of storage. Dehydration of seeds to 26.0, 18.5 and 12.4 % mc showed correspondingly increased survival at 15 and 25°C.

* only here is *seed* the actual seed, in all other places *seed* refers to the pyrene (seed + stony endocarp)

Hancornia speciosa (2000 – collection)

Collecting partner	Antonieta Nassif Salomão. CENARGEN, S.A.I.N. Parc Rural C.P. C.P. 02372. CEP 70770 Brasilia DF, Brazil
Replicating partner	William Vasquez Banco de Semillas Forestales, CATIE, 7170 Turrialba, Costa Rica
Collection date	November 2000
Seed source	Veredas Farm, Planaltina de Goiás Municipality, State of Goiás (seedlot 1) BW 4517 (voucher), State of Goiás (seedlot 2)

Initial trials – (Brazil)

Mc before processing	64.5 ± 1.4
Mc after processing	55.3 ± 3.3
Initial germination (%)	**83%**

Desiccation trial (Brazil)

Seedlot 1							
Mc (%) after desiccation	45.6	45.4	44.9	46.2	17.5	9.9	8.7
Germination (%) after desiccation	**92**	**83**	**86**	**90**	**55**	**2**	**0**
Seedlot 2							
Mc (%) after desiccation	38.3	36.0	31.4	33.9	7.8	6.2	6.3
Germination (%) after desiccation	**87**	**83**	**85**	**70**	**41**	**0**	**0**

Storage trial – (Brazil)

Mc before storage (%)	55.3	46.6	42.2
Germination before storage (%)	**83**	**89**	**91**
Storage at room temperature (25 ± 2°C)			
Mc after 1 month of storage (%)	41.6	29.5	30.9
Germination after 1 month of storage (%)	**83**	**77**	**32**
Mc after 3 months of storage (%)	35.7	26.7	31.3
Germination after 3 months of storage (%)	**53**	**45**	**75**
Mc after 6 months of storage (%)	10.2	16.5	8.9
Germination after 6 months of storage (%)	**0**	**0**	**0**
Storage at 20°C			
Mc after 1 month of storage (%)	41.9	37.2	32.5
Germination after 1 month of storage (%)	**44**	**70**	**88**
Mc after 3 months of storage (%)	44.1	40.2	35.1
Germination after 3 months of storage (%)	**67**	**76**	**48**
Mc after 6 months of storage (%)	-	30.9	42.3
Germination after 6 months of storage (%)	**0**	**49**	**63**

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Storage at 15°C			
Mc after 1 month of storage (%)	48.6	39.2	33.9
Germination after 1 month of storage (%)	**70**	**84**	**81**
Mc after 3 months of storage (%)	45.3	41.1	35.8
Germination after3 months of storage (%)	**54**	**82**	**61**
Mc after 6 months of storage (%)	-	45.9	31.5
Germination after 6 months of storage (%)	**0**	**57**	**4**

Storage trial – (Costa Rica)

Mc before storage (%)	46.4	40.0
Germination before storage (%)	**74 ± 5.2**	**21 ± 2.0**
Storage at room temperature		
Mc after 1 month of storage (%)	42	32.8
Germination after 1 month of storage (%)	**54 ± 10**	**63 ± 3.8**
Mc after 3 months of storage (%)	41.1	30.2
Germination after 3 months of storage (%)	**47 ± 8.2**	**23 ± 3.8**
Mc after 9 months of storage (%)	-	-
Germination after 9 months of storage (%)	-	-
Storage at 15°C		
Mc after 1 month of storage (%)	39.4	31.2
Germination after 1 month of storage (%)	**52 ± 4.6**	**41 ± 2.0**
Mc after 3 months of storage (%)	38.4	30.4
Germination after 3 months of storage (%)	**51 ± 2.0**	**30 ± 7.7**
Mc after 9 months of storage (%)	-	-
Germination after 9 months of storage (%)	-	-
Storage at 5°C		
Mc after 1 month of storage (%)	39.1	27.9
Germination after 1 month of storage (%)	**26 ± 4.0**	**15 ± 6.0**
Mc after 3 months of storage (%)	38.7	27.9
Germination after 3 months of storage (%)	**39 ± 10.8**	**24 ± 5.7**
Mc after 9 months of storage (%)	-	-
Germination after 9 months of storage (%)	-	-

Comments and conclusions

The results above are from the third trial performed on this species. The first two desiccation trials showed a cririca moisture content around 30% which is confirmed by this report. The results from the previous trials were inconclusive but with this report it can be concluded that the seed of *Hancornia speciosa* can be stored for up to 3 months and that the optimal mc for storage is 35-40%. The results from Costa Rica show that storage temperature should be above 5°C.

Illicium verum

Collecting partner	Le Dinh Kha and Nguyen Huy Son Research Centre for Forest Tree Improvement (RCFTI) Chem, Tuilem, Hanoi. Vietnam. Brian Gunn and Chris Doran Australia Tree Seed Centre (ATSC)
Replicating partner	CSIRO, Forestry and Forest Products P.O.Box E4008, Kingston. Canberra Australia
Collection date	November 2000
Seed source	Tan Doan Commune, Van Quan District, Lang Son Province

Initial trials (Vietnam)

Seed weight	0.09 g
Mc after processing (%)	39.1 ± 1.04
Initial germination (%)	**38.5 ± 2.8**

Storage trial (Vietnam)

Mc before storage (%)	39.0	36.0	30.9	23.7	16.3	7.2	6.7
Storage at ambient temperature							
Mc after 1 month of storage (%)	35.1	32.2	30.8	25.5	18.0	9.1	5.6
Germination after 1 month of storage (%)	**0**	**4.5 ± 1.3**	**5.8 ± 4.3**	**19.0 ± 2.5**	**37.3 ± 5.1**	0	0
Mc after 3 months of storage (%)	39.8	32.2	31.4	27.1	16.2	8.9	7.1
Germination after 3 months of storage (%)	**0**	**0**	**0.8 ± 1.5**	**3.0 ± 0.8**	**0**	**0**	**0**
Mc after 6 months of storage (%)	48.0	44.5	42.0	27.7	27.3	7.3	8.9
Germination after 6 months of storage (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mc after 9 months of storage (%)	56.2	39.9	42.6	31.3	26.5	9.4	7.3
Germination after 9 months of storage (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mc after 12 months of storage (%)	48.3	42.0	43.5	31.4	28.6	8.1	10.1
Germination after 12 months of storage (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Storage at 15°C							
Mc after 1 month of storage (%)	38.8	33.2	29.4	23.9	15.4	11.2	4.0
Germination after 1 month of storage (%)	**35.0± 2.8**	**46.5 ±7.4**	**56.3 ± 2.9**	**32.2 ± 2.7**	**4.3 ± 2.2**	**0**	**0**
Mc after 3 months of storage (%)	38.0	36.5	33.0	27.2	19.0	10.9	4.7
Germination after 3 months of storage (%)	**32.5± 1.5**	**40.8 ±7.5**	**67.3 ± 7.2**	**55.3 ± 9.3**	**0**	**0**	0
Mc after 6 months of storage (%)	45.4	37.9	37.4	31.4	22.8	12.2	5.0
Germination after 6 months of storage (%)	**2.0± 0.8**	**13.5 ±1.5**	**29.8± 1.7**	**15.3 ± 2.6**	**0**	**0**	**0**
Mc after 9 months of storage (%)	48.6	38.8	38.1	30.9	24.9	12.7	7.0
Germination after 9 months of storage (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mc after 12 months of storage (%)	48.3	42.4	38.3	32.1	25.9	13.5	6.0
Germination after 12 months of storage (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**

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Storage at 5°C							
Mc after 1 month of storage (%)	37.9	33.1	28.6	23.3	15.4	8.8	3.0
Germination after 1 month of storage (%)	**38.5± 4.1**	**56.5± 6.5**	**50.5 ± 5.1**	**45.3 ± 5.9**	**12.5 ± 6.7**	**0**	**0**
Mc after 3 months of storage (%)	39.4	34.6	28.5	22.8	16.3	9.3	4.9
Germination after 3 months of storage (%)	**41.7± 2.0**	**58.5± 7.1**	**41.0 ± 0.2**	**53.5 ± 2.7**	**24.8 ± 2.1**	**0**	**0**
Mc after6 months of storage (%)	37.2	33.4	-	22.1	13.2	8.6	6.4
Germination afte r6 months of storage (%)	**37.5± 1.7**	**51.3± 3.3**	**43.5 ± 0.1**	**22.8 ± 5.6**	**0**	**0**	**0**
Mc after 9 months of storage (%)	40.0	35.7	32.6	25.1	18.5	9.4	8.5
Germination after 9 months of storage (%)	**41.5± 7.0**	**40.3 ±4.0**	**35.5 ± 9.8**	**20.0 ± 4.7**	**0**	**0**	**0**
Mc after 12 months of storage (%)	40.3	34.1	30.5	25.7	15.0	10.2	8.1
Germination after 12 months of storage (%)	**38.0± 4.8**	**42.5± 8.7**	**26.8 ± 3.6**	**17.0 ± 5.6**	**0**	**0**	**0**

Comments and conclusions

The seed of *Illicium verum* is sensitive to desiccation but tolerates temperatures down to at least 5°C. Best storage was achieved at mc 30-35% and at 5°C. Under these conditions the seed will retain high viability for at least 12 months. When stored at ambient temperature the seed deteriorates quickly.

Lophira lanceolata

Collecting partner

Christiane Sylvie Yameogo/Gamene and Oblé Neya.
Centre National de Semences Forestiéres, 01 BP 2682,
Ouagadougou 01, Route de Kaya, Burkina Faso

Collection date 20-21 March 2001

Seed source Niangologo

Initial trials

Mc before processing (%) 21.41 ± 2.06

Mc after processing (%) 20.92 ± 2.80

Initial germination (%) **49%**

Desiccation trial

Mc after desiccation (%)	17.40	12.65	10.81	7.64	6.10
Germination (%)	**47**	**22**	**13**	**2**	**0**

Storage trial

Initial mc (%)	21.3	17.4	12.65	10.81	7.64	6.1
Storage at 16°C						
Mc after 3 months of storage (%)	22.93	21.21	15.62	12.52	9.81	7.41
Germination after 3 months of storage (%)	**2**	**5**	**1**	**3**	**0**	**0**
Mc after 6 months of storage (%)	22.37	18.23	16.98	13.03	9.02	6.61
Germination after 6 months of storage (%)	**2**	**0**	**0**	**0**	**0**	**0**

After 6 months of storage at 16°C all seeds were dead. No seeds survived storage at –18 or 3-5°C (results not shown).

Comments and conclusions

The results indicate that even though the critical mc is fairly low, between 12.6 and 17.4 %, the seeds do not tolerate low temperatures and viability is lost very fast.

Michelia mediocris

Collecting partner	Prof. Dr. Le Dinh Kha and Dr. Nguyen Huy Son Research Centre for Forest Tree Improvement (RCFTI) Chem, Tuilem, Hanoi, Vietnam
Collection date	October 2000
Seed source	Minh Dai commune, Thanh Son district, Phu Tho province. Vietnam

Initial trials

Seedt weight (with seed coat)	8.45 g
Seed weight (seed coat removed)	2.59 g
Initial moisture content before extraction (%)	27.1
Initial moisture content after extraction (%)	33.6
Initial germination (%)	**31.8%**

Desiccation trial

Mc after desiccation (%)	28.4	24.4	20.1	16.0	14.9	9.3
Germination (%)	**48**	**42**	**42**	**53**	**15**	**0**

Storage trial

Mc before storage (%)	33.1	28.4	24.4	20.1	16.0
Storage at ambient temperature					
Mc after 1 month of storage (%)	33.0	29.6	26.6	23.3	16.5
Germination after 1 month of storage (%)	**33**	**33**	**67**	**46**	**0**
Mc after 3 months of storage (%)	32.9	29.6	29.2	26.6	20.3
Germination after 3 months of storage (%)	**36**	**36**	**40**	**0**	**0**
Mc after 6 months of storage (%)	36.6	32.2	31.2	26.3	24.3
Germination after 6 months of storage (%)	**0**	**0**	**0**	**0**	**0**
Mc after 9 months of storage (%)	41.1	38.5	36.4	33.5	29.9
Germination after 9 months of storage (%)	**0**	**0**	**0**	**0**	**0**
Storage at 15°C					
Mc after 1 month of storage (%)	34.5	30.7	26.4	24.5	17.5
Germination after 1 month of storage (%)	-	**75**	**38**	**51**	**0**
Mc after 3 months of storage (%)	35.4	30.7	27.7	23.8	17.4
Germination after 3 months of storage (%)	**85**	**62**	**63**	**38**	**0**
Mc after 6 months of storage (%)	33.5	31.4	28.7	30.0	27.0
Germination after 6 months of storage (%)	**53**	**62**	**47**	**46**	**0**
Mc after 9 months of storage (%)	36.7	33.2	27.3	29.3	32.3
Germination after 9 months of storage (%)	**31**	**60**	**32**	**25**	**0**
Storage at 5°C					
Mc after 1 month of storage (%)	31.4	27.5	26.5	24.6	17.7
Germination after 1 month of storage (%)	**57**	**68**	**62**	**58**	**-**
Mc after 3 months of storage (%)	33.8	31.2	26.4	26.4	21.8
Germination after 3 months of storage (%)	**74**	**58**	**43**	**41**	**0**
Mc after 6 months of storage (%)	35.0	29.2	27.5	24.9	19.2
Germination after 6 months of storage (%)	**78**	**74**	**57**	**50**	**0**

/cont.....

Mc after 9 months of storage (%)	34.0	32.6	28.6	24.1	22.7
Germination after 9 months of storage (%)	**55**	**71**	**54**	**45**	**0**

Comments and conclusions

Seed of *Michelia mediocris* tolerates desiccation down to around 15% before they loose viability. However, the optimal moisture content for storage seems to be around 30% and at mc below 20% no seed survived the first three months. At 30% mc, seed retained high viability after 9 months of storage. The seed is tolerant to low temperatures, best storage was obtained at 5°C while seed stored at ambient temperature lost viability after 3 months.
Some samples showed an increase in germination during storage and it is possible the seed needs after-ripening.

Shorea macroptera

Collecting partner

Jayanthi Nadarajan and Siti Hasanah Mat Said
Forest Research Institute Malaysia (FRIM)
Kepong 52109
Kuala Lumpur
Malaysia

Collection date 3 January 2002

Seed source Pasoh Forest Reserve, Negeri Sembilan

Initial trials

Fruit weight	1.79g
Seed weight	1.43g
Initial germination	**96%**
Initial moisture content (before extraction)	56.3%
Initial moisture content (after extraction)	54%

Component	Fruit	Whole seed	Seed coat	Embryo	Storage tissue/ cotyledons
Moisture content (%)	54.3	53.9	51.4	73.1	52.7

Desiccation trial

Target moisture content(TMC; %)	35	30	25	23	20	15
Actual Moisture content (%)	34.4	29.4	26.1	23.1	18.6	13.2
Germination (%)	**84**	**80**	**56**	**50**	**34**	**26**
Moisture content of control (%)	48.3	48.5	54.2	51.8	48.6	51.1
Germination of control (%)	**92**	**92**	**94**	**92**	**88**	**90**

Storage trial

Storage duration (weeks)	2	4	6	8	10	12	14	16	18	20
Mc (%) after storage at 25°C, initial mc = 40%	40	39	36	34	28	23	18	12	9	5
Germination (%)	**86**	**80**	**76**	**70**	**66**	**58**	**32**	**20**	**0**	**0**
Mc (%) after storage at 25°C, initial mc = 35%	34	32	31	29	27	24	19	15	10	7
Germination (%)	**78**	**74**	**70**	**64**	**60**	**56**	**34**	**18**	**0**	**0**
Mc (%) after storage at 16°C, initial mc = 40%	39	38	36	33	31	28	24	21	16	11
Germination (%)	**88**	**88**	**74**	**72**	**68**	**64**	**60**	**48**	**28**	**14**

/cont .....

Mc (%) after storage at 16°C, initial mc = 35%	36	34	33	30	28	26	23	21	17	13
Germination (%)	**82**	**80**	**76**	**70**	**66**	**62**	**56**	**50**	**24**	**18**

Comments and conclusions

A rapid decline in germination was noticed when the seeds were dried down to moisture content below 23%. The critical moisture content is about 30%.
After 16 weeks of storage, germination drops below 50%. No seed were viable after 20 weeks of storage at 25 °C at both 40 and 35% moisture content. However, a small percentage of the seeds were still viable after 20 weeks of storage at 16 °C.

Syzygium guineense

Collecting partner

William Omondi
Kenya Forestry Seed Centre
P.O. Box 20412
Nairobi

Seed source

Voiare

Initial trials

	Seed	Embryo	Fruit	Pulp
Weight (g)	1.16±0,3	0.006±0.0018	6.16±1.92	5.0±1.62
Mc before processing (%)	45.7±1.7	80.4±2.2	85.4±0.52	85.4±0.52
Initial germination (%)	**92%**			

Desiccation trial

Mc after desiccation (%)	Seed	38.6±1.6	28.7±0.8	28.0±1.4	21.6±0.2	14.6±1.3	6.3±0.4
	Embryo	66.2±0.4	39.4±1.1	34.3±1.0	27.2±1.1	13.0±0.6	6.3±0.4
Germination (%)		**87**	**76**	**38**	**8**	**0**	**0**

Comments and conclusions

Syzygium guineense seeds are shed at relatively high moisture contents,in this case > 45%, and results indicate that it is at this high mc that germination is maximum. Any desiccation to lower mc levels has a direct effect on germination.

Vatica astrotricha

Collecting partner

Dr. Xiaofeng Wang
College of Biotechnology
South China Agricultural University
Guangzhou 510642
China

Collection date

August 15th 2001

Seed source

Jian Feng Ling, Ledong County, Hainan Province, China

Initial trials

Fruit weight ± SD	0.26 ± 0.09 g
Seed weight ± SD	0.12 ± 0.07 g
Initial mc(%)	55.2 ± 5.2
Initial germination (%)	**56 ± 16.3%**

/cont .....

Desiccation trial						
Mc after desiccation (%)	46.6	42.2	38.8	33.1	22.3	8.1
Germination (%)	**46**	**59**	**64**	**45**	**18**	**0**
Mc of control (%)	47.4	49.6	48.5	51.4	50.0	51.2
Germination (%) of control	**68**	**40**	**34**	**54**	**48**	**59**
Storage trial						
Mc before storage (%)	55.2	51.7	49.1			
Storage at 25°C						
Mc after 1 month of storage (%)	43.0	44.5	39.6			
Germination after 1 month of storage (%)	**62**	**69**	**69**			
Mc after 3 months of storage (%)	-	22.6	39.5			
Germination after 3 months of storage (%)	-	**1**	**14**			
Mc after 6 months of storage (%)	41.4	21.9	36.8			
Germination after 6 months of storage (%)	**0**	**0**	**0**			
Storage at 15°C						
Mc after 1 month of storage (%)	47.2	43.5	32.4			
Germination after 1 month of storage (%)	**1**	**0**	**0**			
Mc after 3 months of storage (%)	53.9	51.1	32.8			
Germination after 3 months of storage (%)	**0**	**0**	**0**			
Mc after 6 months of storage (%)	40.9	39.9	30.9			
Germination after 6 months of storage (%)	**0**	**0**	**0**			
Storage at 5°C						
Mc after 1 month of storage (%)	49.8	41.7	27.4			
Germination after 1 month of storage (%)	**2**	**1**	**0**			
Mc after 3 months of storage (%)	43.8	31.2	24.7			
Germination after 3 months of storage (%)	**1**	**0**	**0**			
Mc after 6 months of storage (%)	38.1	29.4	22.7			
Germination after 6 months of storage (%)	**0**	**0**	**0**			

Comments and conclusions

Seeds collected seemed to be at different stages of maturity. They lost viability rapidly at moisture contents below 38.78%. Thus seeds of *Vatica astrotricha* are recalcitrant with a critical moisture content of about 39%.
Storage trial showed that 5°C and 15°C are not suitable for *Vatica astrotricha*. 25°C was better than 5°C and 15°C. After storage for 1 month at 25°C, the germination percentage of seeds at three different moisture content levels before storage did not decrease and there was little difference between them. However, after storage for 3 months at 25°C, the germination percentage decreased dramatically and the seeds with moisture content of 49.08% before storage had higher viability. After storage for 6 months at different temperatures, all seeds lost their viability.

Preliminary studies on storage behaviour of *Terminalia myriocarpa* seed

by Maitreyee Kundu* and Jonaki Kachari,
Rain Forest Research Institute, P.O. Box 136. Jorhat 785001. Assam. India
*Corresponding author

Introduction

Terminalia myriocarpa Heurck & Muell (family Combretaceae) is a large evergreen timber-yielding tree with spreading crown and pendulous branches, reaching 30-48m in height and 4-6m in girth with a clear bole of 15-18m. It is distributed in the tropical semi-evergreen and evergreen forests of eastern Himalayan region from Sikkim and northern West Bengal eastwards to Assam and Arunachal Pradesh at elevations from 300 to 1500m in India. The timber is moderately hard which finds extensive use in house-building industry and making excellent furniture. It is suitable for manufacturing plywood, railway sleepers, poles etc. and also for the production of wrapping, writing and printing purposes.

The fruit is single-seeded drupe, shining, 0.25 to 0.4 cm long, yellow, 3 cornered, the two lateral angles expanding into two short membranous wings. The panicles of small pink flowers appear in October-November and the seeding time in December to February. Seeds are collected by lopping the small branches containing the fruits. The proper time for collection of seeds is only when they turn shining yellow. One thousand seeds weigh about 2.8-3.0g with 30-32% moisture content.

The germination capacity of fresh matured seeds varies mostly due to variation in the number of empty (unfertile) seeds in a seed lot. In some areas 60-80% seeds are empty. Seeds can be stored for 2-3 months in a dry well-ventilated shed (Troup, 1921). Bahuguna *et al* (1987) reported desiccation sensitivity of the seeds. Hermetic storage of seeds at 66.6% moisture content lost viability within 3 months, though aerated storage at 5°C seeds were viable for six months.

Material and methods

Freshly mature fruits/seeds were collected from Arunachal Pradesh, India, in the month of January. Seeds were then separated manually from the branches and twigs and surface dried for overnight by spreading on the bench-top in laboratory. The seeds were then thoroughly mixed and 400 seeds were counted at random into replications of 100 seeds for determination of percentage of filled seeds by cutting test. 42±5% of seeds contained sound embryo. Before the desiccation test started, initial moisture content and viability was determined. Viability test was carried out by germination test.

Moisture content analysis was carried out on five replications of 1g of seeds each. Seeds were dried in an oven for 17 hrs. at 103°C and moisture contents were expressed on fresh weight basis. The initial moisture content of seeds was 32.6±1.4%.

The seeds were sown for germination (four replication of 100 seeds each) on moist paper at 26±2°C with 12 hrs. photoperiod. Number of seeds germinated was recorded daily and continued till 30 days after sowing. Seeds were considered to be germinated when the radicals grew to at least 1 cm. After that number of rotten, empty and good seeds were determined by cutting test.

The initial germination was 92.5±2.8% of the filled seeds and 38±6% of the total seeds, which was almost the same as observed by cutting test. Here germination capacity was expressed as the percentage of the filled seeds instead of total seeds.

Desiccation trial

Seeds were desiccated to 27.8%, 23.2%, 17.5%, 12.5%, 8.6%, 6.2% and 4.4% in a desiccator and silica was used as desiccant. Before germination, the seeds were humidified over water for 16-17 hrs. Seeds for control were placed over water in a closed box at 99% humidity. The box was opened every alternate day for aeration. The experiment was conducted at 20±2°C.

Storage trial

The seeds after collection were stored in closed airtight polybag at 6.2% and 4.4% moisture content at two temperature levels, ambient (20-30)°C and –20°C. Germination capacity was evaluated after 30 and 180 days.

Results and Conclusions

Table I shows that seeds of *Terminalia myriocarpa* are desiccation tolerant, as drying to even 4.4% moisture content had no effect on germination. Also there was no evidence of chilling sensitivity. Short-term storage (six months) resulted approximately 50% reduction of dry seeds at ambient temperature, whereas no loss of viability was observed at –20°C (table 2). Thus it can be concluded that the seeds of *Terminalia myriocarpa* are not recalcitrant, contrary to earlier reports. Further investigations may be useful for long-term storage of seeds of this species.

References

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Troup, R.S. 1921. The Silviculture of Indian Trees. Vol. 1. Claredon Press, Oxford.

Single seed

Table 1. Results of desiccation trial

Seed moisture content (%)	Germination % of desiccated seeds	Germination % of control
32.6	92.5±2.8	90.5±3.1
27.8	96.3±2.7	94.3±1.6
23.2	90.54±5.5	91.7±2.8
17.5	97.2±1.9	87.2±1.4
12.5	89.7±8.5	85.7±6.2
8.6	89.0±5.2	96.1±2.4
6.2	95.5±4.3	92.4±3.1
4.4	90.4±4.1	91.3±2.2

Table 2. Effect of different storage treatment on germination of *Terminalia myriocarpa* seeds.

Moisture content (%)	Storage temperature	Days stored		
		0	30	180
6.2%	Ambient	91.6±2.6	88.5±3.7	45.0±4.2
	-20ºC	91.6±2.6	91.0±1.9	95.5±4.5
4.4%	Ambient	91.6±2.6	90.3±3.8	54.2±2.5
	-20ºC	91.6±2.6	89.6±7.5	90.5±2.8

Fruits/seeds of *Terminalia myriocarpa*

Preliminary studies on desiccation and storage of *Symplocos racemosa* Roxb. seeds

By L.Manimuthu, V.Sivakumar*, B.Gurudev Singh, and K.Vanangamudi···
Institute of Forest Genetics and Tree Breeding,
(Indian Council of Forestry Research and Education)
P.O.Box 1061, Coimbatore – 641 002. India.
* corresponding author
··· Tamil Nadu Agricultural University, Coimbatore.

Symplocos racemosa Roxb is medium size tree belonging to the family Symplocaceae. It is found in evergreen forests of Western Ghats (Henry *et al*., 1987). It is a rare plant that grows well up to 2000 m altitude. The bark of this plant is of medicinal importance. The pinkish bark contains alkaloids viz., loturine, colloturine and loturidine. The plant and its formulations are used in diarrhoea, for wound healing and to stop haemorrhage. It is also used in skin and eye infections (Dey, 1980).

The single-seeded fruits are fleshy, subcylindrical and purplish black in colour. The seeds are brown and oval, 1.3 cm long and 0.6 mm thick. The 100 seed weight was 16.72 grams. Initial moisture content was 25.13 %.

Methodology

Mature fruits were collected during April 2001 from Silent valley, Kerala and brought to laboratory in two days. The fruit pulp was removed using water and dried in the shade before estimation of moisture content. The seed moisture content was determined by drying in an oven at 105 °C for 17 hours (ISTA, 1999). Four replications each with six seeds were used for determination of moisture content. The seed moisture content was estimated inclusive of seed coat.

Desiccation trial

While taking samples for moisture content determination, four other samples were taken at random. The fresh weight of these samples was determined. As soon as the moisture content of the seedlot was known, the four samples were dried to different target moisture contents. The target moisture contents were 25%, 20%, 15% and 10%. The target weight for drying the seeds was determined using the formula given by (DFSC, 1999). The seeds attained the target weight within 3 days. The seeds with various moisture contents were tested for their germination.

Storage trial

As soon as the samples reached the target weight, each sample was divided into four lots and stored at four temperatures viz. ambient, 20 °C, 10 °C and 0 to –5 °C. Thus at each temperature, the 25%, 20%, 15% and 10% moisture content seeds were stored. The seeds were stored in a closed container.

Germination test

Initial germination, after 10 and 20 days of storage at different moisture contents and temperatures were determined on four replications each with 25 seeds. The germination test was conducted in sand medium kept in a germination room maintained at 25 ± 2 °C and 90 ± 3% RH (ISTA, 1999). The germination was initiated after 44 days of sowing and the final count was taken 30 days after initial germination.

Results and conclusions

The seeds collected were initially having 25.13 % moisture content with 52 % germination. The seeds desiccated to 25, 20, 15, and 10 % moisture content had 42, 37, 28 and 19 % germination respectively. While, the non-desiccated seeds had 46 % germination.

The germination observed under different temperatures and moisture contents after 10 days of storage has been plotted in the graph 1. The germination percentage was found to decrease with reduction in moisture content at all storage temperatures. At the same time, storage of seeds at lower temperatures (10 °C and 0 to –5 °C) was found to improve storability even at high moisture content (25%). The germination after 20 days of storage was also observed to be similar in trend (table 1). No seed stored at ambient temperature were alive after 20 days. Storage of seeds at 0 to –5 °C with 25 % moisture content was found to improve the storability of *Symplocos racemosa* seeds.

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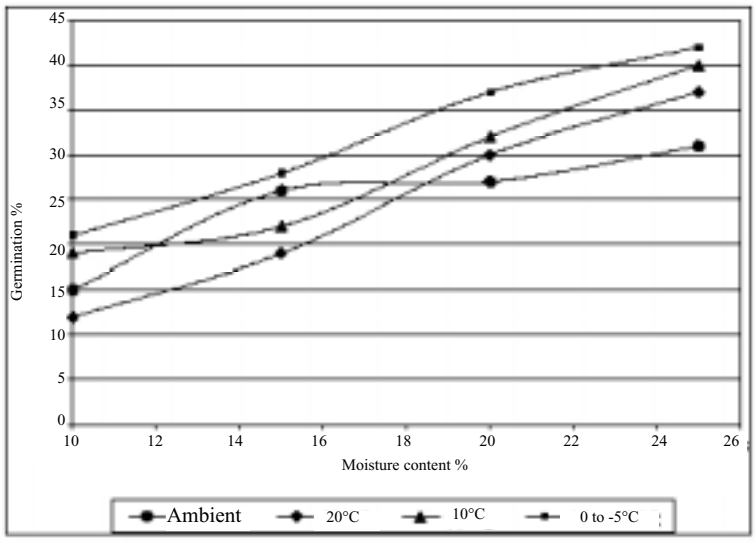
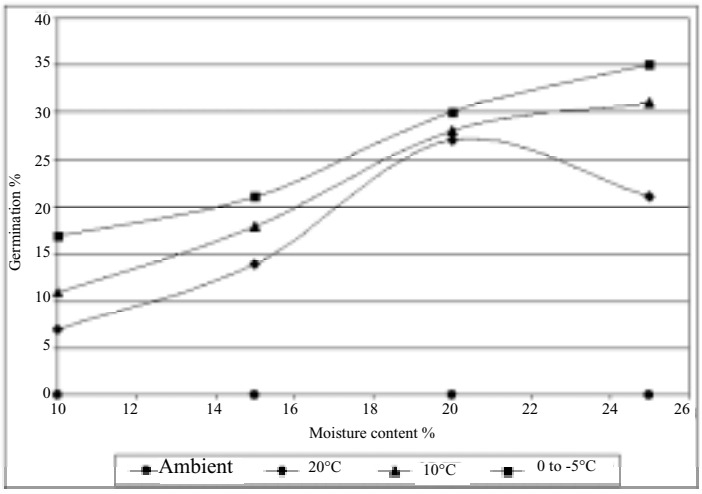
ISTA. (1999). International rules for seed testing. *Seed Science and Technology* **27**: 30-35.

Seeds of *Symplocos recemosa*
Photo: V.Sivakumar



Graph 1. Effect of storage temperature and moisture content on germination in *Symplocos racemosa* (After 10 days of storage)



Graph 2. Effect of storage temperature and moisture content on germination in *Symplocos racemosa* (After 20 days of storage)

Network Participants for the Project on Handling and Storage of Recalcitrant and Intermediate Tropical Forest Tree Seeds

Dr. Weber A.N. Amaral
IPGRI
Via delle Sette Chiese 142
00145 Rome, Italy
Phone: +39 06 6118213
Fax: +39 06 61979661
Email: w.amaral@cgiar.org
Int: www.ipgri.cgiar.org

Dr. Daniel Baskaran
Director
Forest Plantation Division
Forest Research Institute of Malaysia
Kepong
52109 Kuala Lumpur, Malaysia
Phone: +60-3-62702101
Fax: +60-3 6367753
Email: baskaran@frim.gov.my
Int: www.frim.gov.my

Professor Patricia Berjak
Department of Biology
University of Natal, Durban
Private Bag X10
Dalbridge 4014, South Africa
Phone: +27 31 260 3197/3023
Fax: (27) 31 260 1195/2029
Email: berjak@biology.und.ac.za
Int: www.nu.ac.za/nu/default.asp

Mr. Derek Bosimbi
OIC National Tree Seed Centre
P.O. Box 87
Bulolo, Papua New Guinea
Phone:
Fax: +675 4745470
Email:

Mr. Tembo Chanyenga
Forstry Research Institute of Malawi
P.O. Box 270
Zomba, Malawi
Phone: +265 524 782
Fax: +265 522782/548
Email: frim@malawi.net

Prof. Daniel Côme
Applied Plant Physiology Laboratory
University of Paris 6
Tour 53 - 1 étage
4 Place Jussieu
75252 cedex 05 Paris, France
Phone: +33 1 44 27 59 267;
Fax: (33) 1 44 27 59 27;
Email: come@ccr.jussieu.fr

Mr. Pascal Danthu
Forest Plantations Research Program
CIRAD-Forét Madagascar
P.O. 853
Antananarivo, Madagascar
Phone: +221 832 3219
Fax: (221) 832 9617
Email: danthu@isra.refer.sn/
pascal.danthu@cirad.fr

Mr. Ismailia Diallo
CIRAD/Fôret-ISRA/DRPF
B.P. 1716
Dakar, Senegal
Phone: +221 8323219/8324674
Fax: (221) 8329617/8211879
Email: isdiallo@hotmail.com
Int: www.refer.sn/sngal_ct/
rec/isra/isra.htm

Dr. M. Ehsan Dulloo
IPGRI
Via dei Tre Denari, 472/a
00057 Maccarese
Rome, Italy
Phone: +39-066118206
Fax: +39-0061979661
Email: e.dulloo@cgiar.org
Int: www.ipgri.cgiar.org

Dr. Jan M.M. Engels
IPGRI
Via delle Sette Chiese 142
00100 Rome, Italy
Phone: +39 06 51892222
Fax: +39 06 5750309
Email: j.engels@cgiar.org
Int: www.ipgri.cgiar.org

Mr. Deon Erdey
University of Natal, Durban
Department of Biology
Private Bag X10
Dalbridge 4014
Durban, South Africa
Phone: +27 31 269 3197
Fax: (27) 31 269 1195
Email: erdey@biology.und.ac.za
Int: www.nu.ac.za/nu/default.asp

Professor Erik Nymann Eriksen
Department of Agricultural Sciences
Horticulture
Højbakkegård
Agrovej 10
2630 Tåstrup, Danmark
Phone: +45 35 28 35 03
Fax: +45 35 28 34 78
Email: erik.n.eriksen@agsci.kvl.dk
Int: www.kvl.dk

Mr. Edilberto Rojas Espinoza
Centro de Semillas Forestales
BASFOR
Av. Atahuallpa Final Norte (ETSFOR)
P.O. Box 5453
Cochabamba, Bolivia
Phone: +591 4 451116
Fax: (591) 04 451118
Email: basfor@entelnet.bo

Mrs. Sylvie Gamene
Centre National de Semences
Forestieres
B.P. 2682
Route de Kaya
Ouagadougou 01, Burkina Faso
Phone: +226 300857
Fax: (226) 356110
Email: cnsf@fasonet.bf

Mr. Alfonso González F.
CATIE
7170 Turrialba, Costa Rica
Phone: +506 556 6431
Fax: +506 556 1533
Email: wvasquez@catie.ac.cr
Int: www.catie.ac.cr/

Dr. Steven P.C. Groot
Plant Research International
Droevendaalsesteeg 1
P.O. Box 16
6700 AA Wageningen, Holland
Phone: +31 317 476 975
Fax: +31 317 418 094
Email: s.p.c.groot@plant.
wag-ur.nl
Int: http:/www.plant.wageningen-ur.nl

Mr. Basil Gua
Forest Research Station
P.O. Box 79
Munda
Western Province, Solomon Islands
Phone: +677 61082
Fax: (677) 61150
Email:

Mr. Brian Gunn
Australian Tree Seed Centre
CSIRO Forestry and Forest Products
P.O. Box E 4008
Kingston
Canberra, ACT 2604, Australia
Phone: +61 6 281 8218
Fax: (61) 6 281 8266
Email: Brian.Gunn@ffp.csiro.au
Int: www.ffp.csiro.au/tigr/
atscmain

Prof. F. Hoekstra
Wageningen Agricultural University
Arboretumlaan 4
6703 AA Wageningen, Holland
Phone: +31 8370 82147/56
Fax: +31 8370 84740
Email:

Ms Dorthe Joeker
Danida Forest Seed Centre
Krogerupvej 21
3050 Humlebaek, Denmark
Phone: +45 49190500
Fax: (45) 49160258
Email: doj@sns.dk

Mr. Pole Kale
Seed Researcher
PNG National Forest Service
P.O. Box 314
Lae, Papua New Guinea
Phone:
Fax: (675) 4724357
Email: friadmi@global.net.pg

Prof. Le Dinh Kha
Director
Research Centre for Forest Tree
Improvement
Forest Science Institute of Vietnam
Chem Tu Liem
Hanoi, Vietnam
Phone: +84 4 8347813
Fax: (84) 4 8362280
Email: rcfti@netnam.org.vn

Mr. Fausto Lorenzo
ESNACIFOR
Aptdo 45
Siguatepeque, Honduras
Phone: +504 773 0011/18
Fax:
Email: esnabase@sdnhon.org.hn

Mr. Heriel Msanga
Programme Manager
National Tree Seed Programme
P.O. Box 373
Morogoro, Tanzania
Phone: 255 23 260 3192
Fax: 255 23 260 3275 or
Email: ntsp@twiga.com
Int: www.twiga.com/ntsp

Mr. Cossy Musokonyi
Forestry Research Centre
P.O. Box HG595
Highlands
Harare, Zimbabwe
Phone: +263 04 496878/9
Fax: (263) 04 497070
Email: cossym@frchigh.co.zw

Dr. Jayanthi d/o Nadarajan
Forest Research Institute Malaysia
Kepong
52109 Kuala Lumpur, Malaysia
Phone: +603 6342633/6302123
Fax: (603) 6367753
Email: jayanthi@frim.gov.my
Int: www.frim.gov.my

Dr. S.C. Naithani
Seed Biology Lab
School of Life Sciences
Pt. Ravishankar Shukla University
Raipur - 492 010, , India
Phone: +91 771 263038/262536
Fax: +91 771 660398
Email: naithani_nib@
sancharnet.in

Mr. Vilisoni Naitinelia
Forestry Department
P.O. Box 2218
Suva, Fiji
Phone: +679 322311
Fax: (679) 320380
Email:

Mr. Neya Oblé
C.N.S.F., B.P. 2682
Ouagadougou 01, Burkina Faso
Phone: +226 356111/8013
Fax: (226) 356110
Email: cnsf@fasonet.bf

Dr. Jaime Magne Ojeda
Director de Carrera Ingeneria Forestal
Universidad Autonoma Gabriel Rene
Moreno
Km. 9 al Norte, Casila 1356
Santa Cruz de la Sierra, Bolivia
Phone: +591 3 442 466
Fax: +591 3 442 466
Email: jmagne@bibosi.scz.
entelnet.bo/ and
cbiologia@mail.infornet.com.bo

Dr. William Omondi
Kenya Forestry Seed Centre
P.O. Box 20412
Nairobi, Kenya
Phone: +254 154 32891/2
Fax: +254 154 32844/3
Email: kefri@arcc.or.ke

Dr. Hugh W. Pritchard
Royal Botanic Gardens Kew
Wakehurst Place
Ardingly
Sussex RH 17 6TN, England
Phone: +44 1444 894140
Fax: (44) 1444 894110
Email: H.Pritchard@
rbgkew.org.uk
Int: www.rbgkew.org.uk/
index.html

Dr. Javier Rodriguez
CONIF
Avenida Circunvalar No.16-20
Bogota, Colombia
Phone: +57 1 3429089
Fax: (57) 1 3376970
Email: conif@colomsat.net.co
Int: www.colciencias.gov.co/conif

Mr. Daniel Roncacio
CONIF
Avenida Circunvalar No. 16-20
Bogota, Colombia
Phone: +57 1 3429089
Fax: +57 1 3376970
Email: conif@colomsat.net.co
Int: www.colciencias.gov.co/conif

Dr. Suomal Saelim
ASEAN Forest Tree Seed Centre
Muak Lek District
18180 Saraburi, Thailand
Phone: +66 36 341 305
Fax: (66) 36 341 859
Email: ssaelim@hotmail.com

Dr. Rodolfo Salazar
CATIE/PROSEFOR
7170 Turrialba, Costa Rica
Phone: 506 556 1933
Fax: 506 556 7766
Email: rsalazar@computo.
catie.ac.cr
Int: www.catie.ac.cr/

Dr. P.N. Sall
ISRA
Unite de Recherche D'Appui Foret
B.P. 2312
Parc Forestier de Hann
Dakar, Senegal
Phone: +221 323219/321638
Fax: (221) 32 96 17
Email:

Dr. Antonieta Nassif Salomao
CENARGEN-EMBRAPA
S.A.I.N.
Parque Rural - C.P. 02372
CEP 70.849-970
Brasilia DF, Brazil
Phone: +55 61 4484766
Fax: (55) 61 340 3658
Email: antoniet@cenargen.
embrapa.br

Dr. Usep Soetisna
R & D Centre for Biotechnology
P.O. Box 422
Bogor, Indonesia
Phone: +62 21 875 4578
Fax: (62) 21 875 4588
Email: u_soetisna@hotmail.com
Int: www.lipi.go.id/biotek/

Dr. Nguyen Huy Son
Research Centre for Forest Tree
Improvement
Forest Science Institute of Vietnam
Chem Tu Liem
Hanoi, Vietnam
Phone: +84 4 8347813
Fax: +84 4 8362286
Email: rcfti@netnam.org.vn

Mr. Fafetai Saagpolutele
Valima Forest Research and
Investigation Section
Forestry Division
P.O. Box 1874
Apia, Samoa
Phone: 685 22565
Fax: 685 22729
Email:

Mr. Joseph Tungon
Forestry Department
Private Mail Bag 064
Port Vila, Vanuatu
Phone: +678 23856
Fax: (678) 25051
Email: forestry@vanuatu.gov.vu

Mrs Leody Vanikolo
Forestry Division
Ministry of Agriculture & Forestry
P.O. Box 45
Vava'u, Tonga
Phone: +676 70164
Fax: +676 70401
Email:

Ing. William Vasquez
Banco de Semillas Forestales
CATIE
7170 Turrialba, Costa Rica
Phone: +506 556 6431
Fax: (506) 556 1633
Email: wvasquez@catie.ac.cr
Int: http://www.catie.ac.cr

Dr. Jack Vozzo
Southern Research Station
U.S. Forest Service, Box 9681
Mississippi State, MS 39762, U.S.A.
Phone: +1 662 325-8654
Fax: (1) 662 325-3278
Email: jvozzo@cfr.msstate.edu

Mr. Momar Wade
CIRAD/Fôret-ISRA/DRPF
B.P. 1716
Dakar, Senegal
Phone: +221 8323219/8324674
Fax: (221) 8329617/8211879
Email: danthu@refer.sn/
pascal.danthu@cirad.fr

Professor Xiaofeng Wang
College of Biotechnology
South China Agricultural University
Guangzhou 510642, China
Phone: +86 20 85283312
Fax: (86) 20 85282180
Email: xfwang@scau.edu.cn
Int: http://www.scau.edu.cn

Mr. Terry Warra, Director
Papua New Guinea Research Institute
P.O. Box 314
Lae, Papua New Guinea
Phone:
Fax: +675 424357
Email: friadmin@global.net.pg

Mr. James Were
Associate Research Officer
ICRAF MPT-GRU
United Nations Avenue
P.O. Box 30677
Nairobi, Kenya
Phone: +254 2 521 450
Fax: +254 2 521 001
Email: jwere@cgiar.org
Int: www.cgiar/icraf/home.htm

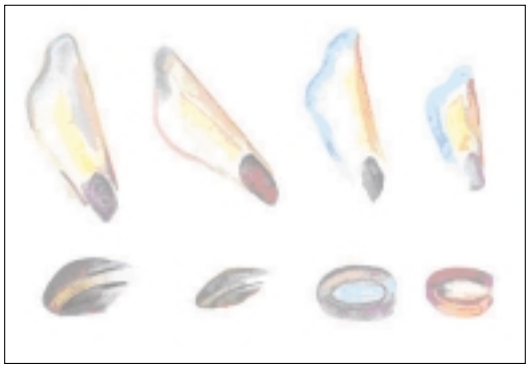
TREE SEEDS 2002, Chania, Crete, Sep. 11-15, 2002 Co-organized by IUFRO, the University of Athens and MAICh

Tentative Timetable

Wednesday 11 September	Arrival, Registration, Gala Dinner
Thursday 12 September	Sessions (morning), City Tour (afternoon)
Friday 13 September	Excursion day - Samaria gorge all day)
Saturday 14 September	Sessions (morning – afternoon)
Sunday 15 September	Half-day Excursion (morning) – Sessions (afternoon) - Farewell Reception

For more information please contact Costas Thanos at cthanos@bio.uoa.gr or or Jack Vozzo at jvozzo@cfr.msstate.edu.

List of contributions (oral presentations and posters) available at http://www.cc.uoa.gr/biology/TreeSeeds2002.htm/



Meeting in the ISTA Forest Tree and Shrub Committee

In connection with the Tree Seeds 2002, IUFRO Meeting in Chania, Crete, and the IPGRI/DFSC final workshop on 'Effective conservation and use of intermediate and recalcitrant tropical forest tree seeds', the ISTA (International Seed Testing Association) Forest Tree and Shrub Committee holds an informal meeting on Monday, September 16, 2002, 9.00-13.00.

The Forest Tree and Shrub Committee wants to take the opportunity to gather tree seed people to meet and discuss specific problems related to tree seed testing. Preliminary plans have been made for a workshop in Prague in 2003. The purpose of the meeting in Chania is to present the work of the Committee, discuss and prioritise tree seed testing issues in general as well as inform about the plans for the workshop in 2003.

For more information about the meeting and/or the Forest Tree and Shrub Committee please contact Professor Zdenka Prochazkova (chairman of the committee) at Prochazkova@vulhmuh.cz.