Handling of Recalcitrant Tropical Tree Seeds

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INTRODUCTION

A large number of tropical tree species have recalcitrant or intermediate seeds, i.e., seeds that are intrinsically short-lived, as they do not tolerate drying to the same extent as orthodox seeds and can not be stored at low temperatures. For most species the optimal conditions during seed handling and storage have not yet been established. This presents serious problems with regard to the short-term utilization of the species and the long-term conservation of the genetic material.

This is the background for a recently started project, funded by Danida, with the objective of determining desiccation tolerance and storage conditions for 20 to 25 important tropical tree seed species. The project is coordinated by IPGRI (International Plant Genetic Resources Institute). DFSC (Danida Forest Seed Centre) provides technical backstopping and a large number of seed centres and research institutes in Africa, Asia, Central, South, and North America, as well as Europe, participate in the project.

RECALCITRANT AND NONRECALCITRANT SEEDS

Most agricultural and horticultural seeds can be dried down and stored for a long time without losing viability. When the seed moisture content is reduced below a certain level, respiration becomes minimal, and the seed is quiescent. The metabolic processes will not start again until the seed has re-imbibed water. The relationship between survival and moisture content and temperature is quite simple. For general guidance, a reduction of the moisture content by 1% and a reduction of the temperature by 5C will respectively double the lifespan of the seed. However, not all seeds tolerate drying and seeds with a high moisture content are metabolically active. They use oxygen and energy and germinate if the conditions are favorable. The metabolic rate can be reduced by lowering the temperature, but many tropical, desiccation-sensitive seeds do not favour low temperatures. High moisture content in combination with high temperature additionally makes the seed more prone to fungal attacks. Consequently, there are internal and external factors that make the storage of recalcitrant tropical tree seeds difficult.

For want of better words, seeds that tolerate drying and storage at low temperatures are called "orthodox". Seeds that hardly tolerate drying are "recalcitrant" and seeds that tolerate drying to some extent, but not low temperatures are called "intermediate".

Many tree seeds, especially from the tropics, are recalcitrant. They are often large fleshy seeds from tree species growing in a humid climate, and it takes controlled experiments to establish in which group the seeds belong. There are recalcitrant seeds in the temperate part of the world too, e.g. acorns and sycamore seeds. Both are desiccation sensitive but can be stored at 4C.

SEED OR PLANT ?

Recalcitrant seeds are not "designed" for long-term storage. As they often originate from climates where water is not a limiting factor, there is no risk associated with the lack of desiccation tolerance. When they drop from the tree they germinate and grow. Problems first arise when we want to collect, transport, and store the seeds.

There is controversy as to whether the storage categories are separate or if there exists a continuum from orthodox to recalcitrant. This discussion is, however, academic as it is necessary to determine the storage physiology separately for each species anyway. Further it is not possible to apply the result from one seed source of a species to the whole species, as different provenances can have different behaviours, e.g. neem (*Azadirachta indica*), an important multipurpose species in the tropics, which is recalcitrant or intermediate depending on the seed source.

The desiccation tolerance that develops during the maturation phase of the orthodox seeds fails to develop in recalcitrant seeds. Therefore, they perhaps should be considered more as plants than as seeds. Their physiological and biochemical background is not yet known. Proteins, sugars, and hormones are being investigated, but there is probably no simple explanation.

Desiccation tolerance also depends on seed maturity and the drying method. Immature orthodox seed can also be damaged by desiccation. Beechnuts demand relatively low drying temperatures if they are to tolerate drying, but they are orthodox. An investigation of desiccation tolerance comprises a number of factors: maturity, temperature and relative humidity during drying, and temperature and moisture content during storage.

SCREENING OF 25 SPECIES

For many, especially tropical tree species, there is very little information on seed handling methods. In developing countries it can be difficult to reach seed sources because of weak infrastructure and almost impossible to time the collection. Procurement is expensive and demand often low. In order to secure both the present utilization of as many species as possible and their future survival, it is essential to determine the optimal seed handling procedures for them.

This is why a project was initiated in Dec. 1995, funded by Danida (The Danish International Development Assistance) and coordinated by IPGRI (International Plant Genetic Resources Institute), with the purpose of determining desiccation tolerance and storage conditions for approximately 25 tropical tree species.

It is primarily seed centres in the tropics which will do this screening, but European research institutes also participate. DFSC (Danida Forest Seed Centre) takes part in the screening and supports the project with technical backup. Each determination is made by at least two institutes to obtain a reproducible result, as many things can go wrong with recalcitrant seeds. The project runs for 3 years, thereafter it is planned to continue with a more strategic project on desiccation tolerance.

The first project will result in directly applicable guidelines for the handling of the investigated species, but equally important is that a protocol for the experiments is being prepared and tested. It will be easy, especially for the institutes participating in the project, to continue with species that can not be covered by the project. The protocol is for everybody to use and hopefully it will be used as there are many species we know very little about.

The experiments are meant to be simple and demand as few resources as possible. The screening starts at collection, as maturity is an important factor. There is also a focus on transportation and seed extraction to keep the seed alive and in good condition at least until desiccation. The seeds are desiccated with silica gel to 5% moisture content. During the desiccation, samples are removed for germination testing at intervals of approximately 3%. If the germination test shows that the seed has been damaged at a moisture content above 15% to 20%, the seed is recalcitrant. If it tolerates down to 8% to 9% before it is damaged, it is probably intermediate; and if 5% to 6% can be reached without damage, it is probably orthodox. After the desiccation trial, the recalcitrant seeds are stored at different, relatively high temperatures (minimum 15C) at the lowest possible moisture content. Orthodox and intermediate seeds are stored in the same way but at lower temperatures (e.g., -20 and 5C).

The species chosen for the project are expected to be recalcitrant or intermediate. But some of them will probably turn out to be more desiccation tolerant than expected. The whole procedure from collection to storage, and especially desiccation, will in some cases be monitored more carefully than normally which will prevent some damage from occurring.

CATIE (Centro Agronomico Tropical de Investigacion y Ensenanza, Costa Rica) and DFSC studied the desiccation tolerance of *Vochysia guatemalensis* seeds. CATIE has not had experience with the species itself, but were told by local seed centres that it was difficult, probably recalcitrant. Both CATIE and DFSC obtained germination percentages of 95% to 100% after desiccation to 5% to 6% moisture content. So it is definitely not recalcitrant. Additional storage experiments will show whether it is orthodox or intermediate. It has, however, been demonstrated that the seeds can germinate at a high percentage, so it is not necessarily the seed that is difficult to germinate but it appears that its treatment is wrong.

A newsletter is issued twice annually. It can be ordered at Danida Forest Seed Centre.: IPGRI/DFSC Newsletter; The Project on Handling and Storage of Recalcitrant and Intermediate Tropical Forest Tree Seed. No 1, July 1996.

LITERATURE CITED

Bewley, J.D. and **M. Black.** 1994. Seeds. Physiology of development and germination. 2nd ed. Plenum Press. New York and London.