植 物 学 报
Acta Botanica Sinica 2003, **45**(6): 638 – 643 http://www.chineseplantscience.com

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Seed Recalcitrance: a Current Assessment

SONG Song-Quan[1,2*], Patricia BERJAK[2], Norman PAMMENTER[2], Tobias M. NTULI[2], FU Jia-Rui[3]

(1. *Xishuangbanna Tropical Botanical Garden, The Chinese Academy of Sciences*, Menghun, Mengla, Yunnan 666303, China;
2. *Plant Cell Biology Research Unit, School of Life and Environmental Sciences, University of Natal*, Durban, 4041 South Africa;
3. *School of Life Sciences, Sun Yat-Sen University*, Guangzhou 510275, China)

Abstract: Seeds have been categorized as orthodox, recalcitrant and intermediate seeds according to their dehydration behaviors. Identification of desiccation-tolerance and -sensitivity of seeds is the basis making storage strategy of seeds and long-term conservation of species gene resources. In addition to the inherent characteristics of the species, developmental status of the seeds, dehydration rate, and the conditions under which they are dried and subsequently re-imbibed are very important factors influencing desiccation tolerance of seeds. Survival, electrolyte leakage rate, and germination/growth rate produced by survived seeds are a excellent synthetic parameter when discussing desiccation tolerance of seeds. Desiccation tolerance of seeds is a quantitative feature. The term "critical water content" is incorrect and has caused some confusion in assessment of seed recalcitrance. A new working approach to quantify the degree of seed recalcitrance has been proposed in this paper.

Key words: desiccation-tolerance; desiccation-sensitivity; orthodox seed; recalcitrant seed, intermediate seed; influence factor and assessment parameter of desiccation tolerance; quantitative feature; critical water content; seed recalcitrance

The terms "orthodox" and "recalcitrant" were introduced by Roberts (1973) to describe the storage behavior of seeds. Many of the species which produce recalcitrant seeds belong to mesic tropical trees, although a few temperate tree species and herbaceous tropical species also produce recalcitrant seeds. The tropical trees that produce recalcitrant seeds includes many important tropical plantation crop species such as rubber, cocoa and coconut, tropical fruit crops such as mango, mangosteen, durian, rambutan, jackfruit, Chinese wampee, lychee and longan, and tropical timber species which belong to the families Dipterocarpaceae and Araucariaceae, etc. Their temperate counterparts, which include oak, chestnut and horse chestnut also produce recalcitrant seeds.

There is some confusion with regards to the concept of "critical water content" which is used to assess desiccation tolerance. One cause of this confusion may result from the fact that critical water content is also dependent on the rate of dehydration. In this regard, it is, therefore, imperative to take into account the drying conditions when comparing studies on desiccation tolerance, even within species.

To date, there has been no detailed list on recalcitrant seeds and no successful method for long-term storage of recalcitrant seeds. This situation poses a serious problem for storage of recalcitrant seeds for agricultural purposes, in the short-term, and conservation of genetic resources, in the long-term. There is a plentiful plant germplasm resource, especially recalcitrant seeds, in Yunnan Province of China. Identification and study of desiccation-tolerance and -sensitivity of seeds, therefore, are very important for making storage strategy of seeds and long-term conservation of species gene resources.

1 Categories of Seed Storage Behavior

Orthodox seeds are shed from the parent plant at low moisture contents, having undergone maturation drying prior to this event, and can generally be further dried to moisture contents in the range of 1% – 5% without damage. In a few species the seeds are shed at high moisture content and undergo a similar dehydration after shedding. Orthodox seeds can usually be stored for long periods depending mainly on the temperature and moisture content during storage. Under typical storage conditions the relationship is such that the longevity approximately doubles with each 5.6 ℃ fall in temperature, or each 1% reduction in moisture content (Ellis and Roberts, 1980).

Recalcitrant seeds, however, do not undergo maturation drying, and are shed at relatively high moisture contents. Such seeds are highly susceptible to desiccation injury, and thus are not storable under conditions suitable for orthodox seeds. Furthermore, many recalcitrant seeds are sensitive to chilling injury at lower temperature (King and Roberts, 1979). Storage at ambient temperatures, in fully imbibed states usually results in microbial contamination. As a result the period of viability remains short, varying from a few weeks to months, depending on the species (Chin and Roberts, 1980).

Ellis *et al* (1990; 1991) have defined a third category of seed type. They withstand desiccation to relatively

Received: 2002-09-09 Accepted: 2003-01-20
Supported by the National Research Foundation of South Africa for providing a Postdoctoral Fellowship to Song S Q, the Knowlege Innovation Project of The Chinese Academy of Sciences (KSCX2-SW-117), Hundreds Talent Program of The Chinese Academy of Sciences and Natural Science Foundation of Guangdong of China (001224).
* Author for correspondence. Tel.: +86 (0)691 8715474; E-mail: <sqsong@xtbg.org.cn>.