From Forest Nursery Notes, Winter 2010

130. © Variation in seed germination between populations of five sub-alpine woody species from eastern Qinghai-Tibet Plateau following dry storage at low temperatures. Want, J. H., Baskin, C. C., Chen, W., and Du, G. Z. Ecological Research 25:195-203. 2010.

Ecol Res (2010) 25: 195–203
DOI 10.1007/s11284-009-0643-0

ORIGINAL ARTICLE

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Variation in seed germination between populations of five sub-alpine woody species from eastern Qinghai-Tibet Plateau following dry storage at low temperatures

Received: 6 February 2009 / Accepted: 19 August 2009 / Published online: 1 October 2009

Abstract Effects of cold-dry storage on dormancy break and viability were determined for seeds of the five sub-alpine woody species *Philadelphus incanus, Berberis vernae, Berberis dubia, Betula utilis*, and *Picea purpurea* collected along an altitudinal gradient on the eastern part of the Qinghai-Tibet Plateau in China. Germination tests were conducted at 20/5°C for seeds stored dry at ambient room temperature for 4 weeks and then at 3–4°C for 0, 6, 12, and 24 weeks. Dormancy break during dry storage, i.e., afterripening, was indicated by an increase in germination percentages and rates. Duration of cold-dry storage and altitude of seed collection had significant effects on germination. With an increase in duration of storage, germination percentages and rates of *P. incanus* and *B. vernae* increased with a decrease in altitude of seed collection, while they increased with an increase in altitude for seeds of *B. utilis* and *P. purpurea*. Seeds of *B. dubia* did not exhibit changes in germination percentages and rates with altitude because a high number of seeds remained dormant during storage. Seed viability after 24 weeks of storage ranged from high (88, 93.3, 92.7%) for *B. utilis* to low (15% for high altitude) for *P. incanus*. The potential for dormancy break to occur during cold-dry storage should be considered when studies on basic seed dormancy are conducted or when seeds from various locations are stored prior to propagating plants from them.

Keywords Afterripening · Altitude · Cold-dry storage · Seed germination · Variation

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Introduction

Forest coverage of the eastern part of the Qinghai-Tibet Plateau in China has sharply declined in recent decades mainly due to disafforestation via commercial timber extraction but also due to forest fires and intensive grazing (Winkler 1998). Deforestation on the Qinghai-Tibet Plateau is reducing the water-holding capacity of soil and thus increasing the possibility of erosion, debris flows, and floods (Winkler 1998). The need for and benefits of reforestation in this region are well recognized (Yan et al. 2005); therefore much consideration is being given to forest protection and reconstruction of damaged forest ecosystems (Wu and Liu 1998). Since woody species are important components of the biodiversity of sub-alpine and high-elevation forests ecosystems of the Qinghai-Tibet Plateau, they are needed for high-quality reforestation and restoration projects. Thus, nursery production of species for use in restoration projects requires information on how best to propagate local forest species. Furthermore, for restoration projects, it is necessary to collect seeds when they mature in autumn, but often they are held in dry storage at low temperatures for varying periods of time before they are sown (Jiang et al. 1992; Sun et al. 1994; Zeng et al. 2001). What effects do collection site and duration of cold-dry storage have on germination of seeds? So far,