

Influence of salinity and temperature on seed germination rate and the hydrotime model parameters for the halophyte, *Chloris virgata*, and the glycophyte, *Digitaria sanguinalis*

H. Zhang^a, L.J. Irving^b, Y. Tian^c, D. Zhou^{a,*}

^a Northeast Institute of Geography and Agroecology, CAS, Changchun 130012, China

^b Graduate School of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Ibaraki 305-8752, Japan

^c Institute of Grassland Science, Northeast Normal University; Key Laboratory of Vegetation Ecology, Ministry of Education, Changchun 130024, China

Received 26 January 2011; received in revised form 23 July 2011; accepted 22 August 2011

Abstract

Effects of salinity, temperature and their interactions on final percentage and the rate of germination were evaluated for two grasses, the halophytic *Chloris virgata* and the glycophyte, *Digitaria sanguinalis*. Seeds were germinated in 0, 50, 100, 150, 200 and 250 mM NaCl solutions under constant temperatures of 15, 20, 25, 30 °C and alternating temperatures of 15/25 and 20/30 °C with a 12 h photoperiod. In *D. sanguinalis*, the hydrotime model described the time course of seed germination well; however, it provided a poor description of *C. virgata* germination. In both species, most of the un-germinated seeds transferred to distilled water were still viable. Results suggest that seeds take salt up, causing inhibition of germination at sub-toxic concentrations; however, when returned to pure water, this extra salt may be able to increase germination rates and percentages.

© 2011 SAAB. Published by Elsevier B.V. All rights reserved.

Keywords: Germination; Halophyte; Hydrotime model; Recovery; Salinity; Temperature

1. Introduction

Successful germination is crucial in the life cycle of terrestrial angiosperms. Seeds that are able to effectively respond to environmental conditions and alter their germination behaviour will be more likely to survive and become established. Tolerance to salinity during germination is critical for the establishment of plants growing in saline soil of arid and semi-arid regions (Chapman, 1974; Ungar, 1995). Despite the importance of germination under salt stress, the mechanisms of salt tolerance in seeds are relatively poorly understood, especially when compared with the amount of information currently available about salt tolerance

physiology and biochemistry in vegetative plants (Hester et al., 2001; Garthwaite et al., 2005; Hu et al., 2005; Ren et al., 2005). According to their degree of salt tolerance, plants are divided into halophytes (salt tolerant) and glycophytes (salt sensitive) species, although this division is largely arbitrary. No comprehensive list of halophyte and glycophyte species exists because of the continuous nature of the salt tolerance gradient, which extends from obligate halophytes through the glycophytes to the most salt sensitive crops (Greenway and Munns, 1980).

Salt reportedly affects seed germination through osmotic effects (Welbaum et al., 1990), ion toxicity or a combination of the two (Huang and Reddman, 1995). However, recent evidence suggests that the osmotic component of salinity may be overstated. Seeds incubated in saline solutions down to –5 MPa were noted to achieve the same final water contents as water control seeds, although the rates of water uptake were decreased (Irving et al., unpublished

* Corresponding author. Tel.: +86 431 85542231; fax: +86 431 85542206.

E-mail address: zhoudaowei@neigae.ac.cn (D. Zhou).

data). Salt mediated decreases in environmental water potential (Ψ) lead to decreased rates of water uptake, inhibiting both germination and leaf elongation (Werner and Finkelstein, 1995; Fricke et al., 2006). However, conventional understanding is that provided Ψ is equal or greater than the seed base water potential (Ψ_b), the seed will germinate. On the other hand, high intracellular concentrations of both Na^+ and Cl^- ions can inhibit critical metabolic steps in dividing and expanding cells (Neumann, 1997), and may be toxic at high concentrations. Salinity-induced declines in the germination of halophytes are reportedly mainly due to osmotic effects only, whereas glycophytes are more likely to exhibit additional ion toxicity (Romo and Haferkamp, 1987; Dodd and Donovan, 1999). It is worth noting that while Dodd and Donovan used both NaCl and PEG in their study, they did not measure the seed water contents. Gummerson (1986) developed the hydrotime model to model seed germination responses to Ψ induced by NaCl;

$$\theta_H = (\Psi - \Psi_b)t_g \quad (1)$$

where θ_H is the hydrotime constant, Ψ_b is the base Ψ that will just prevent germination of fraction g of the seed population, and t_g is the time to a given germination percentage. This model has been reported to accurately describe germination timing, percentages and germination rates at reduced Ψ (Bradford, 1990; Cheng and Bradford, 1999), yet in truth frequently over- or under-estimates germination rates and percentages (for example, Fig. 1, Cheng and Bradford, 1999). Seeds exposed to increased salinity, for example, will commence germination later, germinate more slowly and, ultimately, fewer seeds will germinate (if Ψ is lower than the Ψ_b of some of the seeds).

Salt tolerant species are reported to have high osmotic potentials, allowing them to maintain Ψ_b values lower than the environmental Ψ . This can be achieved in two ways: exclusion of salt from the cells, whilst maintaining osmotic potential using organic solutes, or by allowing NaCl entry into the cells, using it as an osmolyte and having mechanisms for dealing with the toxic effects of salt within the cell (Rajendran et al., 2009). The cellular salt concentration is a function of the fluxes

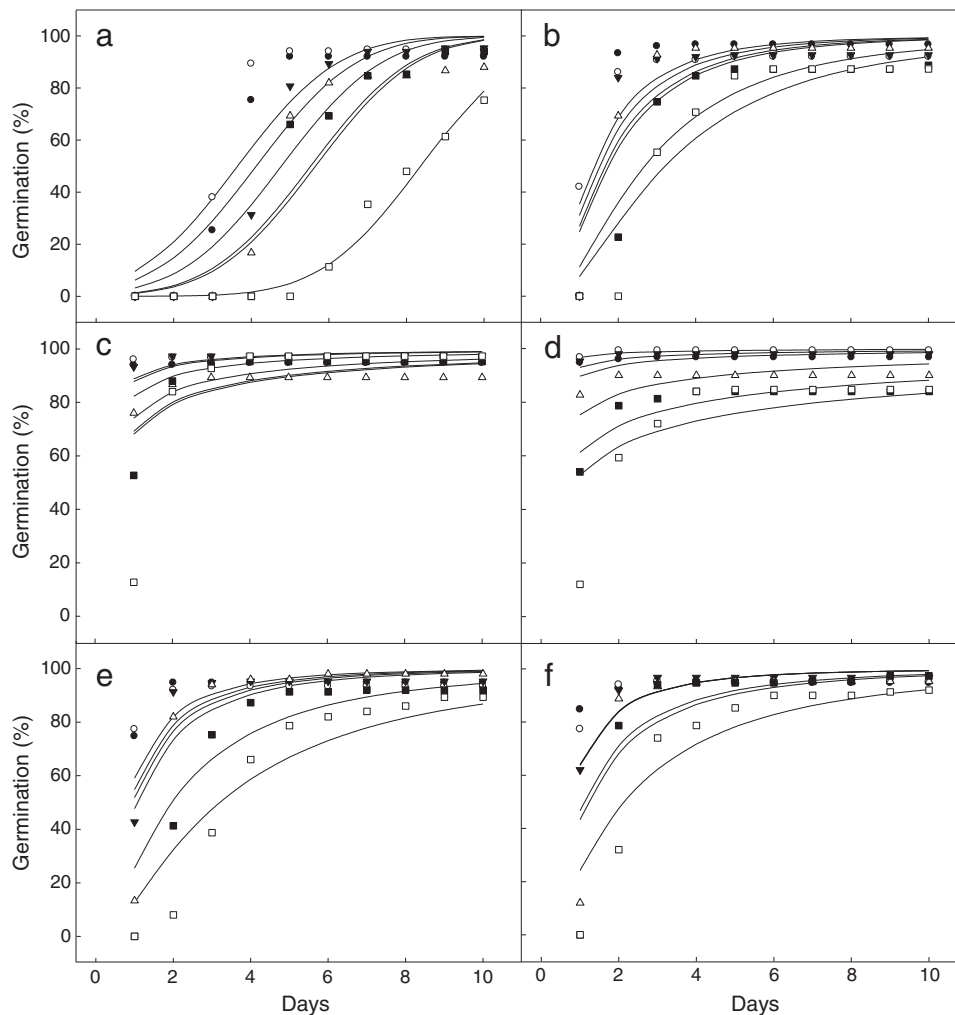


Fig. 1. Germination time courses of *C. virgata* seeds at a range of temperature regimes (a, 15; b, 20; c, 25; d, 30; e, 15/25; f, 20/30 °C) and salinities (●, 0; ○, 50; ▲, 100; △ 150; ■, 200; □, 250 mM NaCl solutions). The symbols are the actual data, and the lines are the time courses predicted by the hydrotime model using the values shown in Table 1.

Download English Version:

<https://daneshyari.com/en/article/4521061>

Download Persian Version:

<https://daneshyari.com/article/4521061>

[Daneshyari.com](https://daneshyari.com)