Does Scarification Time Affect Hydrotime Model Parameters of *Vicia angustifolia* Seed Germination?

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Introduction

Hard seed, also classified as physical dormancy, is very common in forage legumes (Baskin and Baskin 2004). Many methods, based on scarifying seed coat have been developed such as mechanical scarification, chemical scarification to soft hard seed (Baskin and Baskin 1998). Hydrotime is a way to describe the relationship between water potential (Ψ) and seed germination rates and percentages (Bradford 1990) The hydrotime model has proven to be useful for understanding the physiological mechanism of seed germination and has been suggested as a tool to describe seed germination time in relation to water condition (Alvarado and Bradford 2002). Generally, the effect of water condition on legume seed germination was evaluated on seeds after dormancy was broken. However, the way various treatments affecting seed response to water potential and the ecological significance of the response is less well understood (Zuk-gołaszewska *et al*. 2007). This study aimed to test the effect of sulfuric acid scarification on hydrotime model parameters of *Vicia angustifolia*

Materials and methods

Seeds of *Vicia angustifolia* were collected in the Qinghai-Tibet rangelands (102°30'E; 35°16'N) in late August, 2011. Seeds were scarified with concentrated H_2SO_4 for 5, 10 and 15 min and then washed with tap water for 10 min. After treatment, seeds were dried in the room temperature for 48 h. For intact and scarified seeds, germination at reduced water potential (0, -0.2, -0.4, -0.6, -0.8 and -1.0 MPa) was determined utilizing water or polyethylene (PEG6000) solutions. Three replications of 25 seeds each were used for each water potential level.

Seed germination in water and PEG solutions were counted each day for a 14 day period and analyzed by repeated probit regression (Follmann *et al.*1999) based on the hydrotime model (Bradford 1990). To exclude the effect of hard seed, germination was calculated using germinated seed divided by total germinated seed number at 14th day in water solution for each scarification treatment, respectively.

Results and discussion

Final seed germination was greatly improved by acid scarification (Table 1) which is consistent with Wang *et al.* (2007) who showed acid scarification effectively softened hard seed. As scarification time increased, constant hydrotime (θ_H) decreased. In contrast with this, $\Psi_b(50)$ was relatively constant among treatments. The decrease in θ_H implies that a longer scarification improved seed germination uniformity and rate. This may attribute to a faster imbibition rate due to seed coat permeability increase after treatment. Inversely, a relative constant Ψ_b (50) implies scarification will not alter the tolerance of seed germination to water stress. This is consistent with Zuk-gołaszewska *et al*. (2007) who reported that a significant decrease in θ_H while the other parameters of the model remain relatively constant in seed of *Trifolium pretense* after scarification. However, it is worth noting in Zuk-gołaszewska *et al*.'s research, the calculation of hydrotime model parameters did not exclude the effect of hard seed. Since hard seed will not germinate during a short-term experimental period, it is reasonable to assume that hard seed function as seeds without viability, and therefore should be excluded when calculating the hydrotime parameters. Otherwise, θ_H will

Table 1. Germination parameters of *V. angustifolia* seeds after sulfuric acid treatment based on hydro-time model analysis. θ_H is the constant hydrotime and $\Psi b_{(50)}$ the base water potential for 50% of seeds and $\sigma_{\Psi b}$ its standard deviation.

Time of scarification (min.)	θ_H (MPa·d)	$\Psi_{b(50)}$ (MPa)	$\sigma_{\Psi b}$	R^2	Final germination in water	Hard seed (%)
ck	-	-	-	-	25	75
5	4.0	-1.125	0.358	0.853	88	12
10	3.9	-1.108	0.326	0.914	93	7
15	3.4	-1.103	0.337	0.898	96	4
Mean (CV)	3.8(8.5)	-1.112(1.0)	0.340(4.8)			

be potentially increased when hard seed were incorporated into the hydrotime model.

On the other hand, longer scarification with sulfuric acid has been reported to lower seed germination and seed vigor (see Wang *et al*. 2007). This may reduce the tolerance of seed germination to unfavorable condition such as water stress. Interestingly, the present study also shows a slight increase in Ψ_b (50) as scarification time extended. Longer scarifying treatment (>15min) of *V. angustifolia* may be expected to significantly lower Ψ_b(50), although further study is needed to substantiate this point.

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