Effects of Seed Moisture Content Decreasing on Germination Traits of Silver Fir (*Abies alba* Mill.)

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Abstract
Fresh collected seeds from individual plants in Kelardasht (Mazandaran, Iran) with two moisture content levels (12, 20%) were putted under favorable germination condition (cold stratification for three weeks). Then germination traits GR, GS, GE, MDG, PV, GV, and MGT were studied. The results present that moisture content decreasing has significant effects on above mentioned traits. So that all traits showed negative correlation by MC% decreasing, except MGT, i.e. GR reduced 48% (67 to19%), GS 6.7 (7.8 to 1.1), GE 7% (11 to 4%), MDG 2.22 (2.8 to .58), PV 2.82 (3.4 to .58), GV 9.22 (9.52 to .3) and MGT 7.7 (9.11 to 18.7) respectively in two moisture content levels (20, 12%). These observations could be related to seed storage behavior.

Key words: Silver Fir, Germination traits, Moisture content, Storage behavior

Introduction

Seeds have been categorized into two main groups according to their desiccation response and storage physiology: orthodox (desiccation-tolerant) that can be dried, without damage, to low moisture contents, usually much lower than those they would normally achieve in nature and recalcitrant (desiccation sensitive) seeds that do not survive drying to any large degree, and are thus not amenable to long term storage (Roberts, 1973; Berjak, 2005). A third category of intermediate seeds has been recognized (Ellis et al., 1990, 1991).The intermediate seeds are relatively desiccation tolerant more than recalcitrant, but they will not withstand desiccation down to water contents as low as those tolerated by orthodox seeds on the other hand their tolerance is much more limited than is the case with orthodox seeds and they are freezing sensitive and lose viability more rapidly at low temperature (Berjak, 2005).The critical moisture level to which mature embryos can be dried without inducing desiccation damage is generally species dependant and serves as a tool to define whether a seed is orthodox, recalcitrant or intermediate (Vertucci and Farrant, 1995).The longevity of seeds is affected by the reduction in moisture content below a critical value and the estimates of critical moisture content vary considerably among species (Ellis et al. 1988; 1989; 1990; Sanhewe and Ellis, 1996).

A number of studies have investigated seed germination rates as potential correlates of seed desiccation sensitivity (Pritchard et al., 2004; Daws et al., 2005).Seeds germination ability is related to developmental stage, degree of desiccation and rate of the imposed drying treatment (Gosling et al., 1981). Drying conditions, particularly the drying rate may contribute high variability in desiccation tolerance among the non-orthodox (Pammenter and Berjak, 1999). Fir seedlings are produced in 4 altitudinal nurseries in the Caspian region at a total number of 70000 annually which are used for plantation and some ornamental uses (Noorshad M.). Consumed Seeds are collected from individual mother trees and small population around nurseries. The main problem for seedling production of this species is low rate of seedling production in contrast with high amount of seed consumption. Initiatial surveys showed that most of the seeds lose their viability during processing and short storage period before sowing. According to two submitted samples with the same lot and origin of Silver fir to the Caspian forest tree seed centre and seed moisture content and germination traits determination we found that these seeds have non-orthodox seed storage behavior.

Materials and methods

Fir cones were collected from individual trees in Kelardasht (Mazandaran, Iran) and two samples (1, 2) were drawn from the same seed lot after seed extraction. Sample 1were placed in refrigerator (3-5°C) and Sample 2 were putted under ambient temp (18-20°C) for one month. Two submitted samples (1, 2) sent to seed lab for analytical tests. At first, physical traits (1000 seed weigh, MC %) were determined and then 4 replicates of 100 seeds from each sample were stratified in moist sterilized sand and were putted in refrigerator (3-5°C) to overcome dormancy at the Caspian Forest Tree Seed Centre laboratory according to ISTA rules (ISTA, 2008).

After 3 weeks, treated seeds were sown in 4 replicates of 100 between sterilized and placed in germinator (22°C) for germination test. Evaluated seedlings were counted and recorded every 2 days.

Germination traits such as GR (germination rate), GS (germination speed), GE (germination energy), MDG (mean daily germination), PV (peak of velocity), GV (germination value) (Willan, 1985; Panwar and Bharadwaj, 2005) and MGT (mean germination time) (Bewley and Black 1994; Younsheng and Szikaie, 1985; Falleri et al., 1997) were calculated as follows:

GR =(n/N×100) GE = (max germinated seeds a day) $GS = \sum (n/DSS)$ *MDG = (FCG/T)PV = (MCG/DSS) GV= (PV×fMDG)* $MGT = \Sigma\ (ni.\ ti)\ .n^{-1}_{total}$

Where:

G = germinated seeds n = number of germinated seeds in each count

DSS = days from the start of the test FCG = Final cumulative germinated seed

T = total period of germination

MCG = maximum of cumulative germination

FMDG = final mean daily germination

N = number of sown seeds

ni= number of seeds germinated in a specific day (t)

n_{total} = the total number of germinated seeds

One - way (ANOVA) analysis were performed to determine differences in GR, GE, GS, MGT, MDG, PV, GV and MGT

Results

The results of lab analysis showed in table 1.

The analysis of variance revealed that: There are significant differences between all germination traits (GR, GE, GS, MDG, PV, and GVand MGT) in two samples ($P<0.01$).

Table 1: The results of lab analysis (physical & physiological traits) for two samples (1, 2)

Sample	Physical traits		Physiological traits						
	%MC	1000 S.W.	% GR	GS	%GE	MDG	PV	GV	MGT(day)
1	20	123.84	67	7.8	11	2.8	3.4	9.25	9.11
2	12	77.21	19	1.1	4	0.58	0.58	3	18.7

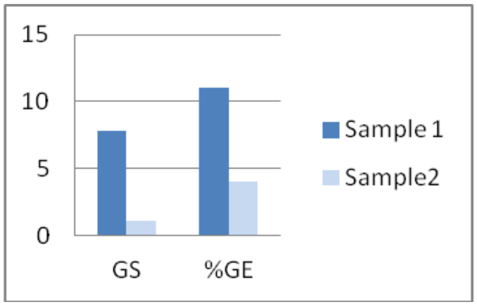

Figure No 1: differences in GR between

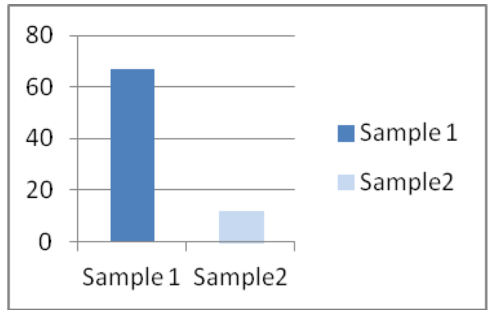

Figure No 2: differences in GS& GE

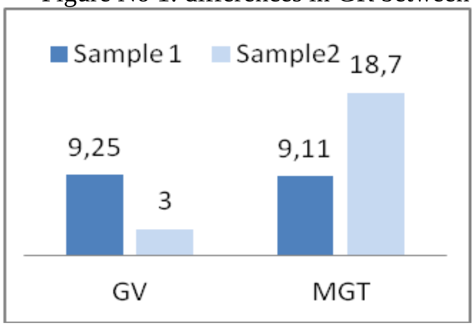

Figure No 3: differences in MDG&PV

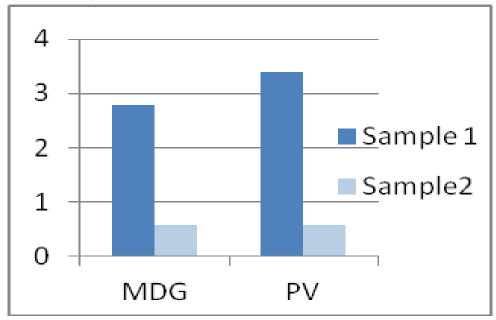

Figure No 4: differences in GV&MGT

Discussion and Conclusion

There is considerable intra-species variation in seeds desiccation responses and their storage behavior which has led to a lack of consistency in classification. Post-harvest behavior of seeds might better be considered as constituting a continuum, subtended by the highest degree of recalcitrance at one end and of orthodoxy at the other, with subtle gradations of non-orthodoxy between the two extremes (Berjak and Pammenter, 1997). *Abies alba* seeds were formerly classified as "intermediate" [(?)-indicates storage characteristics are not yet fully understood] (Gosling, 2007). Despite of a short term brief survey, this study also showed that Fir seeds have not intermediate seed storage behavior. Pammenter and Berjak, (1999) indicated that drying conditions, particularly the drying rate may contribute high variability in desiccation tolerance among the non-orthodox. Present study also showed that slowly desiccated seeds in refrigerator (till to 20%) have had further germination rate. A successful storage condition must ensure that seeds vigor and viability retain uninjured (or only slightly injured) from harvesting until planting. Thus many experiments must be done to determine fir seed storage behavior and proper storage condition. For this purpose their response to desiccation must be initially determined. This can be achieved either passively by routine processing of seeds for long-term conservation and identifying species that fail to survive, or more actively by specific, targeted screening using, for example, 100 seeds (Pritchard et al., 2004) or by fully characterizing the response to dehydration of individual species (e.g. Hong and Ellis, 1996).

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