Effect of moisture content on the viability and vigor of Nordmann, Turkish and Trojan fir seeds

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Introduction

The increasing interest in growing exotic firs, such as Nordmann, Turkish, and Trojan firs, as Christmas trees in the United States is limited by the inconsistent availability of seed from proven high-quality seed sources of these species. Although there are currently a number of small domestic Nordmann and Turkish fir seed orchards and recently established Turkish and Trojan fir seed orchards resulting from the recent CoFirGE trials, for the foreseeable future the use of these species will depend on seed that is imported from native tree stands in the Republic of Georgia and Turkey.

Many conifer species' seeds can be stored for decades without considerable loss of viability and vigor. However, several true firs (*Abies*), have notoriously poor seed storability. Nurseries in the Pacific Northwest indicate that the viability and vigor of Nordmann and Turkish fir seeds degrades significantly after just one or two years in cold storage. There are numerous facets to current harvesting, processing, and storage practices that may be contributing to subpar viability and vigor. The moisture content that seeds are dried to and the temperature they are stored at are two important factors that affect the viability and vigor of stored seeds. Seed importers have commonly noted that the MC of imported seed tends to be in the 10-12% range. In the Pacific Northwest, conifer seeds are commonly stored at moisture contents of 8-10% and temperatures of -10 °C (15 °F). Several studies of *Abies* species, including one of Nordmann fir, indicate that a lower seed moisture content of 6-8% and a storage temperature of -18 °C (0 °F) can better maintain seed germination (viability) and vigor when stored long-term.

To examine the influence of MC on initial seed quality, tests were conducted to assess germination, enzymatic activity, accelerated aging, and speed of germination of domestic and imported seed that were dried to a range of moisture levels.

Objective

Collect base-line data relating to the viability and vigor of Nordmann, Turkish and Trojan fir seed that have been dried to different moisture levels prior to cold storage.

Materials and Methods

Four domestic [Turkish (2) and Nordmann fir (2)] and seven imported [Nordmann (6) and Trojan (1)], freshly harvested and processed seed lots were obtained from seven commercial seed suppliers for use in our tests (Table 1).

Table 1. Origin and moisture content (MC) of seed lots

WSU Code	Supplier Code	Origin	Species	%MC (Initial, unaltered)
SS 1	1	OR Seed Orchard (1)	Turkish fir	6.4
SS 2	2	OR Seed Orchard (2)	Nordmann fir	7.5
SS 3	2	OR Seed Orchard (3)	Turkish fir	8.1
SS 4	3	OR Seed Orchard (4)	Nordmann fir	6.9
SS 5	4	Turkey (Bayramic-Kazdagi)	Trojan fir	9.1
SS 6	5	Georgia (Borjomi/Tadzrici)	Nordmann fir	9.4
SS 7	6	Denmark (Vallo 18)	Nordmann fir	9.7
SS 8	5	Russia (Apsheronsk/Mezmai-1)	Nordmann fir	7.8
SS 9	7	Georgia (Ambrolauri/Tlugi)	Nordmann fir	9.4
SS 10	7	Georgia (Borjomi/Tadzrici)	Nordmann fir	8.9
SS 11	7	Russia (Apsheronsk/Mezmai-2)	Nordmann fir	7.6

Upon receipt, the initial, unaltered MC of each seed lot was determined. Half of the seed from each lot was then placed in a seed drier at 26.7 C (80 F) for 24 hours to reduced the MC of the seed. Seeds generally lose their vigor (ability to germinate under sub-optimal conditions) before viability (ability to germinate normally under ideal conditions). To determine the effect of drying seed lots on the viability and vigor, samples of each of the unaltered initial and dried seed lots were sent to the Oregon State University Seed Laboratory (https://seedlab.oregonstate.edu/) for testing.

Viability Testing

Germination (%):This physiological test determines the percentage of live seeds that produce normal seedlings under favorable germination conditions. Seeds were prechilled for 28 days at 5°C and then germinated at 20-30°C for 28 days.

Tetrazolium (TZ):This quick biochemical test determines the number of live seeds based on *dehydrogenase* activity in seeds. It indicates the percentage of viable (live) and non-viable seeds in any sample regardless of its dormancy level.

Vigor Testing

Accelerated Aging (AAT): Seeds are stressed at high humid/ity43°C for 96 hours, then germinated for 14 days. Ungerminated seeds at the end of the AAT were tested by TZ for viability. High quality seeds tolerate such stress conditions and retain their capabilities to produce normal seedlings when germinated for 14 days.

Speed of Germination Index (SGI): High quality seeds germinate faster than poor quality seeds. The number of normal seedlings recorded in the first count represents the population of fast germinating seeds and thus functions as a vigor measurement. The higher SGI, the faster the seeds germinated.

Results

The initial MC of the seed lots in this trial averaged 8.25% and ranged from 6.4% to 9.7% (Table 1). On average, the four sources of domestic seed had a small, but significantly lower (7.23%) MC than the imported seed (8.84%). Regression analysis of the initial MC data and the seed viability and vigor test results indicated that there was not a significant correlation between the initial MC of the seed and the TZ, Germination, and SGI data (Table 2). Although none of the seeds germinated during the AAT test, based on the AAT TZ tests, up to 19% of the stressed seeds were viable and there was a significant negative correlation between the physiological viability of the AAT stressed seeds and MC (Table 2).

Table 2. Correlation of initial seed moisture content to seed viability and vigor test results.

Test	Regression equation	R^2	"p" value
TZ	Y = -0.2901X + 80.031	0.0015	0.909
AAT TZ	Y = -3.6747X + 38.788	0.5298	0.010
% Ger	Y = -7.0682X + 117.8	0.2604	0.108
SGI	Y = -0.4878X + 8.1328	0.2472	0.120

After 24 hours in the seed dryer, the average MC of the seeds was reduced to 4.73% (4.5% to 5.1%), which was significantly lower than the initial, unaltered MC (Table 3). Analysis of the viability and vigor test results, indicated there was no significant differences in the results between the dried vs. non-dried unaltered seeds (Table 3).

Table 3. Effect of drying on seed moisture content, viability, and vigor.

			% Viability		
Seed Condition	%MC	% Ger.	TZ	AAT TZ	SGI
Unaltered	8.25a	58.9a	74.8a	14.4a	3.9a
Dried	4.70b	59.5a	77.6a	8.5a	4.1a

Additional Research

The work reported in this poster represents the first stage of a 3-year storage trial to determine the effect MC and storage temperatures have on the vigor and viability of Nordmann, Turkish and Trojan fir seed. Seed from each of the seed lots tested in these MC studies were stored at -10 and -18 C during spring 2021. Over the next three years, samples of from each of the 44 seed lots in storage will be retested annually. Changes in the results from these tests will be used to determine the optimal MC and storage temperature to prolong the viability and vigor of seed in storage.

Selected References

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