Effects of Substrate Moisture on Germination of Scotch Pine (*Pinus sylvestris* L.) Seed From Several Sources

E.W. Belcher and B. Perkins

Laboratory director and seed technician, USDA Forest Service, National Tree Seed Laboratory, Dry Branch, GA

*Scotch pine (*Pinus sylvestris *L.) seed from 15 sources were germinated on five different levels of substrate moisture (5, 10, 15, 20, and 25 percent). A substrate moisture level of 10 percent or less was less desirable with crepe cellulose paper than were higher levels. Substrate moisture levels of 15 to 25 percent produced acceptable results.*

Scotch pine seeds from many sources are imported for Christmas tree farms. Previous research showed that Scotch pine seed is sensitive to high substrate moisture during germination. Scotch pine has a very broad natural range, from latitude 40°N to 70°N and longitude 5°W to 140°E. Previous work did not determine if seeds from differing environmental conditions such as those derived by latitude, longitude, and elevation would demonstrate variations in substrate moisture tolerance. This study was undertaken to examine the tolerance to substrate moisture with seeds from the western portion of the range.

Methods and Materials

Seeds from each of 15 sources (table 1) were germinated at 5 different substrate moisture levels: 5, 10, 15, 20, and 25 percent of the water-holding capacity of the substrate (a double layer of crepe cellulose paper). Four germination dishes of 100 seeds each were prepared for each treatment. The seeds were germinated at 22 °C with 3 hours of light and 16 hours of darkness. Tests were terminated at 28 days.

Table 1—*Sources of Scotch pine seed used in this study*

Lot no.	Source	Elevation[a] (m)	Latitude	Longitude
1.	Nfruskovskoe Forest, Orlovsk Oblast, USSR	Unk.	53.0°N	35.0°E
2.	Neliskovitskoe Forest, Kiev Oblast, USSR	Unk.	50.0°N	30.0°E
3.	Novousmansky Forest, Woronesh Oblast, USSR	Unk.	52.0°N	
4.	Vintila Voda Forest District, Romania	800-900	45.5°N	26.3°E
5.	Pirscov Forest District, Romania	950	45.5°N	26.3°E
6.	Nehovia Forest District, Romania	1100-1350	45.7°N	26.3°E
7.	Kamon Seed Orchard, Sarvar, Hungary	Unk.	47.2°N	16.6°E
8.	Kamon Seed Orchard, Sarvar, Hungary	Unk.	47.2°N	16.6°E
9.	Kranichfeld, German Democratic Republic	370	50.5°N	11.1°E
10.	Landskrona, Sweden	300	65.7°N	20.0°E
11.	Landskrona, Sweden	200	65.7°N	20.0°E
12.	Jamtland, Sweden	450	62.3°N	14.5°E
13.	Jamtland, Sweden	350	62.3°N	14.5°E
14.	Jamtland, Sweden	400	62.3°N	14.5°E
15.	Jamtland, Sweden	500	62.3°N	14.5°E

[a]Unk. = unknown.

Percent water-holding capacity has proven to be an accurate measure of substrate moisture. Each piece of crepe cellulose paper was weighed before placement in the dish and the appropriate weight (volume) of water (+ 0.5 gram) was spread evenly over the surface with a calibrated sprayer. The dishes were covered and set overnight to allow the water to spread uniformly throughout the medium. The 100 percent water-holding capacity was determined by saturating the medium with a measured amount of water, allowing it to drain for 1 minute, and then measuring the drained water.

Each lot of 100 seeds was radiographed before placement on the medium, and the full seed percent was determined from the radiograph. Germination was evaluated every 7 days.

Germination percent, days to reach 50 and 90 percent of total germination, percentage abnormal germination, percentage of moldy seeds, and vigor evaluations by Czabator's method (2) were subjected to analyses of variance. Significant differences were examined with Duncan's multiple range test. Correlation coefficients were calculated between latitude, longitude, elevation, and the test measurements.

Results and Discussion

The 5 percent moisture level was so dry that the effects overshadowed all other effects in the analysis. Therefore the data were reanalyzed without the 5-percent data (table 2). Seed mold increased slightly as the substrate moisture increased.

Seed source significantly affected all measurements except percentage of moldy seed and percentage of abnormal seedlings. Correlation coefficients were calculated from the components of the seed sources (latitude, longitude, and elevation) and the germination variables. Only source elevation proved significant (table 3).

Germination decreased as source elevation increased, but seeds from higher elevations germinated faster. This finding might be expected though, because Scotch pine seed development has been reported to be delayed with decreasing mean temperatures (3). Slower seed development may result in less dormancy and thereby less delay in germination.

The sources were also summarized by germination percentage with those above 80 percent in one group (strong) and those below 80 percent in another group (weak) (fig. 1). Although the differences between means at moisture levels above 5 percent are not significantly different, the impact of moisture levels is more noticeable in weak seeds than in strong seeds. Weak seeds appeared to be more moisture specific. This may be related to the specific needs of deteriorating material and competition for food reserves.

In terms of seed testing, there appears to be no interaction between substrate moisture and seed source for Scotch pine. With crepe cellulose paper, a substrate moisture of 15 to 25 percent of the water-holding capacity should produce acceptable results for all of these sources. This means a standard seed test can be used to determine viability of all sources of Scotch pine examined in this study.

Table 2—*Summary of germination measurement means*

Measurement	10% Moisture	15% Moisture	20% Moisture	25% Moisture
Moldy seed (%)	11.4 b	13.9 a	13.4 ab	14.9 a
Germination of filled seed (%)	74.9 b	77.8 a	76.9 ab	76.3 ab
Days to 90% of total	10.4 a	10.3 a	10.0 ab	9.7 b
Days to 50% of total	5.6 a	5.4 ab	5.3 ab	5.2 b
Abnormal germination (%)	4.9 a	3.3 b	3.5 b	3.9 ab
Vigor, Czabator's method	22.2 b	24.6 a	24.6 a	24.5 a

Means within each measurement not followed by the same letter are significantly different at P = 0.01.

Table 3—*Coefficient of determination* (r^2) *of seed source and substrate moisture level as related to laboratory measurements*

Evaluation	Mold	Germination	Speed to 90%	Speed to 50%	Abnormal	Vigor by Czabator
Substrate moisture	0.87*	0.51	0.64	0.60	0.56	0.57
Elevation	0.17	0.65*	0.85*	0.68*	0.01	0.82*
Latitude	0.01	0.20	0.65	0.28	0.13	0.13
Longitude	0.13	0.08	0.42	0.41	0.18	0.04

* Significant at P = 0.01.

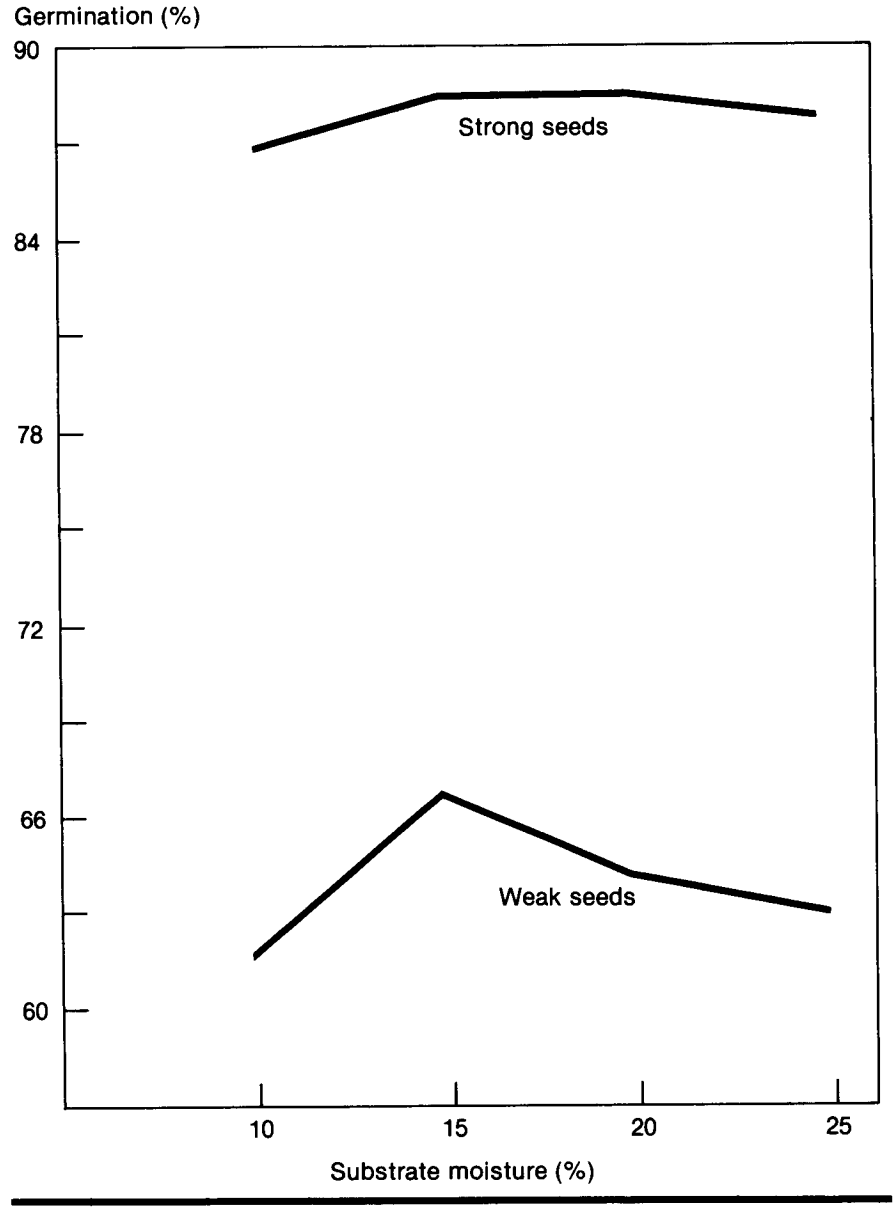

Figure 1—*Mean germination of strong and weak seed lots on five substrate moisture levels.*

Literature Cited

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