

樹木種子發芽에 미치는 溫度效果

A Review on the effect of temperature on tree seed germination

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The term of germination is defined as "the process of the resumption of growth by the emryo plant which has lain dormant in the seed." In a technical sence, germination starts when the seed coat is broken and a living radicle is extruded; in a practical sence it is not considered to take place until the seedling breaks ground.

Most seeds have some type of dormancy which plevents them from germinating immediately after they have matured.

The germination processes are faciliteted by suitable enuironmental factors. The process bagin with the imbibition of water which alone may cause the seed coat to split. This is not germinatin, however. With the imbibition of water, favorable temperatures, and the presence of oxygen, chemical changes are initiated within the seed.

The zymogens are converted into enzymes which become activated with the increasing hydration. The energy available for germination and growth depends on the character and amount of the reserve food, Stored foods are made soluole and move toward cells where growth is beginning.

This review deals with some temperature effect on the tree seed germination.

1. The effect of alternating temperature on germination.

A fluctuating temperature within certain limit is more favorable to germination than a constant temperature. Under natural conditions temperature during the day is considerably higher that at night. This daily change in temperature stimulates germination of seed, as demonstrated by many researches in recent years.

Schrosder (1935) found that optimum temepesatures

for germination of Benzoin aestival L. in the ovens were daily alternations of 10° to 30°C. and 10° to 20° C which gave 88 and 70 percent respectively. Davis (1939) described that the employment of alternating temperatures in germination of seeds is especially useful in seeds with membrances that restrict the gaseous exchange. When such seeds are subjected to high constant temperatures in the germination, both respiratory intensity and catalase activity increase. Duration of this increase depends on the temperature and the extent of the restriction of the oxygen supply; jater a decline occurs until both become quite constant however long in the germination. This condition of the emryo is here designated as fatigue and may pass into a condition of true dormancy. When alternating temperatures are employed there is a rise in both respiratory intensity and catalase activity throughout the period of germination. The period of time required at each temperature of the alternation depends upon the extent of the restriction of the membranes and the temperatures employed. The higher the upper temperature of the alternation may be, the shorter is the time required at that temperature, and the longer at the lower temperature in order to prevent fatigue.

Mork (1944) reported that through at a constant temperature of 40° no germination occurs, ripe seed germinates satisfactorily at temperatures alternating between 17° and 46° Unripe seed appears to be more sensitive to such high temperatures. For ripe seed the minimum appears to be about 20° and at 25° about half of the seed will germinate. Poorly ripened seed required a minimum temperature about 5° lower. The seed from mountain forests requires a minimum of 20° for germination, the optimum is 17° to 35°, but the optimum range is narrower than for lowland seed, as

only about half the seed will germinate with temperatures of 17° to 30°.

Chase (1947) observed that Eastern black walnuts were exposed to fluctuating winter temperatures indicated the superiority of such handling over stratification at constant temperatures. The poor germination of nuts stratified at 65°—75° F indicates the necessity of low temperatures for best results. According to Heit(1948), the seed of *platanus acerifolia* required a 20 to 30°C temperature alternation for maximum germination. Borret (1954) showed that temperatures fluctuating between 20 and 30° gave rather better, and those fluctuating 20 and 36° rather poorer, results of aspen seed germination than a constant temperature of 20°, but differences were slight. Duncan(1954) found that higher germination capacities were attained at alternating temperatures than at constant temperature in Tamarack. Asakawa (1956) observed that germination percent of *Fraxinus mandshurica* var. *gaponica* seeds was highest at 25°C for 4 hours a day and lower when period of 25°C exceeded 22 ours. Few germinated at constant temperature of 25°C.

According to Haasis and Thrapp (1931), alternating temperatures between 32°C (10hr.) and 11° (14hr.) brought better germination than those kept at maintained temperature of 10°C but poorer than those maintained at 32°C. As shown in table 1.

Table 1.		
Temperature, degrees C.	Incubation period days	Germination percentage
Alternating between 32° (10hr.) and 11° (14hr.)	5	11
	7	42
	8	69
maintained at 32°	4	72
	7	82
maintained at 10°	9	0
maintained at 18°	4	0
	9	5

2. The room temperature storage and germination.

In the case of puerto Rico, the most practical method to keep the longevity of the Bamboo seed (*Bambusa arundinacea*) tested was storage over calcium chloride at room temperature 70~90°F Storage over hydrated lime or over charcoal was also a good method if refrigerated (white, 1947). Mork (1951) observed that *Betula verrucosa* and *Betula pubescens* stored dry at room temperature germinated equally well at

all seasons of the year in a thermostat at constant temperature and light, and retained its viability for three years.

According to Luckwill (1952), in apple seeds stored dry at room temperature, the inhibitor disappeared from the endosperm and embryo, but not from the testa. Seed stored under these conditions remained dormant indefinitely. But during after-ripening under moist conditions at 4°C., disappearance of inhibitor from all parts of the seed was demonstrated. (See the Fig. 1).

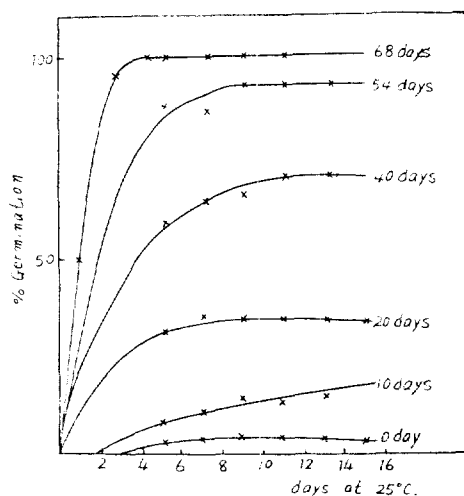


Fig. 1. Progress of after-ripening of apple seeds kept under moist conditions at 4°C. as shown by the germination of excised embryos at 25°C.

3. The effect of cold temperature and stratification on germination.

Usually, the seeds stored at cold temperature bring higher germination. According to Barton (1930), One month storage at 5°C proved most satisfactory for pretreatment of *Taxodium distichan* seeds. Treated seeds germinated to the extent of 39 percent in 28 days while the untreated seeds gave four percent germination in the same length of time. But weekly alternating temperature storage between -5° to 5°C. were tried in the case of *Pinus excelsa*, *Pinus Koraiensis*, *Pinus Lambertiana*, *Pinus strobus*, and *Pinus thunbergii*. This alternating freezing and thawing apparently has no beneficial effect. However sample plantings made in the green house after stratification

inn moist acid peat at 5°C for a period of two months not only saves time in seedling production but also produces more complete seedling stands in the majority of cases. *Pinus austriana*, *Pinus Banksiana*, *Pinus Laricio* and *Pinus Ponderosa* gave much more prompt production of seedlings (stand complete 8 to 48 days sooner) after stratification for two months at 5°C. However, the actual number of seedlings produced from treated and untreated seeds was about the same. *Pinus contorta*, *Pinus coulteri*, *Pinus densiflora*, *Pinus flexilis*, *Pinus insignis*, *Pinus monticola*, *Pinus resinosa*, *Pinus rigida*, *Pinus strobus*, *Pinus thunbergii*, *Abies arizonica*, *Picea omorika*, *Picea sitchensis*, *Thuja gigantea*, *Thuja occidentalis*, and *Thuja Orientalis* show decided beneficial effects of stratification at 5°C for a period of two months. Three months' stratification at 10°C resulted in the best germination (8 percent after 25 days) of *Pinus excelsa* in these tests. This was better than the average control (2 percent in 60 days), but further study is needed. *Pinus koraiensis* responded equally well to stratification for three months at 5°C or for one or two months at 10°C. However, the best germination (33 percent in 43 days) was obtained after the seeds had been stratified for five months at either 0° or 5°C. Stratification of *Cupressus macrocarpa* for two months at 0°C gave about four times as many seedlings in one-half the time required by untreated seeds. *Picea canadensis* and *Picea excelsa* preferred treatment at 0°C for two months, after which they attained germinations of 96 and 90 percent, respectively, in 25 days whereas the average controls gave 48 and 53 percents in 26 days. *Picea pungens*, on the other hand, responded equally well to low-temperature treatment at either 0°C or 5°C for one month, germination tests from these conditions showing percentages of 79 and 80 in 16 days with the corresponding check yielding 47 percent in 50 days.

Schraeder (1935) obtained the results that the rate

of Benzoin aestival seedling production and the total percentage were increased when the seeds were subjected to one month 25°, followed by three months at 1°, 5°, or 10°C before planting. Two and three months at 25°C were no more effective. Barton (1935) showed that *Pinus taeda* seeds under sealed, low temperature storage (5°C or -5° to -15°C) retained their seedling-producing power fully for seven years, whereas in open room temperature storage, there was a decided decline in vitality after one year, and only a few seedlings were obtained thereafter. *Pinus caribaea*, *P. echinata*, and *P. resinosa* kept only slightly better in open storage at room temperature and exhibited the same beneficial effects of seedling at low temperatures. *Pinus palustris* lost vitality much more rapidly. Seeds from open storage at room temperature lost this germination power completely in one year. *Pinus ponderosa*, *Picea excelsa*, and *Picea canadensis* stored only in refrigeration rooms with temperatures of -5°C and -15°C kept well for four to six years.

Nelson (1938) concluded also that storage at low temperatures (approximately 30° - 40° F) aids materially in preventing seed deterioration of Southern Pine. Baldwin (1942) obtained that compound stratification (at more than one temperature) was effective for *Tilia Americana* seeds.

However the stratification of cork-oak acorns in moist peat is not advisable (Mirov, 1943). More specifically, it was found by Roe (1946) that the actual germination of untreated seeds in the can was sixty-three percent, while that of stratified seeds was fifty-two percent. The resting condition of the Red cedar embryos can be overcome by stratifying the seeds in flats of moist sand and peat and holding them at a temperature of about 40 degrees for three months (Chadwick, 1946). But germination of Eastern walnut stratified at controlled temperatures was significantly lower than that of nuts plant in the fall or stratified

Table 2.

	First stratification		Second stratification		Author
	Tem.° F.	Time, Days.	Tem.° F.	Time, Days.	
<i>Tilia americana</i>	68	120	41	90-150	Barton (1934)
<i>Tilia americana</i>	32-43	—	50-54	14-18	Rose (1919)

out doors. Heit (1948) proved that prechilling of *platanus acerifolia* seed was not necessary for obtaining complete germination.

The storage temperature 32° to 40° F for cork-oak acorns (Mirov, 1943), 35° to 38° F for Slash pine seeds (Uebersezig, 1947), a period of three months at 5° C for *Juniperus Virginiana* (Barton, 1952), in a desiccator (with CaCl_2) at 0.5° C for Poplar (species not named) (Kopeckzy, 1954), 10° F for *Populus deltoides* (Mc Carnb and Louestead, 1954), increased the germination percentages.

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