Optimum Temperatures for Stratification of Several Maple Species

József Tóth and Peter W. Garrett

Professor, Hevesi Ákos Technical School of Agriculture, Szombathely, Hungary, and principal forest geneticist, USDA Forest Service, Northeastern Forest Experiment Station, Durham, NH

Scarification of pericarps in several species of maple (Acer) provided as good, or better, germination than the use of unscarified seed. In years when seed are not abundant, this treatment should result in greater germination. Time of seed collection is critical with some maples, and the inconsistencies in different years are probably due to maturity of seed at collection. Tree Planters' Notes 40(3): 9-12; 1989.

Maple (*Acer* L.) is one of the genera favored by urban planners, landscape architects, and highway engineers in both North America and Europe. Because they are desirable in their own right, and because of increasing problems with air pollution and diseases of some of the native species, both public and private nurseries in the United States have introduced a number of species from Europe and Asia.

These "new" species bring with them unique problems of seed production, seed handling and storage, and seed germination. Dormancy in maple is regulated by the embryo and/or the pericarp and varies by species. This paper addresses only the effects of temperature during the stratification process on germination and does not look at the type of dormancy involved.

All of this work was carried out in Hungary in cooperation with the Horticultural University in Budapest.

Materials

Seed (samaras) of the following species were studied:

1. Hedge maple (*Acer campestre* L.), native to parts of Europe and western Asia; now cultivated throughout climate zone IV. Grows to 15 to 20 m (50 to 65 feet).
2. Amur maple (*A. ginnala* Maxim), native to China and Japan; was introduced into the United States about 1860 and is cultivated in climate zone II. Small, reaches only about 7 m (23 feet).
3. California boxelder (*A. negundo* var. *californicum* (Torr. & Gr.) Wesm.), widely used as an ornamental and for shelterbelts in the United States and Canada. Hardy and drought tolerant.
4. Japanese maple (*A. palmatum* Thunb.), native to Japan and Korea; introduced about 1820 and grows well in climate zone V. Has a very desirable crown shape and reaches about 8 m (26 feet).
5. Norway maple (*A. platanoides* L.), probably introduced from Europe in the 1700's and widely used as a yard and street tree in the United States. May reach 30 m (100 feet).
6. Sycamore or planetree maple (*A. pseudoplatanus* L.), native of Europe and western Asia, brought into the United States very early (1600 to 1700's); grows best in climate zone V. May reach 30 m (100 feet).

Methods

Half of the seeds of each species had their pericarps scarified and the others were left intact. Seed of each of these treatments, and for each of the six species, were stratified under one of the following temperature regimens:

1. One group of seed was placed outdoors in the soil under ambient conditions. Climatic conditions at the site did not vary from normal during the time of these tests, i.e., temperature and rainfall were near normal.
2. The second group of seed was stratified in moist sand in a growth chamber at temperatures between 1 to 5 °C (34 to 41 °F).

3. The third group of seed was stratified in the chamber at 5 to 10 °C (41 to 50 °F).
4. The final group of seed was stratified at between -5 and -10 °C (14 to 23 °F).

The stratification period started at the beginning of March except for California boxelder, which was started in April. After stratification, four lots of 100 seed from each species and treatment were germinated between sheets of moist filter paper at 23 °C (70 °F) for 21 days in accordance with International Seed Testing Association rules. Germination was scored according to Association guidelines.

Results

In most, but not all, cases scarification of the pericarp as a pretreatment increased germination. Sycamore maple was the notable exception, with germination that was uniformly high except for the coldest stratification treatment (table 1).

Freezing maple seed (treatment 4) of at least these six species during stratification prevented germination completely with both scarified and intact samaras.

Once the pericarp has been opened (scarified), any stratification temperature from 1 °C (34 °F) to ambient field temperatures will produce very high rates of seed germination.

Germination of intact seed (unscarified), which is the way maple seed are usually handled, varies by treatment and by year of seed collection. Some of the seasonal variation is probably due to variation in stage of maturity of seed, which varies from year to year. If seed are collected at the same time each year, and if the maturity of the seed is ignored when collecting, germination can be expected to vary regardless of subsequent treatments.

The variation between the first three treatments in this study is complex and deserves careful attention in nursery operations. Hedge maple and California boxelder had poorer germination with treatment 2 than with treatments 1 or 3. California boxelder produced the best results under ambient conditions, whereas the other species had varying germination responses which, again, could be at least partially explained by condition of seed at time of collection.

For the scarified seed, treatments 1, 2, and 3 are not significantly different except with hedge maple (1982) and Japanese maple (1983, 1984). For intact pericarps there are many differences and no really consistent patterns. For hedge maple (1983, 1984) and all three years for California boxelder, treatments 1 and 3 are better than treatment 2. For Amur maple, treatment 2 looks better. For Japanese maple (1983, 1984) and Norway maple (1981), treatments 1 and 2 look better than treatment 3 but other years do not follow that trend. Treatment 4 yielded little or no germination for any species or year.

Summary

Although we recognized that techniques for mechanical scarification or cracking of pericarps of maple may not be fully developed at this time, the potential of this treatment for improving germination is interesting and may be useful in the future (table 2). Germination of scarified pericarps under field conditions may not equal that obtained under laboratory conditions, but this study did not look at those differences or the reasons for any such dissimilarities.

In every case, scarification of pericarps provided as good, or better, germination than the use of unscarified seed and in many cases these differences were significant. Where seed are not abundant and where percent of germination is important, some seed treatment before attempting germination would be useful.

What this research may show more clearly than anything else is that time of collection may be critical with some species. The inconsistencies observed in different years for both Norway

Table 1—*Percentage germination for 6 species of maples* (Acer) *with scarified and intact pericarps receiving 4 stratification treatments*

Stratification treatment*	% germination†		Stratification treatment*	% germination†	
	Scarified pericarps	Intact pericarps		Scarified pericarps	Intact pericarps
Hedge maple			Japanese maple		
1982			1982		
1	100	20	1	60	35
2	75	40	2	50	0
3	0	0	3	50	0
4	0	0	4	0	0
1983			1983		
1	100	100	1	100	80
2	100	30	2	100	65
3	100	100	3	58	30
4	0	0	4	0	0
1984			1984		
1	100	90	1	76	72
2	78	34	2	70	64
3	100	92	3	48	28
4	0	0	4	0	0
Amur maple			Norway maple		
1982			1981		
1	100	70	1	100	90
2	100	90	2	100	95
3	100	60	3	100	46
4	80	6	4	0	0
1983			1982		
1	100	70	1	85	30
2	100	86	2	95	30
3	100	55	3	100	35
4	70	0	4	0	0
1984			1983		
1	100	74	1	85	30
2	100	86	2	100	100
3	100	54	3	95	20
4	65	3	4	0	0
California boxelder			1984		
1981			1	100	90
1	95	100	2	96	87
2	95	58	3	100	87
3	95	62	4	0	0
4	0	0	Sycamore maple		
1982			1981		
1	100	100	1	100	100
2	100	38	2	100	100
3	100	70	3	100	86
4	0	0	4	0	0
1983			1982		
1	100	96	1	100	25
2	100	38	2	100	20
3	100	65	3	100	66
4	0	0	4	0	0
			1983		
			1	100	100
			2	92	100
			3	100	90
			4	0	0

*Treatment 1 = outdoors in the soil under ambient conditons; 2 = stratified in moist sand in a growth chamber at 1 to 5 °C (34 to 41 °F); 3 = stratified at 5 to 10 °C (41 to 50 °F); 4 = stratified at −5 to 10 °C (14 to 23 °F).

†Four lots of 100 seeds from each species were germinated between sheets of moist filter paper at 23 °C (70 °F).

Table 2—*Recommended stratification treatments for seeds of 6 maple (Acer) species*

Species	Recommended stratification treatment*		Duration of treatment (days)†
	Scarified pericarps	Unscarified pericarps	
Hedge maple	1	1	90
Amur maple	1	2	60–90
California boxelder	1	1	100–130
Japanese maple	1	1	100–130
Norway maple	2	2	100–300
Sycamore maple	1	2	100–120

*Treatment 1 = outdoors in the soil under ambient conditions; 2 = stratified in moist sand in a growth chamber at 1 to 5 °C (34 to 41 °F).
†*Source:* Schopmeyer, C.S. 1974. Seeds of woody plants of the United States. Agric. Handb. 450. Washington, DC: USDA Forest Service.

maple and sycamore maple may be due to maturity of seed at time of collection. Seed of sycamore maple collected in 1982 obviously were not at the same state of maturity as those collected in 1981 or 1983 and would have wasted time and space in a nursery program.

Some of the results of this study are obvious, whereas others are not so clear. One of the problems with this type of work is that species and individual trees ripen seed at different times. Collecting samaras from several trees on the same date will result in seed at various stages of ripeness, which will effect germination. Because climatic conditions influence seed maturity, collecting from the same tree on the same date over several years may result in the different germination rates observed in this study. Nursery managers must be careful not to adhere too closely to a scheduled date of collection and seed orchard managers should develop information on individual genotypes in the orchard to insure proper seed maturity and maximum germination.

Bibliography

1. Bonner, F.T. 1978. Storage of hardwood seeds. Genetic Resourc. Info. No. 7. Rome: FAO: 10-17.
2. Carl, C.M., Jr.; Snow, A.G., Jr. 1971. Maturation of sugar maple seed. Res. Pap. NF-217. Broomall, PA: USDA Forest Service, Northeastern Forest Research Station. 9 pp.
3. Hess, D. 1979. Növényelettan [plant physiology]. In: Natura. Budapest. 457 p.
4. Krüssmann, G. 1964. Die Baumschule [the tree nursery]. Berlin: Parey Press. 635 p.
5. Probocskai, E. 1965. Faiskola [tree nursery]. Mezögazdasági kiadó Budapest. 689 p.
6. Rehder, A. 1954. Manual of cultivated trees and shrubs, 2d ed. New York: Macmillan. 99 p.
7. Schopmeyer, C.S., tech. coord. 1974. Seeds of woody plants in the United States. Ag. Handb. 450. Washington, DC: USDA Forest Service. 883 p.
8. Toth, J. 1983. Erdészetileg fontosabb juhar fajpk magkezelése [seed treatment of important maple species]. Az Erdo 32(4): 182-183.
9. Tóth, J. 1984. A juharok magcsemete nevelése [rearing of maple seedlings]. Master's thesis. Kertészet Egyetem, Budapest. 139 p.