THE USE OF PENTANE TO SEPARATE FILLED AND EMPTY SUGAR MAPLE SAMARAS

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Many sugar maple samaras do not contain seeds; the proportion of filled samaras may vary from 20 to 74 percent among seed trees (Carl and Yawney 1966). Because samaras are relatively large, removal of the empty samaras from seed collections would reduce seed handling and storage space considerably. But the greatest benefit of such separations would take place in the nursery. Sowing time would be reduced, and seedling density-an important factor influencing seedling development (Shipman 1964; Stoeckeler 1950, 1967; Sluder 1964) - could be controlled more precisely.

For several years our attempts to develop a separation procedure were ineffective. Some separation by wind was achieved, but the results were highly variable. And, separations had proved impossible in all liquids tested because sugar maple samaras are bouyant.

McLemore (1965) reported the successful use of n-pentane for separating full and empty longleaf pine seed. So we tried pentane to test separating sugar maple samaras. Pentane did separate filled and empty samaras: empty samaras floated in the pentane; filled samaras quickly sank. Further study was undertaken to determine the degree of separating efficiency, and to determine if pentane affected the viability of sugar maple seed.

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Methods

Seeds were collected from two trees in Burlington, Vt., during the first week of October 1966. The seeds from each tree were kept separate throughout the study.

The separating efficiency of pentane was determined on the basis of five lots of 200 samaras each, from each seed tree. After separation, both groups of samaras-sinkers and floaters-were cut open; and the seeds were counted. The first flotation tests were made 2 days after the seeds were collected; and tests were repeated periodically thereafter as the seeds dried, to determine the moisture level at which significant changes in separation occurred.

The phase of the study dealing with the effects of pentane on viability was designed to establish a safe length of time, if any, that seeds can be immersed. Samaras were first immersed only long enough to permit separation. The samaras separated instantly, but some of the samaras were immersed as long as 30 seconds when a large number was separated. After this initial separation, samples of filled samaras were then soaked for additional periods of 5, 30, and 60 minutes. The soak treatments were applied a few days after the collections were made. Each treatment was replicated five times; each replicate consisted of 50 samaras except for the controls, which had double this number to provide a seed count similar to the other

treatments.

Although normally whole samaras are separated, excised seeds (seeds removed from pericarp but with testa intact) were used in one experiment to impose a severity test. The seeds were excised shortly after collection, and samples were soaked for 1, 5, and 60 minutes. Each treatment was replicated five times and each replicate, including controls, consisted of 50 seeds.

After treatment, the samaras were placed in mesh bags and stored in an unheated building to air dry. The excised seeds were stored in open beakers in a refrigerator held at 2° C. All samples remained under these storage conditions approximately 70 days. Then the germination tests were begun. The germination procedure was similar to the plastic box method described by Carl and Yawney (1966).

Results and Discussion

The moisture content of sugar maple samaras can vary from about 30 to 160 percent (dry weight basis), depending upon when they are. collected. In our study, we found that when the moisture content is above 50 percent, pentane separation of filled and empty samaras is instantaneous and between 95 and 100 percent effective (fig. 1). The results are shown in the separation tests (table 1) .

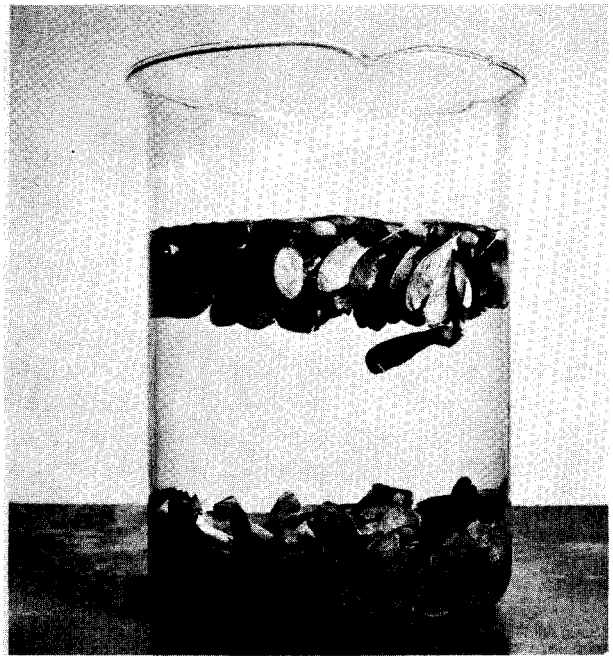

Figure 1.—Example of the separating ability of pentane with sugar maple samaras.

One hundred-percent efficiency was not achieved because seed-eating larvae or frass were present in some samaras, or because of holes in the fruit coats, which caused the unfilled samaras to sink.

When the moisture content of the freshly collected samaras is less than 50 percent, the separating efficiency of the pentane is considerably reduced. Therefore, we recommend that collections be made when the samaras are yellowish green, but before they turn brown. This will ensure mature seeds, and their moisture content is in excess of 50 percent. Separations should be made shortly after collection.

TABLE 1.—*Efficiency of n-pentane for separating sugar maple samaras*[1]

Seed source	Sinkers		Floaters	
	Classified as filled	Containing seeds[2]	Classified as empty	Empty
	Number	*Percent*	*Number*	*Percent*
A	702	96.7	298	100
B	465	96.1	535	100
A and B	1,167	96.5	833	100

[1] Based on five 200 samara samples per seed source.

[2] Sinkers without seed either contained seed-eating larvae or frass or had holes in their fruit coats.

The germination data indicate that soaking either samaras or excised seeds in pentane for periods as long as 1 hour does not harm viability. The average germination percent for each tree and treatment were between 93 and 100 percent for the whole samaras (table 2) and between 98 and 100 percent for the excised seeds (table 3). The rate of germination is given by treatments (figs. 2 and 3). Because of their similarity, germination data for the two trees were combined.

Pentane delays the germination of seed in the samaras about I to 2 weeks (figs. 2 and 3). The delay was not so evident with the excised seeds.

The delay in germination may be caused by dehydration of the embryo by the pentane. Preliminary experiments seem to indicate that pentane has a drying effect on sugar maple fruits. Because pentane is readily absorbed by both the pericarp and the testa, this dehydrating effect may work

TABLE 2.—*Final germination results of sugar maple samaras soaked in pentane for varying periods of time*

Pentane soak period	Seed source		Average
	A	B	
Minutes	*Percent*	*Percent*	*Percent*
0.5[1]	98.0	95.0	96.5
5	99.6	93.4	96.5
30	98.4	94.5	96.4
60	98.8	95.2	97.0
0 (control)	98.5	95.9	97.2

[1] Time required to separate the samaras.

TABLE 3.—*Final germination results of excised sugar maple seeds soaked in pentane for varying periods of time*

Pentane soak period	Seed source		Average
	A	B	
Minutes	*Percent*	*Percent*	*Percent*
1	98.0	100.0	99.0
5	100.0	99.2	99.6
60	99.2	100.0	99.6
0 (control)	98.8	98.8	98.8

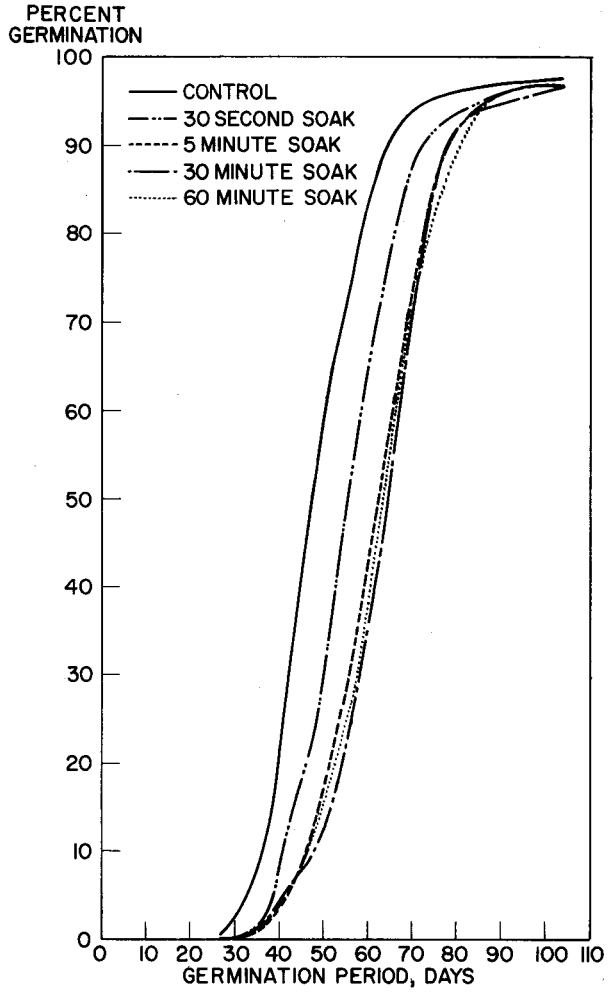

Figure 2.—Germination of sugar maple seeds as affected by soaking whole samaras in n-pentane for periods up to 1 hour.

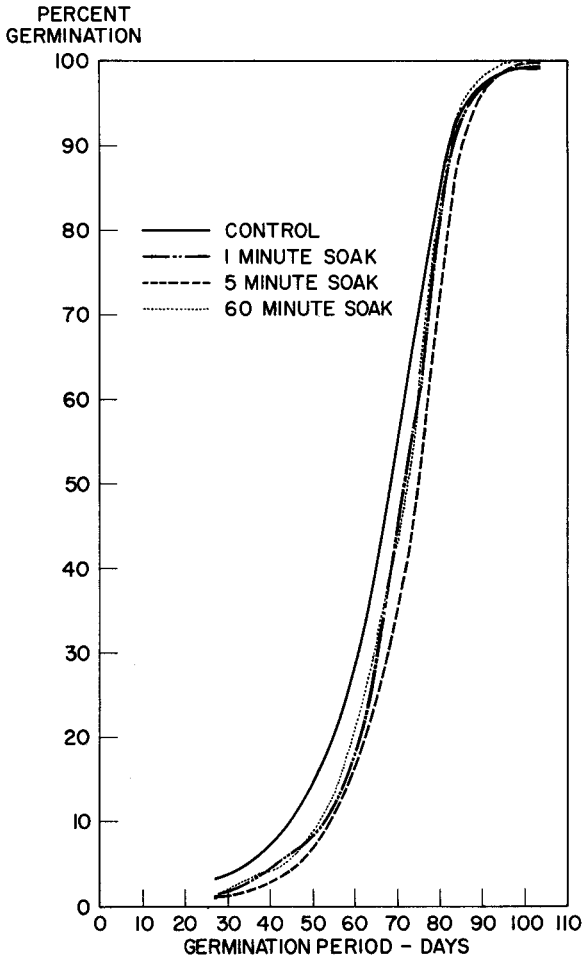

Figure 3—Germination of excised sugar maple seeds as affected by soaking in n-pentane for periods up to 1 hour.

directly on the embryo, as well as on the pericarp. The experiments of Webb and Dumbroff [2] indicate that the water uptake by sugar maple seeds is restricted by the testa. They theorize that the testa may serve as a timer, complementing the metabolic block in the embryo in prolonging dormancy and preventing premature emergence. Their theory would account for the delay in germination of the seeds in the treated samaras because these seeds would have to imbibe more water than the controls.

This theory would further explain why the excised seed, both control and treated, either germinated at the same rate or lagged behind the seeds in the treated samaras (compare figs. 2 and 3). The handling of the excised seeds permitted greater dehydration of the embryos, both treated and controls; hence, more time was required to imbibe water through the testa. However, more intensive study is necessary to determine the cause for the delay.

Summary

Pentane separates filled and empty sugar maple samaras. It is between 95 and 100 percent effective when the moisture content of the samaras to be separated is over 50 percent (dry weight basis). Although soaking in pentane for periods as long as 1 hour does not adversely affect viability, it does delay germination by as much as 2 weeks. The seeds for this study were held for 70 days between treatment and germination, but further experiments are necessary to determine the effects of pentane on sugar maple seeds stored for extended periods.

[2] Webb, D. Paul, and E. B. Dumbroff. Personal communication, 1968.

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